

Bibliography

- Abbott, J. J., Nagy, Z., Beyeler, F., and Nelson, B. J. (2007). Robotics in the small—part I: microrobotics, *IEEE Robot. Autom. Mag.*, **14**, pp. 92–103.
- Acerbi, A., Marocco, D., and Vogt, P. (2008). Social learning in embodied agents, *Connect. Sci.*, **20(2)**, pp. 69–72.
- Acerbi, A., and Nolfi, S. (2007). Social learning and cultural evolution in embodied and situated agents, in *Proceedings of the First IEEE Symposium on Artificial Life (ALIFE '07)* (IEEE Press, Honolulu, HI), pp. 333–340.
- Achilles, T., and Von Kiedrowski, G. (1993). A self-replicating system from three starting materials, *Angew. Chem. Int. Ed. in Engl.*, **32(8)**, pp. 1198–1201.
- Achtelik, M., Bachrach, A., He, R., Prentice, S., and Roy, N. (2009). Autonomous navigation and exploration of a quadrotor helicopter in GPS-denied indoor environments, in *First Symposium on Indoor Flight Issues (AUVSI, Arlington, MA)*, pp. 1–12.
- Adams, P. (1998). Hebb and darwin, *J. Theor. Biol.*, **195(4)**, pp. 419–38.
- Adler, P., and Thovert, J. (1998). Real porous media: local geometry and macroscopic properties, *Appl. Mech. Rev.*, **51**, pp. 537–585.
- Adorni, G., Bonarini, A., Clemente, G., Nardi, D., Pagello, E., and Piaggio, M. (2001). Art'00 - azzurra robot team for the year 2000, in P. Stone, T. Balch, and G. Kraetzschmar (eds.), *RoboCup 2000 - LNAI 2019* (Springer Verlag, Berlin), pp. 559–562.
- Agassounon, W., Martinoli, A., and Easton, K. (2004). Macroscopic modeling of aggregation experiments using embodied agents in teams of constant and time-varying sizes, *Auton. Robot.*, **17(2–3)**, pp. 163–192.
- Agresti, J., Kelly, B., Jaschke, A., and Griffiths, A. (2005). Selection of ribozymes that catalyse multiple-turnover Diels-Alder cycloadditions by using in vitro compartmentalization, *Proceedings of the National Academy of Sciences of the USA*, **102(45)**, pp. 16170–16175.

- Aharoni, A., Amitai, G., Bernath, K., Magdassi, S., and Tawfik, D. (2005). High-throughput screening of enzyme libraries: thiolactonases evolved by fluorescence-activated sorting of single cells in emulsion compartments, *Chem. Biol.*, **12**(12), pp. 1281–1289.
- Ahrens, S., Levine, D., Andrews, G., and How, J. P. (2009). Vision-based guidance and control of a hovering vehicle in unknown, GPS-denied environments, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 3155–3160.
- Al-Shamma'a, A. I., Shaw, A., and Saman, S. (2004). Propagation of electromagnetic waves at MHz frequencies through seawater, *IEEE Trans. Antennas Propag.*, **52**(11), pp. 2843–2849, 10.1109/TAP.2004.834449.
- Alazzawi, L., and Elkateeb, A. (2008). Performance evaluation of the wsn routing protocols scalability, *J. Comp. Sys. Netw. Comm.*, **2008**, pp. 1–9, <http://dx.doi.org/10.1155/2008/481046>.
- Alba, E., and Tomassini, M. (2002). Parallelism and evolutionary algorithms, *IEEE Trans. Evol. Comp.*, **6**(5), pp. 443–462.
- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. (2002). *Molecular Biology of the Cell* (Garland Science).
- Alcocer, A., Oliveira, P., and Pascoal, A. (2006). Underwater acoustic positioning system based on buoys with GPS, in *Proceeding of the European Conference on Underwater Acoustics (ECUA '06)* (Carvoeiro, Portugal).
- Ali, M., Jensen, C. R., Mogensen, V. O., Andersen, M. N., and Henson, I. (1999). Root signalling and osmotic adjustment during intermittent soil drying sustain grain yield of field grown wheat, *Field Crops Res.*, **62**(1), pp. 35–52.
- Alidaee, B., Wang, H., and Landram, F. (2009). A Note on Integer Programming Formulations of the Real-Time Optimal Scheduling and Flight Path Selection of UAVs, *IEEE Trans. Control Sys. Technol.*, **17**(4), pp. 839–843.
- Alissandrakis, A., Nehaniv, C., and Dautenhahn, K. (2002). Imitation with ALICE: learning to imitate corresponding actions across dissimilar embodiments, *IEEE Trans. Sys. Man Cybern. Part A Sys. Humans*, **32**(4), pp. 482–496.
- Alissandrakis, A., Nehaniv, C., and Dautenhahn, K. (2007). Solving the correspondence problem in robotic imitation across embodiments: synchrony, perception and culture in artefacts, in C. Nehaniv, and K. Dautenhahn (eds.), *Imitation and Social Learning in Robots, Humans and Animals* (Cambridge University Press), pp. 249–273.

- Alissandrakis, A., Nehaniv, C. L., and Dautenhahn, K. (2003). Synchrony and perception in robotic imitation across embodiments, in *IEEE Int. Symp. Comput. Intell. Robot. Autom.*, pp. 923–930.
- Allen, M., and Lin, V. (2007). Guidance and control of an autonomous soaring vehicle with flight test results, in *Proceedings of the 45th AIAA Aerospace Sciences Meeting and Exhibit*, pp. 1–26, AIAA paper AIAA-2007–867.
- Allen, T., and Cullis, P. (2004). Drug delivery systems: entering the mainstream, *Science*, **303**, pp. 1818–1822.
- Allen, V., Philp, D., and Spencer, N. (2001). Transfer of stereochemical information in a minimal self-replicating system, *Org. Lett.*, **3(5)**, pp. 777–780.
- Allred, J., Hasan, A. B., Panichsakul, S., Pisano, W., Gray, P., Huang, J., Han, R., Lawrence, D., and Mohseni, K. (2007). SensorFlock: an airborne wireless sensor network of micro-air vehicles, in *Proceedings of the 5th International Conference on Embedded Networked Sensor Systems* (ACM Press), pp. 117–129.
- Alonso, O., Diéguez, A., Casanova, R., Sanuy, A., Scholz, O., Corradi, P., and Samitier, J. (2007). An optical interface for inter-robot communication in a swarm of microrobots, *RoboComm '07: Proceedings of the 1st international Conference on Robot Communication and Coordination*.
- Alper, H., and Stephanopoulos, G. (2009). Engineering for biofuels: exploiting innate microbial capacity or importing biosynthetic potential? *Nat. Rev. Microbiol.*, **7(10)**, pp. 715–723.
- Alterovitz, G., Muso, T., and Ramoni, M. F. (2009). The challenges of informatics in synthetic biology: from biomolecular networks to artificial organisms, *Briefings Bioinf.*, **11(1)**, pp. 80–95.
- Altmann, J., and Veit, D. (eds.) (2007). *Grid Economics and Business Models* (Springer Verlag).
- Altshuler, Y., Yanovsky, V., Wagner, I., and Bruckstein, A. (2008). Efficient cooperative search of smart targets using UAV swarms, *Robotica*, **26(4)**, pp. 551–557.
- Altshuler, Y., Yanovsky, V., Wagner, I. A., and Bruckstein, A. (2005). The cooperative hunters - efficient cooperative search for smart targets using UAV swarms, in *Proceedings of the Second International Conference on Informatics in Control, Automation and Robotics*, pp. 165–170.
- Alvareiz-Ramírez, J. (1993). Using nonlinear saturated feedback to control chaos: Hénon map, *Phys. Rev.*, **E48(6)**, pp. 3165–3167.

- Ambrosino, G., Ariola, M., Ciniglio, U., Corrado, F., Pironti, A., and Virgilio, M. (2006). Algorithms for 3D UAV path generation and tracking, in *Proceedings of the IEEE Conference on Decision and Control (CDC)* (IEEE Press), pp. 5275–5280.
- Ame, J., Rivault, C., and Deneubourg, J. (2004). Cockroach aggregation based on strain odour recognition, *Anim. Behav.*, **68**, pp. 793–801, 10.1016/j.anbehav.2004.01.009.
- Amé, J.-M., Halloy, J., Rivault, C., Detrain, C., and Deneubourg, J. L. (2006). Collegial decision making based on social amplification leads to optimal group formation, *Proceedings of the National Academy of Sciences of the United States of America*, **103(15)**, pp. 5835–5840, <http://www.jstor.org/stable/30050186>.
- Amé, J.-M., Rivault, C., and Deneubourg, J.-L. (2004). Cockroach aggregation based on strain odour recognition, *Anim. Behav.*, **68**, pp. 793–801.
- Ampatzis, C., Tuci, E., Trianni, V., Christensen, A. L., and Dorigo, M. (2009). Evolving self-assembly in autonomous homogeneous robots: experiments with two physical robots, *Artif. Life*, **15(4)**, pp. 465–484.
- Amstutz, P., Correll, N., and Martinoli, A. (2009). Distributed boundary coverage with a team of networked miniature robots using a robust market-based algorithm, *Ann. Math. Artif. Intell. Special issue on Coverage, Exploration, and Search*, **52(2–4)**, pp. 307–333.
- Anderson, B., Bitmead, R., Johnson, C., Kokotovic, P., Kosut, R., Mareels, I., Praly, L., and Riedle, B. (1986). *Stability of Adaptive Systems: Passivity and Averaging Analysis* (MIT Press, Berlin).
- Anderson, B., Fidan, B., Yu, C., and Walle, D. (2008). UAV formation control: theory and application, in *Recent Advances in Learning and Control, Lecture Notes in Control and Information Sciences*, Vol. 371 (Berlin: Springer), pp. 15–33.
- Anderson, C., and McShea, D. W. (2001). Intermediate-level parts in insect societies: adaptive structures that ants build away from the nest, *Insect. Soc.*, **48(4)**, pp. 291–301.
- Anderson, C., and Ratnieks, F. L. W. (1999a). Task partitioning in insect societies. I. effect of colony size on queuing delay and colony ergonomic efficiency, *Am. Nat.*, **154**, pp. 521–535.
- Anderson, C., and Ratnieks, F. L. W. (1999b). Worker allocation in insect societies: coordination of nectar foragers and nectar receivers in honey bee (*Apis mellifera*) colonies, *Behav. Ecol. Sociobiol.*, **46**, pp. 73–81.
- Anderson, C., Theraulaz, G., and Deneubourg, J.-L. (2002). Self-assemblages in insect societies, *Insect. Soc.*, **49(2)**, pp. 99–110.

- Anderson, E. (1978). Performance monitors: a tutorial summary, in *Int. CMG Conference*, pp. 253–254.
- Anderson, J., and Prieve, D. (1991). Diffusiophoresis caused by gradients of strongly adsorbing solutes, *Langmuir*, **7**, pp. 403–406.
- Andrievsky, B. R., and Fradkov, A. L. (2003). Combined adaptive controller for UAV guidance, in *Proceedings of the European Control Conference (ECC)*, pp. 71–79.
- ANGELS (2009–2011). *ANGuliform robot with ELectric Sense* (European Communities).
- Anonymous (2007). Geneticist seeks engineer: must like flies and worms, *Nat. Meth.*, **4**, p. 463.
- ANU (2010). Serafina AUV, <http://serafina.anu.edu.au/>.
- Aoyama, H., Santo, T., Iwata, F., and Sasaki, A. (1997). Pursuit control of micro-robot based on magnetic footstep, in *Proceedings of the International Conference on Micromechatronics for Information and Precision Equipment*, pp. 256–260.
- Appelqvist, P., Halme, A., Schönberg, T., Vainio, M., and Wang, Y. (1997). Designing simple co-operative sensor/actuator robots for liquid process environments, in *Proceedings on the 1st international conference on advanced intelligent mechatronics* (Waseda University, Tokio), pp. 1–6, 1st IEEE international conference on advanced intelligent mechatronics, Tokyo, 1997.
- AquaJelly (2008). *AquaJelly: an autonomously controlled artificial jellyfish* (Festo AG & Co. KG).
- Arbat, A., Edqvist, E., Casanova, R., Brufau, J., Canalis, J., Samitier, J., Johansson, S., and Diéguez, A. (2009). Design and validation of the control circuits for a micro-cantilever tool for a micro-robot, *Sens. Actuators A: Phys.*, **153(1)**, pp. 76–83.
- Arbuckle, D., and Requicha, A. (2004). Active self-assembly, *Proceedings of IEEE International Conference on Robotics and Automation (ICRA 2004)*, **1**, pp. 896–901.
- Arbuckle, D. J., and Requicha, A. A. G. (2010). Self-assembly and self-repair of arbitrary shapes by a swarm of reactive robots: algorithms and simulations, *Auton. Robot.*, **28(2)**, pp. 197–211.
- ARGOS (2010). Argos ocean and weather, <http://www.argos-system.org/html/applications/ocean.en.html>.
- Aristotle (1989). *Metaphysics* (Cambridge, MA, Harvard University Press, London, William Heinemann Ltd., translated by H. Tredennick, G. Cyril Armstrong. 1933).

- Arkin, R. (1998a). *Behavior-Based Robotics* (The MIT Press).
- Arkin, R. C. (1998b). *Behavior-Based Robotics*, chapter 9: Social Behavior (MIT Press, Cambridge, MA).
- Arkin, R. C., Balch, T., and Nitz, E. (1993). Communication of behavioral state in multi-agent retrieval tasks, in *Proceedings of the 1993 International Conference on Robotics and Automation*, pp. 588–594.
- Armengol, E., and Plaza, E. (2001a). Lazy induction of descriptions for relational case-based learning, in P. F. L. De Raedt (ed.), *Machine Learning: EMCL 2001*, Lecture Notes in Artificial Intelligence (Springer Verlag), pp. 13–24.
- Armengol, E., and Plaza, E. (2001b). Similarity assessment for relational CBR, in *Case-based reasoning research and development: IC-CBR 2001*, Lecture Notes in Artificial Intelligence (Springer Verlag), pp. 44–58.
- Arnold, V. (1983). *Geometrical methods in the theory of ordinary differential equations* (Springer Verlag, Berlin).
- Artieda, J., Sebastián, J. M., Campoy, P., Correa, J. F., Mondragón, I. F., Martínez, C., and Olivares, M. (2009). Visual 3-D SLAM from UAVs, *J. Intell. Robot. Sys.*, **55**(4–5), pp. 299–321.
- Arvind, D. K. (2004). Speckled computing, in *In Proceedings of the Workshop on Wireless Sensor Networks, invited talk*.
- Asada, M., Hosoda, K., Kuniyoshi, Y., Ishiguro, H., Inui, T., Yoshikawa, Y., Ogino, M., and Yoshida, C. (2009). Cognitive developmental robotics: a survey, *IEEE Trans. Auton. Ment. Dev.*, **1**(1), pp. 12–34.
- Asada, M., Kitano, H., Noda, I., and Veloso, M. (1999). Robocup: today and tomorrow—what we have learned, *Artif. Intell.*, **110**(2), pp. 193–214.
- Asadpour, M., F. Tache, Caprari, G., Karlen, W., and Siegwart, R. (2006). Robot-animal interaction: Perception and behavior of insbot, *Int. Journal of Advanced Robotics Systems*, **3**, pp. 93–98.
- Ashby, W. (1958). Requisite variety and its implications for the control of complex systems, *Cybernetica*, **1**, pp. 83–99.
- Ashby, W. R. (1960). *Design for a brain: the origin of adaptive behavior* (New York, Wiley).
- Astor, J. C., and Adami, C. (2000). A developmental model for the evolution of artificial neural networks, *Artif. Life*, **6**(3), pp. 189–218, <http://dx.doi.org/10.1162/106454600568834>.
- Astrom, K. (1987). Adaptive feedback control, *Proceedings of the IEEE*, **75**(2), pp. 185–217.

- Åström, K. J. (1980). Design principles for self-tuning regulators, in *Methods and Applications in Adaptive Control*, no. 24 in Lecture Notes in Control and Information Sciences (Berlin: Springer Verlag), pp. 1–20.
- Ataka, M., Omodaka, A., Takeshima, N., and Fujita, H. (1993). Fabrication and operation of polyimide bimorph actuators for a ciliary motion system, *IEEE J. MEMS*, **2(4)**, pp. 146–150.
- Atkins, E. M., Durfee, E. H., and Shin, K. G. (1997). Detecting and reacting to unplanned-for world states, in *Proceedings of the 14th National Conference on Artificial Intelligence (AAAI)*, pp. 571–576.
- Atkinson, S., and Williams, P. (2009). Quorum sensing and social networking in the microbial world. *J. R. Soc. Interface*, **6(40)**, pp. 959–78.
- Attarzadeh, A. (2006). *Development of advanced power management for autonomous micro-robots* Master's Thesis, University of Stuttgart, Germany.
- Aunger, R. (2002). *The Electric Meme: A New Theory of How We Think* (New York, The Free Press).
- Avstreich, A. (1981). The emerging self: psychoanalytic concepts of self development and their implications for dance therapy, *Am. J. Dance Therapy*, **4(2)**, pp. 21–32.
- Baas, N. (1994). Emergence, hierarchies, and hyperstructures, in C. Langton (ed.), *Artificial Life III* (Addison-Wesley), pp. 515–537.
- Babaoglu, O., Jelasity, M., Montresor, A., Fetzer, C., Leonardi, S., Moorsel, A. v., and Steen, M. v. (2005). *Self-star Properties in Complex Information Systems: Conceptual and Practical Foundations (Lecture Notes in Computer Science)* (New York: Springer Verlag).
- Babin, M., and Stramski, D. (2002). Light absorption by aquatic particles in the near-infrared spectral region, *Limnol. Oceanogr.*, **47(3)**, pp. 911–915.
- Bachmann, R. J., Boria, F. J., Ifju, P., Quinn, R., Kline, J. E., and Vaidyanathan, R. (2005). Utility of a sensor platform capable of aerial and terrestrial locomotion, in *Proceedings of the IEEE/ASME International Conference on Advanced Intelligent Mechatronics* (IEEE Press), pp. 1581–1586.
- Bachmann PA, L. J., Luisi PL (1992). Autocatalytic self-replicating micelles as models for prebiotic structures. *Nature*, **357**, pp. 57–59.
- Back, R. J. R., and Kurki-Suonio, F. (1988). Distributed cooperation with action systems, *ACM Trans. Program. Lang. Syst.*, **10(4)**, pp. 513–554, <http://doi.acm.org/10.1145/48022.48023>.
- Back, R. J. R., and Sere, K. (1991). Stepwise refinement of action systems, *Structured Programming*, **12**, pp. 17–30.

- Bäck, T. (2001). Introduction to the special issue: Self-adaptation, *Evol. Comput.*, **9(2)**, pp. 3–4, <http://dx.doi.org/10.1162/106365601750190361>.
- Bacon, M. A., Davies, W. J., Mingo, D., and Wilkinson, S. (2002). *Root Signals*, chapter 28, third edit edn. (Marcel Dekker, New York), pp. 461–470.
- Baele, G., Bredeche, N., Haasdijk, E., Maere, S., Michiels, N., Van de Peer, Y., Schmickl, T., Schwarzer, C., and Thenius, R. (2009). Open-ended on-board evolutionary robotics for robot swarms, in A. Tyrrell (ed.), *Proceedings of the IEEE Congress on Evolutionary Computation (IEEE CEC-09)* (Trondheim, Norway: IEEE Press).
- Bag, B., and von Kiedrowski, G. (1996). Templates, autocatalysis and molecular replication, *Pure Appl. Chem.*, **68(11)**, pp. 2145–2152.
- Baglio, S., Castorina, S., Fortuna, L., and Savalli, N. (2002a). Development of autonomous, mobile micro-electro-mechanical devices, in *Proceedings of the IEEE International Symposium on Circuits and Systems*, Vol. IV, pp. 285–288.
- Baglio, S., Castorina, S., Fortuna, L., and Savalli, N. (2002b). Technologies and architectures for autonomous “mems” microrobots, in *Proceedings of the IEEE International Symposium on Circuits and Systems*, Vol. II, pp. 584–587.
- Bahl, P., and Padmanabhan, V. (2000). RADAR: an in-building RF-based user location and tracking system. in *IEEE Infocom*, Vol. 2, pp. 775–784.
- Bahr, A. (2009). *Cooperative Localization for Autonomous Underwater Vehicles*, Ph.D. thesis, Massachusetts Institute of Technology.
- Bahr, A., and Leonard, J. J. (2008). Cooperative localization for autonomous underwater vehicles, *Exp. Rob.*, **39**, pp. 387–395, 10.1007/978-3-540-77457-0_35.
- Bahr, A., Walter, M. R., and Leonard, J. J. (2009). Consistent cooperative localization, in *Int. Conference Robot. Autom. (ICRA)*.
- Bailey, T., and Durrant-Whyte, H. (2006). Simultaneous localization and mapping (SLAM): part II, *IEEE Robot. Autom. Mag.*, **13(3)**, pp. 108–117.
- Balanis, C. A. (1997). *Fundamental Parameters of Antennas*, Vol. Second Edition (John Wiley & Sons), pp. 28–53.
- Balch, T., and Arkin, R. C. (1994). Communication in reactive multiagent robotic systems, *Auton. Robot.*, **1**, pp. 1–25.
- Balch, T., and Hybinette, M. (2000). Behavior-based coordination of large-scale robot formations, in *ICMAS '00: Proceedings of the Fourth International Conference on MultiAgent Systems (ICMAS-2000)* (IEEE Computer Society, Washington, DC, USA), ISBN 0-7695-0625-9, p. 363.

- Baldassarre, G., Nolfi, S., and Parisi, D. (2003). Evolving mobile robots able to display collective behaviour, *Artif. Life*, **9**(3), pp. 255–267.
- Baldassarre, G., Parisi, D., and Nolfi, S. (2006). Distributed coordination of simulated robots based on self-organization, *Artif. Life*, **12**(3), pp. 289–311.
- Baldassarre, G., Trianni, V., Bonani, M., Mondada, F., Dorigo, M., and Nolfi, S. (2007). Self-organised coordinated motion in groups of physically connected robots, *IEEE Trans. Sys. Man Cybern. Part B Cybern.*, **37**(1), pp. 224–239.
- Bales, J. W., and Chryssostomidis, C. (1995). High bandwidth, low-power, short-range optical communication underwater, in *Proceedings of the International Symposium on Unmanned Untethered Submersible Technology* (Durham, NH, USA).
- Baltes, J., Lagoudakis, M., Naruse, T., and Shiry, S. (eds.) (2010). *RoboCup 2009: Robot Soccer World Cup XIII, Lecture Notes in Artificial Intelligence*, Vol. 5949 (Berlin: Springer Verlag), ISBN 978-3-642-11875-3.
- Baluška, F., Mancuso, S., Volkmann, D., Barlow, P. W., and Barlow, P. W. (2004). Root apices as plant command centres: the unique brain-like status of the root apex transition zone, *Biologia*, **59**, Suppl. 13, pp. 1–13.
- Balzani, V., Venturi, M., and Credi, A. (2003). *Molecular Devices and Machines. A Journey into the Nanoworld* (Wiley-VCH, Weinheim, Germany).
- Bar-Yam, Y. (2004). A mathematical theory of strong emergence using multiscale variety, *Complexity Int.*, **9**(6), pp. 15–24, <http://dx.doi.org/10.1002/cplx.20029>.
- Bar-Yehuda, R., Goldreich, O., and Itai, A. (1992). On the time-complexity of broadcast in multi-hop radio networks: an exponential gap between determinism and randomization, *J. Comp. Sys. Sci.*, **45**(1), pp. 104–126, 10.1016/0022-0000(92)90042-H.
- Barabási, A.-L., and Albert, R. (1999). Emergence of scaling in random networks, *Science*, **286**, pp. 509–512.
- Barrenetxea, G., Ingelrest, F., Schaefer, G., Vetterli, M., Couach, O., and Parlange, M. (2008). Sensorscope: out-of-the-box environmental monitoring, *Information Processing in Sensor Networks, 2008. IPSN '08. International Conference on*, pp. 332–343.
- Basset, P., Kaiser, A., Stefanelli, B., Walenne, M., Collard, D., and Buchaillot, L. (2003). A 100 v-ic for the remote powering and control of a microrobot using an electrostatic ciliary motion system, *Transducers*, **2**, pp. 1711–1713.

- Basso, M., Evangelisti, A., Genesio, R., and Tesi, A. (1998). On bifurcation control in time delay feedback systems, *Int. J. Bifurcation and Chaos*, **8(4)**, pp. 713–721.
- Basu, P., Redi, J., and Shurbanov, V. (2004). Coordinated flocking of UAVs for improved connectivity of mobile ground nodes, in *Proceedings of the IEEE Military Communications Conference*, Vol. 3 (IEEE Press), pp. 1628–1634.
- Batchelor, G. (1967). *Introduction to Fluid Dynamics* (Cambridge University Press, Cambridge).
- Beard, R., Kingston, D., Quigley, M., Snyder, D., Christiansen, R., and Johnson, W. (2005). Autonomous vehicle technologies for small fixed-wing UAVs, *J. Aerospace Comp. Inform. Comm.*, **2(1)**, pp. 92–108.
- Beard, R. W., Mclain, T. W., Nelson, D. B., Kingston, D., and Johanson, D. (2006). Decentralized cooperative aerial surveillance using fixed-wing miniature UAVs, *Proceedings of the IEEE*, **94(7)**, pp. 1306–1324.
- Becker, R. A., Chambers, J. M., and Wilks, A. R. (1988). *The new S language. A programming environment for data analysis and graphics* (Chapman & Hall, London).
- Beckers, R., Holland, O., and Deneubourg, J.-L. (1994a). From local actions to global tasks: stigmergy and collective robotics, in R. Brooks, and P. Maes (eds.), *Proceedings of the Fourth Workshop on Artificial Life*, pp. 181–189.
- Beckers, R., Holland, O. E., and Deneubourg, J.-L. (1994b). From local actions to global tasks: stigmergy and collective robotics, *Artif. Life*, **4**, pp. 181–189.
- Bedau, M., Hansen, P. G., and Parke, E. (2010). *Living Technology: 5 Questions* (Automatic Press / VIP).
- Bedau, M. A. (2002). Downward causation and the autonomy of weak emergence, *Principia*, **6(1)**, pp. 5–50.
- Beer, R. (1990). *Intelligence as Adaptive Behaviour: An Experiment in Computational Neuroethology* (Academic Press).
- Beer, R. D. (1995). A dynamical systems perspective on agent-environment interaction, *Art. Intell.*, **72**, pp. 173–215.
- Beer, R. D., and Gallagher, J. C. (1992). Evolving dynamical neural networks for adaptive behavior, *Adapt. Behav.*, **1**, pp. 91–122.
- Begon, M., Townsend, C. R., and Harper, J. L. (2006). *Ecology: from individuals to ecosystems* (Malden, MA : Blackwell Pub.).
- Behkam, B., and Sitti, M. (2006). Towards hybrid swimming microrobots: Bacteria assisted propulsion of polystyrene beads, *Proceedings of the 28th IEEE (EMBS Annual International Conference)*, pp. 2421–2424.

- Belew, R., McInerney, J., and Schraudolph, N. (1990). Evolving networks: using the genetic algorithm with connectionist learning, in C. L. *et al.* (ed.), *Proceedings of the Second Conference on Artificial Life* (Addison-Wesley, Reading, MA), pp. 511–547.
- Belew, R., and Mitchell, M. (1996). *Adaptive Individuals in Evolving Populations: Models and Algorithms* (Addison-Wesley).
- Bell, D. J., Leutenegger, S., Dong, L. X., and Nelson, B. J. (2007). Flagella-like propulsion for microrobots using a magnetic nanocoil and rotating electromagnetic field, in *Proceedings of the 2007 IEEE International Conference on Robotics and Automation (ICRA)*.
- Bellew, C. L., Hollar, S., and Pister, K. S. J. (2003). An SOI process for fabrication of solar cells, transistors and electrostatic actuators, *Transducers*, **2**, pp. 1075–1079.
- Bellingham, J. G., and Rajan, K. (2007). Robotics in remote and hostile environments, *Science*, **318**, pp. 1098–1102, 10.1126/science.1146230.
- Benecke, W. R. (1988). Thermally excited silicon microactuators, *IEEE Trans. Electron. Devices*, **35(6)**, pp. 758–763.
- Beni, G. (2005). From swarm intelligence to swarm robotics, in E. Şahin and W. M. Spears (eds.), *Swarm Robotics—SAB 2004 International Workshop*, volume 3342 of *LNCS* (Springer Verlag, Berlin), pp. 1–9.
- Beni, G., and Wang, J. (1989). Swarm intelligence, in *Proceedings of the 7th Annual Meeting of the Robotic Society of Japan*, pp. 425–428.
- Beni, G., and Wang, J. (2005). Swarm intelligence in cellular robotic systems, in *Proceedings of the NATO Advanced Workshop on Robots and Biological Systems*.
- Bergbreiter, S., and Pister, K. (2007). Design of an autonomous jumping microrobot, *Robotics and Automation, 2007 IEEE International Conference on*, pp. 447–453.
- Berglund, N., and Gentz, B. (2006). *Noise-Induced Phenomena in Slow-Fast Dynamical Systems. A Sample-Paths Approach* (Springer Verlag, London).
- Bermudez i Badia, S., Pyk, P., and Verschure, P. (2005). A biologically based flight control system for a blimp-based UAV, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 3053–3059.
- Bernath, K., Magdassi, S., and Tawfik, D. (2005). Directed evolution of protein inhibitors of DNA-nucleases by in vitro compartmentalization (IVC) and nano-droplet delivery, *J. Mol. Biol.*, **345(5)**, pp. 1015–1026.
- Berne, M., and Pogorel, G. (2003). Challenges for Wi-Fi, business models and spectrum issues, *Ann. Telecommun.*, **58(3–4)**, pp. 576–583.

- Berns, A., and Ghosh, S. (2009). Dissecting self-* properties, *Self-Adaptive and Self-Organizing Systems, International Conference on*, **0**, pp. 10–19, <http://doi.ieeecomputersociety.org/10.1109/SASO.2009.25>.
- Berntson, G. M. (1994). Modelling root architecture: are there tradeoffs between efficiency and potential of resource acquisition? *New Phytol.*, **127**, pp. 483–493.
- Berry, G., and Boudol, G. (1992). The chemical abstract machine, in *Selected papers of the Second Workshop on Concurrency and compositionality* (Elsevier Science Publishers Ltd., Essex, UK), pp. 217–248, [http://dx.doi.org/10.1016/0304-3975\(92\)90185-1](http://dx.doi.org/10.1016/0304-3975(92)90185-1).
- Bertelle, C., Flouret, M., Jay, V., Olivier, D., and Ponty, J.-L. (2001). Automata with multiplicities as behaviour model in multi-agent simulations, in *Proceeding of SCI'2001* (Orlando, Florida, USA).
- Bertschinger, J., and Neri, D. (2004). Covalent DNA display as a novel tool for directed evolution of proteins in vitro, *Protein Engineering, Design and Selection*, **17(9)**, pp. 699–707.
- Bertuccelli, L., Alighanbari, M., and How, J. (2004). Robust planning for coupled cooperative UAV missions, in *Proceedings of the IEEE Conference on Decision and Control*, Vol. 17 (IEEE Press), pp. 2917–2922.
- Best, M. (1999). How culture can guide evolution: an inquiry into gene/meme enhancement and opposition, *Adapt. Behav.*, **7**, 3–4, p. 289.
- Betancor, L., and Luckarift, H. (2008). Bioinspired enzyme encapsulation for biocatalysis, *Trends Biotechnol.*, **26**, pp. 566–572.
- Beyeler, A., Zufferey, J.-C., and Floreano, D. (2009). Vision-based control of near-obstacle flight, *Auton. Robot.*, **27(3)**, pp. 201–219.
- Beyer, H.-G. (1995). Toward a theory of evolution strategies: Self-adaptation, *Evol. Comput.*, **3(3)**, pp. 311–347, <http://dx.doi.org/10.1162/evco.1995.3.3.311>.
- Bhadauria, D., and Isler, V. (2009). Data gathering tours for mobile robots, in *Proceedings of the International Conference on Intelligent Robots and Systems (IROS)* (St. Louis, MO, USA).
- Bhatta, P., Fiorelli, E., Lekien, F., Leonard, N. E., Paley, D. A., Zhang, F., Bachmayer, R., Davis, R. E., Fratantoni, D. M., and Sepulchre, R. (2005). Coordination of an underwater glider fleet for adaptive ocean sampling, in *Proceedings of the International Workshop on Underwater Robotics* (Genoa, Italy).
- Bianco, R., and Nolfi, S. (2004). Toward open-ended evolutionary robotics: evolving elementary robotic units able to self-assemble and self-reproduce, *Connect. Sci.*, **4**, pp. 227–248.

- Biedrzycki, M., Jilany, T., Dudley, S., and Bais, H. (2010). Root exudates mediate kin recognition in plants, *Commun. Integrat. Biol.*, **3**, pp. 1–8.
- Billard, A., and Hayes, G. (1999). DRAMA, a connectionist architecture for control and learning in autonomous robots, *Adapt. Behav.*, **7(1)**, pp. 35–63.
- Binns, L. A., Valachis, D., Anderson, S., Gough, D. W., Nicholson, D., and Greenway, P. (2002). Distributed SLAM, in *Signal Processing, Sensor Fusion, and Target Recognition XI, SPIE proceedings series*, Vol. 4729 (SPIE), pp. 62–68.
- Birman, J. (2004). Braids, knots and contact structures, <http://www.citebase.org/abstract?id=oai:arXiv.org:math/0403489>.
- Bishop, J., Burden, S., Klavins, E., Kreisberg, R., Malone, W., Napp, N., and Nguyen, T. (2005a). Programmable parts: a demonstration of the grammatical approach to self-organization, *Intelligent Robots and Systems, 2005. (IROS 2005). 2005 IEEE/RSJ International Conference on*, pp. 3684–3691.
- Bishop, J., Burden, S., Klavins, E., Kreisberg, R., Malone, W., Napp, N., and Nguyen, T. (2005b). Self-organizing programmable parts, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*.
- Blackmore, S. (1999). *The Meme Machine* (Oxford University Press).
- Blakemore, R. (1975). Magnetotactic bacteria, *Science*, **190**, pp. 377–379.
- Blitz, D. (1992). *Emergent evolution: qualitative novelty and the levels of reality* (Dordrecht; Boston: Kluwer).
- Blow, M. (2005). Stigmergy: biologically-inspired robotic art, in *Proceedings of the Symposium on Robotics, Mechatronics and Animatronics in the Creative and Entertainment Industries and Arts* (The Society for the Study of Artificial Intelligence and the Simulation of Behaviour).
- Blum, C. (2005). Ant colony optimization: introduction and recent trends, *Phys. Life Rev.*, **2(4)**, pp. 353–373.
- Bodi, M., Thenius, R., Schmickl, T., and Crailsheim, K. (2009). Robustness of two interacting robot swarms using the BEECLUST algorithm, in I. Troch and F. Breitenecker (eds.), *MATHMOD 2009 - 6th Vienna International Conference on Mathematical Modelling*.
- Bojinov, H., Casal, A., and Hogg, T. (2002). Multiagent control of self-reconfigurable robots, *Artif. Intell.*, **142(2)**, pp. 99–120.
- Boletis, A., Driesen, W., Breguet, J.-M., and Brunete, A. (2006). Solar cell powering with integrated global positioning system for mm3 size

- robots, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS-06)* (IEEE, Beijing, China), pp. 5528–5533.
- Bonabeau, E. (1999). Editor's introduction: stigmergy, *Artif. Life*, **5(2)**, pp. 95–96. Special issue on stigmergy.
- Bonabeau, E. (2002). Agent-based modeling: methods and techniques for simulating human systems, *Proceedings of the National Academy of Sciences*, **99**, pp. 7280–7287.
- Bonabeau, E., Dorigo, M., and Theraulaz, G. (1999). *Swarm Intelligence: From Natural to Artificial Systems* (Oxford University Press).
- Bonabeau, E., Theraulaz, C., and Deneubourg, J.-L. (1996). Quantitative study of the fixed threshold model for the regulation of division of labor in insect societies, *Proceedings of the Royal Society of London, Series B Biological Sciences*, **263**, pp. 1565–1569.
- Bonabeau, E., Theraulaz, G., and Deneubourg, J.-L. (1998). Fixed response thresholds and the regulation of division of labour in insect societies, *Bull. Math. Biol.*, **60**, pp. 753–807.
- Bonani, M., Longchamp, V., Magnenat, S., Rétornaz, P., Burnier, D., Roulet, G., Vaussard, F., Bleuler, H., and Mondada, F. (2010). The marXbot, a miniature mobile robot opening new perspectives for the collective-robotic research, in *IEEE/RSJ 2010 International Conference on Intelligent Robots and Systems (IROS 2010)*.
- Bonarini, A. (2010). airwiki.ws.dei.polimi.it/index.php/Robogames.
- Bonarini, A., Aliverti, P., and Lucioni, M. (2000). An omnidirectional vision sensor for fast tracking for mobile robots, *IEEE Transactions on Instrumentation and Measuring*, **49(3)**, pp. 509–512.
- Bonarini, A., Lazaric, A., Restelli, M., and Vitali, P. (2006). Self-development framework for reinforcement learning agents, in *Proceedings of the 5th International Conference on Development and Learning (ICDL06)* (Bloomington, USA).
- Bonarini, A., and Matteucci, M. (2000). Learning context motivation in coordinated behaviors, in *Proceedings of Intelligent Autonomous Systems 6 (IAS-6)* (IOS Press, Amsterdam, NL), pp. 519–526.
- Bonarini, A., Matteucci, M., and M. Restelli (2004). A model to manage data reliability in behavior-based robotics, in *Proceedings of IAV 2004, 5th IFAC Symposium on Intelligent Autonomous Vehicles* (Elsevier, Amsterdam, NL).
- Bonarini, A., Matteucci, M., and Restelli, M. (2007a). Mrt: robotics off-the-shelf with the modular robotic toolkit, in B. D. (ed.), *Software*

- Engineering for Experimental Robotics, Springer Tracts in Advanced Robotics*, Vol. 30 (Berlin: Springer Verlag), pp. 345–364.
- Bonarini, A., Matteucci, M., and Restelli, M. (2007b). Problems and solutions for anchoring in multi-robot applications, *J. Intell. Fuzzy Sys.*, **18(3)**, pp. 245–254.
- Boncheva, M., Bruzewicz, D., and Whitesides, G. (2003). Millimeter-scale self-assembly and its applications, *Pure Appl. Chem.*, **75(5)**, pp. 621–630.
- Bondi, A. (2000). Characteristics of scalability and their impact on performance, in *Proceedings of the Second International Workshop on Software and Performance* (ACM Press), ISBN 1-58113-195-X, pp. 195–203, <http://doi.acm.org/10.1145/350391.350432>.
- Bongard, J. C. (2000). The legion system: a novel approach to evolving heterogeneity for collective problem solving, in R. Poli, W. Banzhaf, W. Langdon, K. Miller, P. Nordin, and T. Fogarty (eds.), *Genetic Programming* (Springer Verlag, Berlin, Germany), pp. 25–37.
- Bonvilain, A., and Chaillet, N. (2003). Microfabricated thermally actuated microrobot, in *Proceedings of the IEEE International Conference on Robotics and Automation*, pp. 2960–2965.
- Boonma, P., and Suzuki, J. (2008). Exploring self-star properties in cognitive sensor networking, in *Performance Evaluation of Computer and Telecommunication Systems, 2008. SPECTS 2008. International Symposium on*, pp. 36–43.
- Borde, J., Teston, F., Santandrea, S., and Boulade, S. (2004). Feasibility of the Proba 3 formation flying demonstration mission as a pair of microsats in GTO, in *Small Satellites, Systems and Services*, Vol. 571, p. 12.
- Boross, G., Orosz, K., and Farkas, I. (2009). Human microRNAs co-silence in well-separated groups and have different predicted essentialities, *Bioinformatics*, **25**, pp. 1063–1069.
- Botterhuis, N., Sun, Q., Magusin, P., van Santen, R., and Sommerdijk, N. (2006). Hollow silica spheres with an ordered pore structure and their application in controlled release studies, *Chemistry*, **12**, pp. 1448–1456.
- Bouabdallah, S., Murrieri, P., and Siegwart, R. (2005). Towards autonomous indoor micro VTOL, *Auton. Robot.*, **18(2)**, pp. 171–183.
- Bouabdallah, S., and Siegwart, R. (2007). *Advances in Unmanned Aerial Vehicles*, chapter Design and Control of a Miniature Quadrotor (Springer Press), pp. 171–210.
- Bowling, M., and Veloso, M. (2002). Multiagent learning using a variable learning rate, *Artif. Intell.*, **136**, pp. 215–250.

- Bowling, M., and Veloso, M. (2003). Simultaneous adversarial multi-robot learning, in *IJCAI'03: Proceedings of the 18th international joint conference on Artificial intelligence* (Morgan Kaufmann Publishers Inc., San Francisco, CA, USA), pp. 699–704.
- Braitenberg, V. (1986). *Vehicles: Experiments in Synthetic Psychology* (The MIT Press, Cambridge, MA).
- Brandt, D. (2006). Comparison of a* and rrt-connect motion planning techniques for self-reconfiguration planning, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (Beijing, China).
- Branicky, M., Borkar, V., and Mitter, S. (1998). A unified framework for hybrid control: model and optimal control theory, *IEEE Trans. Autom. Control*, **43(1)**, pp. 31–45.
- Branke, J., and Schmeck, H. (2008). Evolutionary design of emergent behavior, in R. Würtz (ed.), *Org. Comput.* (Springer), pp. 123–140.
- Branson, K., Robie, A. A., Bender, J., Perona, P., and Dickinson, M. H. (2009). High-throughput ethomics in large groups of drosophila, *Nat. Meth.*, **6(6)**, pp. 451–457, <http://dx.doi.org/10.1038/nmeth.1328>.
- Brauth, S. E., Hall, W. S., and Dooling, R. J. (1991). *Plast. Dev.* (The MIT Press).
- Bray, D. (2001). *Cell Movements: From Molecules to Mobility* (Garland Science).
- Breguet, J.-M., and Renaud, P. (1996). A 4 degrees-of-freedom microrobot with nanometer resolution, *Robotics*, **43**, pp. 199–203.
- Breguet, J.-M., Schmitt, C., and Clavel, R. (2000). Micro/nanofactory: Concept and state of the art, in *Proc. SPIE: Microrobotics and Microassembly*, Vol. 4194, pp. 1–12.
- Breivik, J. (2001). Self-organization of template-replicating polymers and the spontaneous rise of genetic information, *Entropy*, **3(4)**, pp. 273–279.
- Brener, N., Ben Amar, F., and Bidaud, P. (2008). Designing modular lattice systems with chiral space groups, *Int. J. Rob. Res.*, **27(3–4)**, pp. 279–297, <http://dx.doi.org/10.1177/0278364908089349>.
- Breyer, J., Ackermann, J., and McCaskill, J. (1997). Evolving reaction-diffusion ecosystems with self-assembling structures in thin films, *Artif. Life*, **4(1)**, pp. 25–40, <http://dx.doi.org/10.1162/106454698568422>.
- Brisset, P., Drouin, A., Gorraz, M., Huard, P.-S., and Tyler, J. (2006). The Papparazzi Solution, in *Proceedings of the 2nd Micro Air Vehicle Conference and Competition (EMAV'06)* (Braunschweig, Germany).

- Brisset, P., and Hattenberger, G. (2008). Multi-UAV control with the paparazzi system, in *Proceedings of the first conference on Humans Operating Unmanned Systems*.
- Brooks, R. A. (1986). A robust layered control system for a mobile robot, *IEEE J. Robot. Automat.*, **RA-2(1)**, pp. 14–23.
- Brooks, R. A., and Flynn, A. M. (1989). Fast, cheap and out of control: a robot invasion of the solar system, *J. Brit. Inter. Soc.*, **42**, pp. 478–485.
- Bruce, M., McConnell, I., Fraser, H., and Dickinson, A. (1991). The disease characteristics of different strains of scrapie in sinc congenic mouse lines: implications for the nature of the agent and host control of pathogenesis, *J. Gen. Virol.*, **72**, pp. 595–603.
- Brukman, O., and Dolev, S. (2008). Self-* programming: runtime parallel control search for reflection box, *Self-Adaptive and Self-Organizing Systems, International Conference on*, **0**, pp. 481–482, <http://doi.ieeecomputersociety.org/10.1109/SASO.2008.48>.
- Bryson, M., and Sukkarieh, S. (2007). Co-operative localisation and mapping for multiple UAVs in unknown environments, in *Proceedings of the Aerospace Conference (IEEE Press)*, pp. 1–12.
- Bryson, M., and Sukkarieh, S. (2009). Architectures for cooperative airborne simultaneous localisation and mapping, *J. Intell. Robot. Sys.*, **55(4-5)**, pp. 267–297.
- Bull, L., Studley, M., Bagnall, A., and Whitley, I. (2007). Learning Classifier System Ensembles With Rule-Sharing, *IEEE Trans. Evol. Comput.*, **11(4)**, pp. 496–502.
- Buresch, T., Eiben, A. E., Nitschke, G., and Schut, M. (2005). Effects of evolutionary and lifetime learning on minds and bodies in an artificial society, in D. Corne, Z. Michalewicz, B. McKay, A. E. Eiben, D. Fogel, C. Fonseca, G. Greenwood, G. Raidl, K. Tan, and A. Zalzala (eds.), *Proceedings of the IEEE Congress on Evolutionary Computation (CEC 2005)* (IEEE Press), pp. 1448–1454.
- Bushev, M. (1994). *Synergetics: chaos, order, self-organization* (World Scientific Publisher).
- Butler, Z., Corke, P., Peterson, R., and Rus, D. (2006). From robots to animals: virtual fences for controlling cattle, *Int. J. Robot. Res.*, **25(5-6)**, pp. 485–508.
- Butler, Z., Fitch, R., and Rus, D. (2002). Distributed control for unit-compressible robots: goal-recognition, locomotion, and splitting, *IEEE/ASME Trans. on Mechatronics, special issues on self-reconfigurable robots*, **7(4)**, pp. 418–403.

- Butler, Z., and Rus, D. (2003). Distributed planning and control for modular robots with unit-compressible modules, *Int. J. Robot. Res.*, **22(9)**, pp. 699–716.
- Butlerow, A. (1861). Formation synthétique d'une substance sucrée, *Compt. Rend. Acad. Sci.*, **53**, pp. 145–147.
- Butz, M. (2002). *Anticipatory Learning Classifier Systems*, Genetic Algorithms and Evolutionary Computation (Kluwer Academic Publisher).
- Butz, M. (2006). Rule-based evolutionary online learning systems: a principled approach to lcs analysis and design.
- Byrne, J., Cosgrove, M., and Mehra, R. (2006). Stereo based obstacle detection for an unmanned air vehicle, in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)* (IEEE Press), pp. 2830–2835.
- Caglioti, V., Citterio, A., and Fossati, A. (2006). Cooperative, distributed localization in multi-robot systems: a minimum-entropy approach, in *Proceedings of the IEEE Workshop on Distributed Intelligent Systems: Collective Intelligence and Its Applications DIS 2006*, pp. 25–30, 10.1109/DIS.2006.20.
- Cai, Z., and Duan, Z. (2005). A multiple particle filters method for fault diagnosis of mobile robot dead-reckoning system, in *IEEE International Conference on Intelligent Robots and Systems*, pp. 481–486.
- Calingaert, P. (1967). System performance evaluation: survey and appraisal, *Commun. ACM*, **10(1)**, pp. 12–18.
- Callaway, R. M., and Mahall, B. E. (2007). Family roots, *Nature*, 448, pp. 145–147.
- Calvin, W. (1996). *The cerebral code* (Cambridge, MA., MIT Press).
- Camazine, S. (1993). The regulation of pollen foraging by honey bees: how foragers assess the colony's need for pollen, *Behav. Ecol. Sociobiol.*, **32(4)**, pp. 265–272, 10.1007/BF00166516.
- Camazine, S., Crailsheim, K., N., H., Robinson, G., Leonhard, B., and Kropiunigg, H. (1998). Protein trophallaxis and the regulation of pollen foraging by honey bees (*Apis mellifera* L.), *Apidologie*, **29**, p. 113–126.
- Camazine, S., Deneubourg, J., Franks, N., J., Sneyd, Theraulaz, G., and Bonabeau, E. (2001). *Self-Organization in Biological Systems* (Princeton University Press).
- Camazine, S., Deneubourg, J.-L., Franks, N., Sneyd, J., Theraulaz, G., and Bonabeau, E. (2003). *Self-Organization in Biological Systems* (Princeton University Press, Princeton, NJ, USA).

- Cangelosi, A., and Parisi, D. (1998). The emergence of “language” in an evolving population of neural networks, *Connect. Sci.*, **10**, pp. 83–93.
- Canham, R., Jackson, A. H., and Tyrrell, A. (2003). Robot error detection using an artificial immune system, in *2003 NASA/DoD Conference on Evolvable Hardware (EH'03)*, pp. 588–594.
- Cao, Y., Fukunaga, A., Kahng, A., and Meng, F. (1995). Cooperative mobile robotics: antecedents and directions, *Intelligent Robots and Systems, IEEE/RSJ International Conference on*, **1**, p. 226, <http://doi.ieeecomputersociety.org/10.1109/IROS.1995.525801>.
- Cao, Y. U., Fukunaga, A. S., and Kahng, A. B. (1997). Cooperative mobile robotics: antecedents and directions, *Auton. Robot.*, **4**, pp. 7–27.
- Caprari, G., Arras, K., and Siegwart, R. (2000). The autonomous miniature robot alice: from prototypes to applications, *Intelligent Robots and Systems, 2000. (IROS 2000). Proceedings. 2000 IEEE/RSJ International Conference on*, **1**, pp. 793–798 vol. 1.
- Caprari, G., Colot, A., Siegwart, R., Halloy, J., and Deneubourg, J.-L. (2005). Building mixed societies of animals and robots, *IEEE Robot. Autom. Mag.*, **12(2)**, pp. 58–65.
- Caprari, G., and Siegwart, R. (2005a). Mobile micro-robots ready to use: Alice, in *Proceedings of the 2005 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2005)*, pp. 3295–3300.
- Caprari, G., and Siegwart, R. (2005b). Mobile micro-robots ready to use: Alice, in *Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. 3295–3300.
- Cariani, P. (1997). Emergence of new signal-primitives in neural networks, *Intellectica*, **2**, pp. 95–143.
- Carlson, J., and Murphy, R. R. (2005). How UGVs physically fail in the field, *IEEE Trans. Robot.*, **21(3)**, pp. 423–437.
- Carnelli, I., Dachwald, B., and Vasile, M. (2009). Evolutionary neurocontrol: a novel method for low-thrust gravity-assist trajectory optimization, *J. Guid. Control Dynam.*, **32(2)**, pp. 615–624.
- Carnie, R., Walker, R., and Corke, P. (2006). Image processing algorithms for UAV “sense and avoid”, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 2848–2853.
- Carr, P. A., and Church, G. M. (2009). Genome engineering. *Nat. Biotechnol.*, **27(12)**, pp. 1151–1162, <http://dx.doi.org/10.1038/nbt.1590>.
- Carrillo, L., Marzo, J., Harle, D., and Vilà, P. (2003). A review of scalability and its application in the evaluation of the scalability measure of antnet routing, in *Proceedings of the IASTED-CSN 2003*.

- Carter, J., and Saunders, V. (1997). *Virology: Principles and Applications* (Wiley).
- Casal, A., and Yim, M. (1999). Self-reconfiguration planning for a class of modular robots, in *Proc. SPIE: Sensor Fusion and Decentralized Control in Robotic Systems II*.
- Caselles, J. (2005). *Exploration of embodiment in real microrobotic swarm* (Master Thesis, University of Stuttgart, Germany).
- Casillas, J., Cordon, O., and Herrera, F. (2000). Learning fuzzy rules using ant colony algorithms, in *Proceedings of the 2nd International Workshop on Ant Algorithms (ANTS 2000)*, Brussels, Belgium, pp. 13–21.
- Castano, A., and Will, P. (2001). Representing and discovering the configuration of conro robots, in *proceedings of IEEE International Conference on Robotics and Automations*.
- Cavalier-Smith, T. (1995). Membrane heredity, symbiogenesis, and the multiple origins of algae, in R. Arai and M. Kato (eds.), *Biodiversity and Evolution* (Tokyo: The National Science Museum Foundation), pp. 75–114.
- Cavallaro, J., and Walker, I. (1994). A survey of NASA and military standards on fault tolerance and reliability applied to robotics, in *Proceedings of AIAA/NASA Conference on Intelligent Robots in Field, Factory, Service, and Space*, pp. 282–286.
- Cecil, J., Powell, D., and Vasquez, D. (2007). Assembly and manipulation of micro devices—a state of the art survey, *Robot. Comp. Integr. Manuf.*, **23**(5), pp. 580–588, DOI: 10.1016/j.rcim.2006.05.010.
- Chaimowicz, L., Michael, N., and Kumar, V. (2005). Controlling swarms of robots using interpolated implicit functions, *Int. Conference on Robotics*, pp. 2487–2492, 10.1109/ROBOT.2005.1570486.
- Chalam, V. (1987). *Adaptive Control Systems: Techniques and Applications* (CRC).
- Chang, D., Shadden, S., Marsden, J., and Olfati-Saber, R. (2003). Collision avoidance for multiple agent systems, in *Proceedings of the 42nd IEEE Conference on Decision and Control* (IEEE Press), pp. 539–543.
- Changeux, J. (1985). *Neuronal Man: The Biology of Mind* (Princeton University Press).
- Chantemargue, F., and Hirsbrunner, B. (1999). A collective robotics application based on emergence and self-organization, in *Proceedings of ICYCS'99* (Nanjing, China).
- Charikar, M., Lehman, E., Liu, D., Panigrahy, R., Prabhakaran, M., Rasala, A., Sahai, A., and Shelat, A. (2002). Approximating the smallest grammar: Kolmogorov complexity in natural models, in *Proceedings*

- of the 34th ACM Symposium on the Theory of Computing (ACM Press), ISBN 1-58113-495-9, pp. 792–801, <http://doi.acm.org/10.1145/509907.510021>.
- Chaté, H., and Manneville, P. (1992). Emergence of effective low-dimensional dynamics in the macroscopic behavior of coupled map lattices, *Europhys. Lett.*, **17(4)**, pp. 291–296.
- Chaumont, N., Egli, R., and Adami, C. (2007). Evolving virtual creatures and catapults, *Artif. Life*, **13(2)**, pp. 139–157, <http://dx.doi.org/10.1162/artl.2007.13.2.139>.
- Chen, P.-C., Shen, G., and Zhou, C. (2008). Chemical sensors and electronic noses based on 1-D metal oxide nanostructures, *IEEE Trans. Nanotechnol.*, **7(6)**, pp. 668–682.
- Chen, W., Gong, R., and Dai, K. (2006). Two new space-time triple modular redundancy techniques for improving fault tolerance of computer systems, in *IEEE International Conference on Computer and Information Technology*.
- Chen, X. (2003). *Optimization of communication in a swarm of micro-robots* Master's Thesis, University of Stuttgart, Germany.
- Chen, Y., and Kobayashi, H. (2002). Signal strength-based indoor geolocation, in *IEEE International Conference on Communicatins*, Vol. 1, pp. 436–439.
- Cheng, B., Giese, H., Inverardi, P., Magee, J., and de Lemos, R. (2008). *Software Engineering for Self-Adaptive Systems* (Dagstuhl Seminar 08031).
- Cheng, C.-M., Hsiao, P.-H., Kung, H. T., and Vlah, D. (2006). Performance measurement of 802.11a wireless links from UAV to ground nodes with various antenna orientations, in *Proceedings of the 15th IEEE International Conference on Computer Communications and Networks* (IEEE Press), pp. 303–308.
- Chiang, C.-J., and Chirikjian, G. S. (2001). Similarity metric with applications in modular robot motion planning, *Auton. Robot.*, **10(1)**, pp. 91–106.
- Chichka, D., and Speyer, J. (1998). Solar-powered, formation-enhanced aerial vehicle systems for sustained endurance, in *Proceedings of the 1998 American Control Conference*, Vol. 2 (IEEE Press), pp. 684–688.
- Chirikjian, G. S. (1994). Kinematics of a metamorphic robotic system, in *Proceedings of the International Conference on Robotics and Automation*, IEEE Computer Society Press, pp. 449–455.
- Choi, J., Lee, J., Xu, Y., and Oh, S. (2010). Navigation strategies for swarm intelligence using spatio-temporal gaussian processes, *Special issue on Swarm Robotics, Neural Computation and Applications* To appear.

- Chou, H.-H., and Reggia, J. (1997). Emergence of self-replicating structures in a cellular automata space, *Phys. D*, **110**, pp. 252–276.
- Christensen, A., O’Grady, R., and Dorigo, M. (2009a). From fireflies to fault-tolerant swarms of robots, *IEEE Trans. Evol. Comput.*, **13(4)**, pp. 754–766.
- Christensen, A. L., O’Grady, R., and Dorigo, M. (2007). Morphology control in a multirobot system - distributed growth of specific structures using directional self-assembly, *IEEE Robot. Autom. Mag.*, **14(4)**, pp. 18–25.
- Christensen, A. L., O’Grady, R., and Dorigo, M. (2008). SWARMORPH-script: a language for arbitrary morphology generation in self-assembling robots, *Swarm Intell.*, **2(2–4)**, pp. 143–165.
- Christensen, A. L., O’Grady, R., and Dorigo, M. (2009b). Parallel task execution, morphology control and scalability in a swarm of self-assembling robots, in *Proceedings of 9th Conference on Autonomous Robot Systems and Competitions, Robotica 2009* (IPCB-Instituto Politécnico de Castelo Branco, Castelo Branco, Portugal), pp. 127–133.
- Christensen, D. J. (2007). Experiments on fault-tolerant self-reconfiguration and emergent self-repair, in *Proceedings of the (IEEE) Symposium on Artificial Life*.
- Christensen, D. J., and Stoy, K. (2006). Selecting a meta-module to shape-change the atron self-reconfigurable robot, in *proceedings of IEEE International Conference on Robotics and Automations*.
- Christensen, T., Noergaard, M., Madsen, C., and Hoover, A. (2000). Sensor networked mobile robotics, *Computer Vision and Pattern Recognition, IEEE Computer Society Conference on*, **2**, p. 2782, <http://doi.ieeecomputersociety.org/10.1109/CVPR.2000.854956>.
- Chumachenko, N., Novikov, Y., and Yarus, M. (2009). Rapid and simple ribozymic aminoacylation using three conserved nucleotides, *J. Am. Chem. Soc.*, **131(14)**, pp. 5257–5263.
- Ciacci, C., Nembrini, J., Prorok, A., and Martinoli, A. (2008). Assembly of configurations in a networked robotic system: a case study on a reconfigurable interactive table lamp, in *Proceedings of the 2008 IEEE Symposium on Swarm Intelligence (SIS 2008)*.
- Ciacci, C., Raemy, X., Pugh, J., and Martinoli, A. (2007). Communication in a swarm of miniature robots: the e-puck as an educational tool for swarm robotics, *Proceedings of Simulation of Adaptive Behavior (SAB-2006), Swarm Robotics Workshop*, **4433**, pp. 103–114, <http://infoscience.epfl.ch/record/100015?ln=en&of=HD>.
- CIM (2006). Production robots are becoming team players, *CIM Fabricating, Fabricating/Robotics*, 2006–04–01.

- Cliff, D. (2003). Biologically-inspired computing approaches to cognitive systems: a partial tour of the literature, *Hewlett-Packard Company*.
- CoCoRo (2011–2013). *Collective Cognitive Robots, FP7* (European Communities).
- Codd, E. (1968). *Cellular Automata* (Academic Press, New York).
- Coffey, W., Kalmykov, Y., and Waldron, J. (2004). *The Langevin Equation. With Applications to Stochastic Problems in Physics, Chemistry and Electrical Engineering*, 2nd edn. (World Scientific, Singapore).
- Cohen, H., Tawfik, D., and Griffiths, A. (2004). Altering the sequence specificity of HaeIII methyltransferase by directed evolution using in vitro compartmentalization, *Protein Eng. Des. Sel.*, **17**(1), pp. 3–11.
- Cole, D., Goktogan, A., and Sukkarieh, S. (2006). The demonstration of a cooperative control architecture for UAV teams, *Exp. Rob.*, **39**, pp. 501–510.
- Colestock, H. (2008). *Industrial Robotics* (McGraw-Hill/TAB Electronics).
- Collins, L., Kurland, C., Biggs, P., and Penny, D. (2009). The modern RNP world of eukaryotes, *J. Hered.*, **100**(5), pp. 597–604.
- Communities, E. (2003–2007). Grant IST-2004-507006 "I-SWARM, 6th Framework Programme Project No. FP6-2002-IST-1.
- Conn, M., Wintner, E., and Rebek, J. (1994). Template effects in new self-replicating molecules, *Angew. Chem. Int. Ed. Eng.*, **33**(15), pp. 1577–1579.
- Conrad, M. (1999). *Adaptability: The Significance of Variability from Molecule to Ecosystem* (Plenum Press, New York).
- Consortium TEP (2007). Identification and analysis of functional elements in 1% of the human genome by the ENCODE pilot project, *Nature*, **447**, pp. 799–816.
- Constantinescu, C., Kornienko, S., Kornienko, O., and Heinkel, U. (2004). An agent-based approach to support the scalability of change propagation, in *Proceedings of ISCA04* (San-Francisco, USA), pp. 157–164.
- Coradeschi, S., and Saffiotti, A. (2000). Anchoring symbols to sensor data: preliminary report, in *Proceedings of the 17th AAAI Conf* (Austin, Texas), pp. 129–135.
- Corke, P., Detweiler, C., Dunbabin, M., Hamilton, M., Rus, D., and Vasilescu, I. (2007). Experiments with underwater robot localization and tracking, in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA '07)* (Roma, Italy), ISBN 1-4244-0601-3, pp. 4556–4561, 10.1109/ROBOT.2007.364181.

- Cormen, T., Leiserson, C., Rivest, R., and Stein, C. (2009). *Introduction to Algorithms, Third Edition* (MIT Press).
- Corradi, P., Edqvist, E., Quaglia, C., Petrone, M., Menciassi, A., and Dario, P. (2010). A multifunctional vibrating microcantilever for application in microbotic systems, *J. Micromech. Microeng.* (submitted).
- Corradi, P., Schmickl, T., Scholz, O., Menciassi, A., and Dario, P. (2009a). Optical networking in a swarm of microrobots, in *Nano-Net, Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering*, Vol. 3(2) (Berlin: Springer Verlag), pp. 107–119.
- Corradi, P., Scholz, O., Knoll, T., Menciassi, A., and Dario, P. (2009b). An optical system for communication and sensing in millimetre-sized swarming microrobots, *J. Micromech. Microeng.*, **19**(1), p. 015022.
- Correll, N. (2007). *Coordination schemes for distributed boundary coverage with a swarm of miniature robots: synthesis, analysis and experimental validation*, Ph.D. thesis, Ecole Polytechnique Federale de Lausanne (EPFL).
- Correll, N. (2008). Parameter estimation and optimal control of swarm-robotic systems: a case study in distributed task allocation, *Proceedings of the 2008 IEEE International Conference on Robotics and Automation (ICRA 2008)*, pp. 3302–3307.
- Correll, N., Arechiga, N., Bolger, A., Bollini, M., Charrow, B., Clayton, A., Dominguez, F., Donahue, K., Dyar, S., Johnson, L., Liu, H., Patrikalakis, A., Robertson, T., Smith, J., Soltero, D., Tanner, M., White, L., and Rus, D. (2009a). Building a distributed robot garden, in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* (St. Louis, MO), pp. 1509–1516.
- Correll, N., and Martinoli, A. (2006a). Collective inspection of regular structures using a swarm of miniature robots, in M. H. A. Jr., and O. Khatib (eds.), *Proceedings of the 9th International Symposium on Experimental Robotics (ISER)*, Springer Tracts in Advanced Robotics, Vol. 21 (Singapore: Springer), pp. 375–385.
- Correll, N., and Martinoli, A. (2006b). System identification of self-organized robotic swarms, in *8th International Symposium on Distributed Autonomous Robotic Systems (DARS)*.
- Correll, N., and Martinoli, A. (2006c). Towards optimal control of self-organized robotic inspection systems, in *In 8th International IFAC Symposium on Robot Control (SYROCO)* (Bologna, Italy).

- Correll, N., and Martinoli, A. (2007). Modeling self-organized aggregation in a swarm of miniature robots, in *Proceedings of the IEEE 2007 International Conference on Robotics and Automation Workshop on Collective Behaviors Inspired by Biological and Biochemical Systems*.
- Correll, N., and Martinoli, A. (2009). Multirobot inspection of industrial machinery, *IEEE Robot. Autom. Mag.*, **16(1)**, pp. 103–112.
- Correll, N., Rus, D., Bachrach, J., and Vickery, D. (2009b). Ad-hoc wireless network coverage with networked robots that cannot localize, in *IEEE International Conference on Robotics and Automation* (Kobe, Japan), p. 8 pages.
- Correll, N., Schager, M., and Rus, D. (2008). Social control of herd animals by integration of artificially controlled congeners, in *Proceedings of the 10th International Conference on Simulation of Adaptive Behavior (SAB)*. Springer Lecture Notes in Artificial Intelligence LNAI 5040 (Osaka, Japan), pp. 437–447.
- Correll, N., Sempo, G., de Meneses, Y. L., Halloy, J., Deneubourg, J.-L., and Martinoli, A. (2006). Swistrack: a tracking tool for multi-unit robotic and biological research, in *IEEE/RSJ Conference on Intelligent Robots and Systems, to appear*.
- Cory, R., and Tedrake, R. (2008). Experiments in fixed-wing UAV perching, in *Proceedings of the AIAA Conference on Guidance, Navigation, and Control*, AIAA paper AIAA-2008-7256.
- Coutts, M. P. (1983). Root architecture and tree stability, *Plant and soil*, **71(1–3)**, pp. 171–188.
- Couzin, I. (2009). Collective cognition in animal groups, *Trends Cogn. Sci.*, **13(1)**, pp. 36–43.
- Couzin, I., Krause, J., Franks, N., and Levin, S. (2005). Effective leadership and decision-making in animal groups on the move, *Nature*, **433(7025)**, pp. 513–516.
- Cozzi, L., D'Angelo, P., and Sanguineti, V. (2006). Encoding of time-varying stimuli in populations of cultured neurons, *Biol. Cybern.*, **94(5)**, pp. 335–349, <http://dx.doi.org/10.1007/s00422-006-0051-2>.
- Crailsheim, K. (1998). Trophallactic interactions in the adult honeybee (*Apis mellifera* L.), *Apidologie*, **29**, p. 97–112.
- Crespi, V., Galstyan, A., and Lerman, K. (2008). Top-down vs bottom-up methodologies in multi-agent system design, *Auton. Robot.*, **24(3)**, pp. 303–313, <http://dx.doi.org/10.1007/s10514-007-9080-5>.
- Crick, F. (1970). Central dogma of molecular biology, *Nature*, **227**, pp. 561–563.

- Crowther, B. (2004). Rule-based guidance for flight vehicle flocking, *Proceedings of the Institute of Mechanical Engineers, Part G: J. Aerosp. Eng.*, **218(2)**, pp. 111–124.
- Crutchfield, P. (1994). The calculi of emergence: computation, dynamics and induction, *Phys. D*, **75**, pp. 11–54.
- Şahin, E., and Winfield, A. F. T. (eds.) (2008). *Swarm Intelligence: Special Issue on Swarm Robotics*, Vol. 2(2-4) (Springer).
- Csuhaj-Varju, E., Kelemen, J., Paun, G., and Dassow, J. (1994). *Grammar Systems: A Grammatical Approach to Distribution and Cooperation* (Gordon and Breach Science Publishers), ISBN 2881249574.
- Cubukcu, E., Kort, E. A., Crozier, K. B., and Capasso, F. (2006). Plasmonic laser antenna, *Appl. Phys. Lett.*, **89**, 9, 093120.
- Cummings, M., Nehme, C., Crandall, J., and Mitchell, P. (2007). Predicting operator capacity for supervisory control of multiple uavs, in *Innovations in Intelligent Machines - 1, Studies in Computational Intelligence*, Vol. 70 (Berlin: Springer), pp. 11–37.
- Curran, D., and O’Riordan, C. (2006). Increasing population diversity through cultural learning, *Adapt. Behav.*, **14(4)**, pp. 315–338, <http://dx.doi.org/10.1177/1059712306072335>.
- Curreli, M., Zhang, R., Ishikawa, F. N., Chang, H.-K., Cote, R. J., Zhou, C., and Thompson, M. E. (2008). Real-time, label-free detection of biological entities using nanowire-based fets, *IEEE Trans. Nanotechnol.*, **7(6)**, pp. 651–667.
- Curtis, S., Mica, J., Nuth, J., Marr, G., Rilee, M., and Bhat, M. (2000). ANTS (Autonomous Nano-Technology Swarm): an artificial intelligence approach to asteroid belt resource exploration, in *International Astronautical Federation, 51th Congress*.
- Dachwald, B. (2004). Optimization of interplanetary solar sailcraft trajectories using evolutionary neurocontrol, *J. Guid. Control Dynam.*, **27(1)**, pp. 66–72.
- Dailey, K. W. (2004). *The FMEA Handbook* (DW Publishing).
- Dale, K., and Husbands, P. (2010). The evolution of reaction-diffusion controllers for minimally cognitive agents, *Artif. Life*, **16(1)**, pp. 1–19, <http://dx.doi.org/10.1162/artl.2009.16.1.16100>.
- Damoto, R., Kawakami, A., and Hirose, S. (2001). Study of super-mechano colony: concept and basic experimental set-up, *Adv. Robot.*, **15(4)**, pp. 391–408.
- Dankert, H., Wang, L., Hoopfer, E. D., Anderson, D. J., and Perona, P. (2009). Automated monitoring and analysis of social behavior in drosophila, *Nat. Meth.*, **6(4)**, pp. 297–303, <http://dx.doi.org/10.1038/nmeth.1310>.

- Dantu, K., Goyal, P., and Sukhatme, G. S. (2009). Relative bearing estimation from commodity radios, in *IEEE International Conference on Robotics and Automation* (IEEE), pp. 3871–3877.
- Dario, P., Vallegi, R., Carrozza, M. C., Montesi, M. C., and Cocco, M. (1992). Microactuators for microrobotics: a critical survey, *J. Micromech. Microeng.*, **2**, pp. 141–157.
- Darley, V. (1994). Emergent phenomena and complexity, in *Proceedings of the Alive IV Workshop* (Cambridge, MA).
- DARPA (2010). DARPA – Defense Advanced Research Projects Agency, Last accessed on 2010-01-27.
- D'Arrigo, P., and Santandrea, S. (2003). APIES: a mission for the exploration of the main asteroid belt using a swarm of microspacecraft, 4th Symposium on Small Satellites, Systems and Services (European Space Agency, ESA SP-571).
- DARS (1992). Proceedings of the 1992 international symposium on Distributed Autonomous Robotic Systems (DARS'92), September 21–22, Wako, Saitama, Japan.
- Darwin, E. (1800). *Phytologia: or the Philosophy of Agriculture and Gardening*. (J. Johnson, London).
- Dautenhahn, K. (1995). Getting to know each other - artificial social intelligence for autonomous robots, *Robot. Auton. Sys.*, **16**, pp. 333–356.
- Dautenhahn, K., and Nehaniv, C. L. (2002). *The agent-based perspective on imitation* (MIT Press, Cambridge, MA, USA), ISBN 0-262-04203-7, pp. 1–40.
- Davies, R. P. W., Aggeli, A., Boden, N., McLeish, T. C. B., Nyrkova, I. A., and Semenov, A. N. (2009). *Mechanisms and principles of 1D self-assembly of peptides into β -sheet tapes*, *Adv. Chem. Eng.*, Vol. 35, pp. 11–43.
- Davies, W. J., and Zhang, J. (1991). Root signals and the regulation of growth and development of plants in drying soil. *Annu. Rev. Plant Physiol. Plant Mol. Biol.*, **42**, pp. 55–76.
- Davis, P. (1979). *Circulant matrices* (John Willey & Sons).
- Dawkins, R. (1976). *The Selfish Gene* (Oxford University Press).
- Dawkins, R. (1982a). *The Extended Phenotype* (Oxford: Oxford University Press).
- Dawkins, R. (1982b). Replicators and vehicles, in R. Brandon, and R. Burian (eds.), *Genes, Organisms, Populations* (Cambridge: The MIT Press), pp. 161–180.
- de Aragón, A. (1996). Future applications of micro/nano-technologies in space systems, *Technical Directorate, Systems and Programmatics Department, System Studies Division, ESTEC, Noordwijk, The Netherlands*.

- De Greef, J., and Nolfi, S. (2010). Evolution of implicit and explicit communication in a group of mobile robots, in S. Nolfi, and M. Mirulli (eds.), *Evolution of Communication and Language in Embodied Agents* (Springer Verlag, Berlin, Germany), pp. 179–214.
- De Nardi, R. (2004). *Flocking of UAVs Software model and limited vision simulations*, Ph.D. thesis, University of Padua Italy.
- De Nardi, R., Holland, O., Woods, J., and Clark, A. (2006). SwarMAV: a swarm of miniature aerial vehicles, in *Proceedings of the 21st International UAV Systems Conference*.
- De Schutter, G., Theraulaz, G., and Deneubourg, J.-L. (2001). Animal–robots collective intelligence, *Ann. Math. Artif. Intell.*, 31, pp. 223–238.
- de Vries, H., and Biesmeijer, J. C. (2002). Self-organization in collective honeybee foraging: emergence of symmetry breaking, cross inhibition and equal harvest-rate distribution, *Behav. Ecol. Sociobiol.*, **51(6)**, pp. 557–569, 10.1007/s00265-002-0454-6.
- Debarros, H., Esquivel, D., and Farina, M. (1990). Magnetotaxis, *Sci. Progr.*, **74**, pp. 347–359.
- DeGrandi-Hoffman, G., and Hagler, J. (2000). The flow of incoming nectar through a honey bee (*apis mellifera* L) colony as revealed by a protein marker, *Insect. Soc.*, **47**, pp. 302–306.
- del Amo, V., Slawin, A., and Philp, D. (2008). Manipulating replication processes within a dynamic covalent framework, *Organic Letters*, **10(20)**, pp. 4589–4592.
- Delage, E., Lee, H., and Ng, A. Y. (2006). A dynamic Bayesian network model for autonomous 3D reconstruction from a single indoor image, in *IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, pp. 2418–2428.
- DeLima, P., York, G., and Pack, D. (2006). Localization of ground targets using a flying sensor network, in *Proceedings of the IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing-Vol 1* (IEEE Press), pp. 194–199.
- DeMarse, T. B., Wagenaar, D. A., Blau, A. W., and Potter, S. M. (2001). The neurally controlled animat: biological brains acting with simulated bodies, *Auton. Robot.*, **11(3)**, pp. 305–310, <http://dx.doi.org/10.1023/A:1012407611130>.
- Demiris, Y., and Hayes, G. (2002). Imitation as a dual-route process featuring predictive and learning components: a biologically-plausible computational model, in K. Dautenhahn and C. Nehaniv (eds.), *Imitation in Animals and Artefacts*, chapter 13 (MIT Press).

- Demiris, Y., and Johnson, M. (2007). Simulation theory of understanding others: a robotics perspective, in C. L. Nehaniv and K. Dautenhahn (eds.), *Imitation and Social Learning in Robots, Humans and Animals* (Cambridge University Press), pp. 89–102.
- Demiris, Y., and Khadhoury, B. (2005). Hierarchical, attentive, multiple models for execution and recognition (HAMMER), in *Proceedings of the ICRA 2005*.
- Denaro, D., and Parisi, D. (1996). Cultural evolution in a population of neural networks, in *Proceedings of the 8th Italian Workshop on Neural Nets* (Springer Verlag, London), pp. 100–111.
- Deneubourg, J., Aron, S., Goss, S., Pasteels, J., and Duerinck, G. (1986). Random behaviour, amplification processes and number of participants: how they contribute to the foraging properties of ants, *Phys. D*, **22**, pp. 176–186.
- Deneubourg, J., and Goss, S. (1989). Collective patterns and decision-making, *Ethol. Ecol. Evol.*, **1**, pp. 295–311.
- Deneubourg, J., Pasteels, J., and Verhaeghe, J. (1983). Probabilistic behaviour in ants: a strategy of errors? *J. Theor. Biol.*, **105(2)**, pp. 259–271, DOI: 10.1016/S0022-5193(83)80007-1.
- Deneubourg, J.-L., Aron, S., Goss, S., and Pasteels, J. M. (1990). The self-organizing exploratory pattern of the argentine ant, *J. Insect Behav.*, **3**, pp. 159–168.
- Deneubourg, J.-L., Goss, S., Pasteels, J. M., Fresneau, D., and Lachaud, J.-P. (1987). Self-organization mechanisms in ant societies (ii): learning in foraging and division of labour, *Experientia Suppl.*, **54**, pp. 177–196.
- Desbiens, A. L., Asbeck, A. T., and Cutkosky, M. R. (2009). Scansorial landing and perching, in *Proceedings of the 14th International Symposium on Robotics Research*, pp. 1–14.
- Detrain, C., Deneubourg, J., and Pasteels, J. (1999). *Information Processing in social Insects* (Birkhäuser).
- Detrain, C., and Deneubourg, J.-L. (2002). Complexity of environment and parsimony of decision rules in insect societies, *Biol. Bull.*, **202**, pp. 268–274.
- Detrain, C., Deneubourg, J.-L., Goss, S., and Quinet, Y. (1991). Dynamics of collective exploration in the ant *Pheidole pallidula*, *Psyche*, **98(1)**, pp. 21–31.
- Detrain, C., Natan, C., and Deneubourg, J.-L. (2001). The influence of the physical environment on the self-organised foraging patterns of ants, *Naturwissenschaften*, **88**, pp. 171–174.

- Diamond, J. (1997). *Guns, Germs, and Steel: The Fates of Human Societies: W* (W.W. Norton & Co.).
- Dieci, G., Fiorino, G., Teichmann, M., and Pagano, A. (2007). The expanding RNA polymerase III transcriptome, *Trends Genet.*, **23**(12), pp. 614–622.
- Dietl, M., steffen Gutmann, J., and Nebel, B. (2001). Cooperative sensing in dynamic environments, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS-01)*, pp. 1706–1713.
- Dittrich, P., Ziegler, J., and Banzhaf, W. (2001). Artificial chemistries—a review, *Artif. Life*, **7**(3), pp. 225–275, <http://dx.doi.org/10.1162/106454601753238636>.
- Dixon, C., Frew, E., and Argrow, B. (2005). Radio leashing of an unmanned aircraft, in *Proceedings of Infotech@Aerospace*, AIAA paper AIAA-2005-7030.
- Dixon, C., and Frew, E. W. (2009). Maintaining optimal communication chains in robotic sensor networks using mobility control, *Mobile Netw. Appl. J.*, **14**(3), pp. 281–291.
- Dodd, I., and Davies, W. (2006). The relationship between leaf growth and ABA accumulation in the grass leaf elongation zone, *Plant Cell Environ.*, **19**(9), pp. 1047–1056.
- Doherty, E., and Doudna, J. (2000). Ribozyme structure and mechanism, *Annu. Rev. Biochem.*, **69**, pp. 597–615.
- Dohnal, J., and Štěpánek, F. (2010). Inkjet fabrication and characterisation of calcium alginate microcapsules, *Powder Technol.*, **200**, pp. 254–259.
- Doi, N., Kumadaki, S., Oishi, Y., Matsumura, N., and Yanagawa, H. (2004). In vitro selection of restriction endonucleases by in vitro compartmentalization, *Nucl. Acid Res.*, **32**(12), p. e95.
- Donald, B. R., Levey, C. G., McGray, C. D., Paprotny, I., and Rus, D. (2006). An untethered, electrostatic, globally-controllable mems micro-robot, *J. Microelectromech. Sys.*, **15**(1), pp. 1–15.
- Dong, L., and Nelson, B. J. (2007). Robotics in the small—part II: nanorobotics, *IEEE Robot. Autom. Mag.*, **14**, pp. 111–121.
- Dong, L., Nelson, B. J., Fukuda, T., and Arai, F. (2006). Towards nanotube linear servomotors, *IEEE Trans. Autom. Sci. Eng.*, **3**(3), pp. 228–235.
- Doniec, M., Vasilescu, I., Detweiler, C., Rus, D., Chitre, M., and Hoffmann-Kuhnt, M. (2009). Aquaoptical: a lightweight device for high-rate long-range underwater point-to-point communication, in *In Proceedings of OCEANS*, pp. papernumber 090601–157.
- Dorigo, M. (1992). *Otimizzazione, Apprendimento Automatico, ed Algoritmi Basati su Metafora naturale*, Ph.D. thesis, Politecnico di Milano, Italy.

- Dorigo, M., and Birattari, M. (2007). Swarm intelligence, *Scholarpedia*, **2(9)**, p. 1462.
- Dorigo, M., Gambardella, L. M., Birattari, M., Martinoli, A., Poli, R., and Stützle, T. (2006a). *Ant Colony Optimization and Swarm Intelligence* (Springer Verlag, Berlin).
- Dorigo, M., and Şahin, E. (2004). Guest editorial: Swarm Robotics, *Auton. Robot.*, **17(2-3)**, pp. 111–113
- Dorigo, M., and Stützle, T. (2004). *Ant colony optimization* (MIT Press, Cambridge, MA).
- Dorigo, M., Trianni, V., Şahin, E., Groß, R., Labella, T. H., Baldassarre, G., Nolfi, S., Deneubourg, J.-L., Mondada, F., Floreano, D., and Gambardella, L. M. (2004). Evolving self-organizing behaviors for a *swarm-bot*, *Auton. Robot.*, **17(2-3)**, pp. 223–245.
- Dorigo, M., Tuci, E., Groß, R., Trianni, V., Labella, T., Nouyan, S., Ampatzis, C., Deneubourg, J.-L., Baldassarre, G., Nolfi, S., Mondada, F., Floreano, D., and Gambardella, L. (2005a). The SWARM-BOTS project, in *Proceedings of the 1st International Workshop on Swarm Robotics at SAB 2004*, Lecture Notes in Computer Science, Vol. 3342 (Berlin: Springer Verlag), pp. 31–44.
- Dorigo, M., Tuci, E., Groß, T., Trianni, V., Labella, T., Nouyan, S., and Ampatzis, C. (2005b). The SWARM-BOT project, in E. Şahin and W. Spears (eds.), *Swarm Robotics Workshop: State-of-the-art Survey*, no. 3342 in Lecture Notes in Computer Science (Berlin/Heidelberg: Springer Verlag), pp. 31–44.
- Dorigo, M., Tuci, E., Trianni, V., Groß, R., Nouyan, S., Ampatzis, C., Labella, T. H., O’Grady, R., Bonani, M., and Mondada, F. (2006b). SWARM-BOT: design and implementation of colonies of self-assembling robots, in G. Y. Yen, and D. B. Fogel (eds.), *Computational Intelligence: Principles and Practice* (IEEE Computational Intelligence Society, NY), pp. 103–135.
- Doudna, J., and Cech, T. (2002). The chemical repertoire of natural ribozymes, *Nature*, **418(6894)**, pp. 222–228.
- Doussan, C., Vercambre, G., and Pages, L. (1998). Modelling of the hydraulic architecture of root systems: an integrated approach to water absorption—distribution of axial and radial conductances in maize, *Ann. Bot.*, **81(2)**, pp. 225–232.
- Ducard, G., and D’Andrea, R. (2009). Autonomous quadrotor flight using a vision system and accommodating frames misalignment, in *Proceedings of the IEEE International Symposium on Industrial Embedded Systems* (IEEE Press), pp. 261–264.

- Dudek, G., and Jenkin, M. (2008). Inertial sensors, GPS, and odometry, in *Springer Handbook of Robotics* (Springer Berlin Heidelberg), pp. 477–490.
- Dudek, G., Jenkin, M., and Wilkes, D. (1996). A taxonomy for multi-agent robotics, *Auton. Robot.*, **3**, pp. 375–397.
- Dudney, N. (2008). Thin film micro-batteries, *Electrochem. Soc. Interface*, Fall, pp. 44–48.
- Durna, M., Erkmen, A. M., and Erkmen, I. (2000a). Self-reconfiguration in task space of a holonic structure, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, Vol. 3, pp. 2366–2373.
- Durna, M., Erkmen, A. M., and Erkmen, I. (2000b). The self-reconfiguration of a holonic hand: the holonic regrasp, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, Vol. 3, pp. 1993–1998.
- Durrant-Whyte, H., and Bailey, T. (2006). Simultaneous localization and mapping (SLAM): part I, *IEEE Robot. Autom. Mag.*, **13(2)**, pp. 99–110.
- Durrant-Whyte, H. F. (1988). *Integration, Coordination and Control of Multi-Sensor Robot Systems* (Kluwer Academic Publishers).
- Dussutour, A., Fourcassie, V., Helbing, D., and Deneubourg, J.-L. (2004). Optimal traffic organization in ants under crowded conditions, *Nature*, **428(6978)**, pp. 70–73.
- Dussutour, A., Fourcassie, V., Helbing, D., and Deneubourg, J.-L. (2006). Optimal traffic organization in ants under crowded condition, *Nature*, **428**, pp. 70–73.
- Dyson, F. (1985). *The origin of life* (Cambridge: Cambridge University Press).
- Ebefors, T. (2000). *Polyimide V-Groove Joints for Three-Dimensional Silicon Transducers Exemplified Through a 3D Turbulent Gas Flow Sensor and Micro-Robotic Devices*, Ph.D. thesis, Royal Institute of Technology (KTH).
- Ebefors, T., Mattsson, J., Kälvesten, E., and Stemme, G. (2000). A robust micro conveyer realized by arrayed polyimide joint actuators, *IOP J. Micromech. Microeng.*, **10(3)**, pp. 337–349.
- Ebefors, T., Mattsson, J. U., Klvesten, E., and Stemme, G. (1999). A walking silicon micro-robot, *Transducers*, **10(3)**, pp. 1202–1205.
- Ebeling, W., and Feistel, R. (1986). *Physik der Selbstorganisation und Evolution* (Akademie-Verlag).
- Edelen, M. R. (2003). *Swarm Intelligence and Stigmergy: Robotic Implementation of Foraging Behaviour*, master's thesis, University of Maryland.

- Edelman, G. (1987). *Neural Darwinism* (The Theory of Neuronal Group Selection New York, Basic Books).
- Edqvist, E. (2009). *Applications of Active Materials*, Ph.D. thesis, Uppsala University, Sweden.
- Edqvist, E., Snis, N., and Johansson, S. (2008). Gentle dry etching of P(VDF-TrFE) multilayer micro actuator structures by use of an inductive coupled plasma, *J. Micromech. Microeng.*, **18**(1), p. 015007.
- Edqvist, E., Snis, N., Mohr, R. C., Scholz, O., Corradi, P., Gao, J., Diéguez, A., Wyrsh, N., and Johansson, S. (2009). Evaluation of building technology for mass producible millimetre-sized robots using flexible printed circuit boards, *J. Micromech. Microeng.*, **19**(7), p. 075011.
- Egardt, B. (1979). *Stability of Adaptive Controllers*, Lecture Notes in Control and Information Sciences, Vol. 20 (Springer Verlag, Berlin).
- Eiben, A. E., Elia, D., and van Hemert, J. I. (1999). Population dynamics and emerging mental features in AEGIS, in W. Banzhaf, J. Daida, A. E. Eiben, M. Garzon, V. Honavar, M. Jakiela, and R. Smith (eds.), *Proceedings of the Genetic and Evolutionary Computation Conference*, Vol. 2 (Morgan Kaufmann, Orlando, Florida, USA), ISBN 1-55860-611-4, pp. 1257–1264.
- Eiben, A. E., Haasdijk, E., and Bredeche, N. (2010). Embodied, on-line, on-board evolution for autonomous robotics, in P. Levi and S. Kernbach (eds.), *Symbiotic Multi-Robot Organisms: Reliability, Adaptability, Evolution*, chapter 7, Cognitive Systems Monographs (Springer Verlag), pp. 361–382.
- Eiben, A. E., and Smith, J. (2003). *Introduction to Evolutionary Computing* (Springer).
- Eigen, M. (1971a). Molekulare selbstorganisation und evolution. (selforganization of matter and the evolution of biological macromolecules), *Naturwissenschaften*, **58**(10), pp. 465–523.
- Eigen, M. (1971b). Selforganization of matter and the evolution of biological macromolecules, *Naturwissenschaften*, **10**, pp. 465–523.
- Eigen, M., and Schuster, P. (1977). The hypercycle, *A principle of natural self-organisation Part A: emergence of the hypercycle*. *Naturwissenschaften*, **64**, pp. 541–565.
- Eigen, M., and Schuster, P. (1978). The hypercycle, *A principle of natural self-organization. Part C: The realistic hypercycle*. *Naturwissenschaften*, **65**(7), pp. 341–369.
- Elfving, S., Uchibe, E., Doya, K., and Christensen, H. (2008). Biologically inspired embodied evolution of survival, in Z. Michalewicz and R. G.

- Reynolds (eds.), *Proceedings of the 2008 IEEE Congress on Evolutionary Computation IEEE Congress on Evolutionary Computation*, Vol. 3 (IEEE Press, Hong Kong), ISBN 978-1-4244-1823-7, pp. 2210–2216.
- Ellery, A. (2000). *An Introduction to Space Robotics* (Springer Verlag New York, Inc., Secaucus, NJ, USA), ISBN 185233164X.
- Elsayed, E. A. (1996). *Reliability Engineering* (Addison-Wesley Longman).
- Endo, G., Morimoto, J., Matsubara, T., Nakanishi, J., and Cheng, G. (2008). Learning cpg-based biped locomotion with a policy gradient method: Application to a humanoid robot, *Int. J. Rob. Res.*, **27**(2), pp. 213–228, <http://dx.doi.org/10.1177/0278364907084980>.
- Engelson, V. (2000). Simulation and visualization of autonomous helicopter and service robots, *Linköping Electronic Articles in Computer and Information Science*, ISSN 1401-9841, **5**, 013.
- Eniola, A., and Hammer, D. (2003). Artificial Polymeric Cells for Targeted Drug Delivery, *J. Control. Release*, **87**, pp. 15–22.
- Epstein, J. M., and Axtell, R. (1996). *Growing artificial societies: social science from the bottom up* (MIT Press, Cambridge, MA.).
- Epstein, N. (1989). On tortuosity and the tortuosity factor in flow and diffusion through porous media, *Chem. Eng. Sci.*, **44**, pp. 777–779.
- Ermak, D., and McCammon, J. (1978). Brownian dynamics with hydrodynamic interactions, *J. Chem. Phys.*, **69**, pp. 1352–1360.
- Estlin, T., Gaines, D., Chouinard, C., Castano, R., Bornstein, B., Judd, M., Nesnas, I., and Anderson, R. (2007). Increased Mars rover autonomy using AI planning, scheduling and execution, in *2007 IEEE International Conference on Robotics and Automation*, pp. 4911–4918.
- Estrin, D., Govindan, R., Heidemann, J., and Kumar, S. (1999). Next century challenges: scalable coordination in sensor networks, in *Proceedings of the 5th annual ACM/IEEE international conference on Mobile computing and networking*, pp. 263–270.
- Etkin, B., and Reid, L. D. (1995). *Dynamics of Flight: Stability and Control*, 3rd edn. (Wiley).
- EU (2010). Future and Emerging Technologies (FET).
- Eustice, R. M., Whitcomb, L. L., Singh, H., and Grund, M. (2007). Experimental results in synchronous-clock one-way-travel-time acoustic navigation for autonomous underwater vehicles, in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA '07)* (Roma, Italy), ISBN 1-4244-0601-3, pp. 4257–4264, 10.1109/ROBOT.2007.364181.

- Euston, M., Coote, P., Mahony, R., Kim, J., and Hamel, T. (2008). A complementary filter for attitude estimation of a fixed-wing UAV, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (IEEE Press), pp. 340–345.
- Evans, C., Mermoud, G., and Martinoli, A. (2010). Comparing and modeling distributed control strategies for miniature self-assembling robots, in V. Kumar (ed.), *Proceedings of the 2010 IEEE Int. Conf. on Robotics and Automation (ICRA 2010)* (Anchorage, Alaska, USA), pp. 1438–1445.
- Evans, J., and Messina, E. (2000). Performance metrics for intelligent systems, in *Performance Metrics for Intelligent Systems (PerMIS) Proceedings*, Vol. Part II.
- Everett, H. R., Gage, D. W., Gilbreath, G. A., Laird, R. T., and Smurlo, R. P. (1994). Real-world issues in warehouse navigation, in *Proceedings of the SPIE Conference on Mobile Robots IX*, Vol. 2352 (Boston, MA), pp. 629–634.
- Falik, O., Reides, P., Gersani, M., and Novoplansky, A. (2005). Root navigation by self inhibition, *Plant Cell Environ.*, **28**(4), pp. 562–569.
- Farr, N., Chave, A., Freitag, L., Preisig, J., White, S., Yoerger, D., and Titterton, P. (2005). Optical modem technology for seafloor observatories, in *Proceedings of MTS/IEEE Oceans 2005* (Washington, DC, USA), ISBN 0-933957-34-3, pp. 928–934, 10.1109/OCEANS.2005.1639874.
- Fatikow, S. (2008). *Automated Nanohandling by Microrobots* (Springer Verlag, London).
- Fausett, L. (ed.) (1994). *Fundamentals of neural networks: architectures, algorithms, and applications* (Prentice-Hall, Inc., Upper Saddle River, NJ, USA), ISBN 0-13-334186-0.
- Federation, R. (2010). <http://www.robocup.org>.
- Fellermann, H., Doerr, M., Hanczyc, M. M., Laursen, L. L., Maurer, S., Merkle, D., Monnard, P.-A., Stoy, K., and Rasmussen, S. (2010). *Artificial Life XII: Proceedings of the Twelfth International Conference on the Synthesis and Simulation of Living Systems* (The MIT Press).
- Feringa, B. (2001). *Molecular Switches* (Wiley-VCH Verlag, Weinheim, Germany).
- Fernando, C. (2010a). *Neuronal Replicators Solve the Stability-Plasticity Dilemma* (GECCO 2010 Portland, Oregon).
- Fernando, C., and Di Paolo, E. (2004). The Chemoton: A model for the origin of long RNA templates, *Proceedings of the Ninth International Conference on the Simulation and Synthesis of Living Systems, ALIFE'9 Boston, September 12th-15th*.

- Fernando, C., Karishma, K., and Szathmáry, E. (2008). Copying and evolution of neuronal topology, *PLoS ONE*, **3**(11), p. e3775.
- Fernando, C., and Szathmáry, E. (2009). *Chemical, neuronal and linguistic replicators. Towards an Extended Evolutionary Synthesis* (M. P. a. G. Müller. Cambridge, MA, MIT Press).
- Fernando, S. E., C. (2010b). Chemical, neuronal and linguistic replicators, in M. Pigliucci and G. Muller (eds.), *Evolution: The Extended Synthesis* (MIT Press), pp. 209–249.
- Feron, E., and Johnson, E. N. (2008). *Aerial Robotics* (Springer), pp. 1009–1029.
- Ferrein, A., Hermanns, L., and Lakemeyer, G. (2006). Comparing sensor fusion techniques for ball position estimation, in A. Bredenfeld, A. Jacoff, I. Noda, and Y. Takahashi (eds.), *RoboCup 2005: Robot Soccer World Cup IX - LNAI 4020* (Springer Verlag, Berlin), pp. 154–165.
- Ferrell, C. (1994). Failure recognition and fault tolerance of an autonomous robot, *Adapt. Behave.*, **2**(4), 375–398.
- Feynman, R. P. (1961). There's plenty of room at the bottom, *Miniaturization*, **12-2**.
- Ficici, S., Watson, R., and Pollack, J. (1999). Embodied evolution: a response to challenges in evolutionary robotics, in J. L. Wyatt, and J. Demiris (eds.), *Proceedings of the 8th European Workshop on Learning Robots*, pp. 14–22, citeseer.ist.psu.edu/article/ficici99embodied.html.
- Fidleris, V., and Whitmore, R. (1961). Experimental determination of the wall effect for spheres falling axially in cylinder vessels, *Br. J. Appl. Phys.*, **12**, pp. 490–494.
- Fielding, C., and Luckner, R. (2000). Industrial considerations for flight control, in *Flight Control Systems*, Vol. 57, 1st edn., chapter 1 (The Institution of Electrical Engineers (IEE)), p. 28.
- Fiorelli, E., Leonard, N. E., Bhatta, P., Paley, D. A., Bachmayer, R., and Fratantoni, D. M. (2006). Multi-auv control and adaptive sampling in monterey bay, *IEEE J. Ocean. Eng.*, **31**(4), pp. 935–948.
- Fitch, R., Butler, Z., and Rus, D. (2003). Reconfiguration planning for heterogeneous self-reconfiguring robots, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*.
- Fitch, R., Butler, Z., and Rus, D. (2005). Reconfiguration planning among obstacles for heterogeneous self-reconfiguring robots, in *Proceedings of the IEEE International Conference on Robotics and Automation*.
- Fitch, R. C. (2004). *Heterogenous Self-Reconfiguring Robotics*, Ph.D. thesis, Dartmouth College, Hanover, New Hampshire, USA.

- Flener, P., Frisch, A., Hnich, B., Kiziltan, Z., Miguel, I., Pearson, J., and Walsh, T. (2002). Breaking row and column symmetries in matrix models, in *Proceedings of the 8th International Conference on Principles and Practice of Constraint Programming (CP-02)* (Springer Verlag, London, UK), ISBN 3-540-44120-4, pp. 462–476.
- Floreano, D., and Mattiussi, C. (2008). *Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies* (The MIT Press), ISBN 0262062712, 9780262062718.
- Floreano, D., Mitri, S., Magnenat, S., and Keller, L. (2007). Evolutionary conditions for the emergence of communication in robots, *Current Biology*, **17**(9), pp. 514–519.
- Floreano, D., and Nolfi, S. (1997). Adaptive behavior in competing co-evolving species, in *Proceedings of the 4th European Conference on Artificial Life* (MIT Press), pp. 378–387.
- Floreano, D., and Urzelai, J. (2000). Evolutionary robots with on-line self-organization and behavioral fitness, *Neural Networks*, **13**(4–5), pp. 431–443.
- Floreano, D., Zufferey, J.-C., Srinivasan, M. V., and Ellington, C. P. (2009). *Flying Insects and Robots* (Springer).
- Flynn, A. (1987). Gnat robots (and how they will change robotics), in *Proceedings of the IEEE Micro Robots and Teleoperators Workshop*.
- Flynn, A. (1988). Gnat robots: a low-intelligence low-cost approach, in *Solid-State Sensor and Actuator Workshop, 1988. Technical Digest, IEEE*, pp. 63–66, 10.1109/SOLSEN.1988.26434.
- Fodor, J. A., and Pylyshyn, Z. W. (1988). Connectionism and cognitive architecture: a critical analysis. *Cognition*, **28**, pp. 3–71.
- Foehring, R., and Lorenzon, N. (1999). Neuromodulation, development and synaptic plasticity, *Can. J. Exp. Psychol.*, **53**, pp. 45–61.
- Fogel, D. (1995). *Evolutionary Computation: Toward a New Philosophy of Machine Intelligence* (Piscataway, NJ: IEEE Press).
- Fogel, L. J., Owens, A. J., and Walsh, M. J. (1966). *Artificial Intelligence through Simulated Evolution* (John Wiley & Sons, New York, NY).
- Forrester, J. (1971). *World Dynamics* (Wright-Allen, Cambridge, Massachusetts).
- Forster, A., and Church, G. (2006). Towards synthesis of a minimal cell, *Mol. Sys. Biol.*, **2**, p. 45.
- Forster, A., and Symons, R. (1987). Self-cleavage of plus and minus RNAs of a virusoid and a structural model for the active site, *Cell*, **49**, pp. 211–220.

- Fournier-Bidoz, S., Arsenault, A., Manners, I., and Ozin, G. (2005). Synthetic self-propelled nanorotors, *Chem. Commun.*, **4**, pp. 441–443.
- Fox, D., Burgard, W., and Thrun, S. (2000). A probabilistic approach to collaborative multi-robot localization, *Auton. Robot.*, **8(3)**, pp. 325–344, 10.1023/A:1008937911390.
- Frankel, R., and Blakemore, R. (1980). Navigational compass in magnetic bacteria, *J. Magn. Magn. Mater.*, **15-18(part 3)**, pp. 1562–1564.
- Fraser, G., and Wotawa, F. (2005). Cooperative planning and plan execution in partially observable dynamic domains, in *RoboCup 2004 : Robot Soccer World Cup VIII*, Vol. LNCS 3276 (Springer Verlag, Berlin), pp. 524–531.
- Frater, M. R., Ryan, M. J., and Dunbar, R. M. (2006). Electromagnetic communications within swarms of autonomous underwater vehicles, in *Proceedings of the ACM International Workshop on Underwater Networks (WUWNet '06)* (Los Angeles, CA, USA), ISBN 1-59593-484-7, pp. 64–70, 10.1145/1161039.1161053.
- Frei, R., Serugendo, G. D. M., and Barata, J. (2008). Designing self-organization for evolvable assembly systems, in *SASO*, pp. 97–106.
- Freitag, L., Grund, M., Singh, S., Partan, J., Koski, P., and Ball, K. (2005). The WHOI micro-modem: an acoustic communications and navigation system for multiple platforms, in *Proceedings of MTS/IEEE Oceans 2005* (Washington, DC, USA), ISBN 0-933957-34-3, pp. 1086–1092, 10.1109/OCEANS.2005.1639901.
- Freitas, A. (2002). A survey of evolutionary algorithms for data mining and knowledge discovery, in A. Ghosh, and S. Tsutsui(Eds.) (eds.), *Advances in Evolutionary Computation* (Springer Verlag).
- Freitas, R. (2006). Pharmacytes: an ideal vehicle for targeted drug delivery, *J. Nanosci. Nanotechnol.*, **6**, pp. 2769–2775.
- Freitas, R. A., Healy, T. J., and Long, J. E. (1981). Advanced automation for space missions, *Proceedings of the 7th international joint conference on Artificial Intelligence*, **2**, pp. 803–808.
- Freundl, E., Steudle, E., and Hartung, W. (1998). Water uptake by roots of maize and sunflower affects the radial transport of abscisic acid and its concentration in the xylem, *Planta*, **207**, pp. 8–19.
- Frew, E., Lawrence, D. A., Dixon, C., Elston, J., and Pisano, W. J. (2007). Lyapunov guidance vector fields for unmanned aircraft applications, in *Proceedings of the American Control Conference (ACC)*, pp. 371–376.

- Frew, E. W., and Brown, T. X. (2008). Airborne communication networks for small unmanned aircraft systems, *Proceedings of the IEEE, Special Issue on Aviation Information Systems*, **96(12)**, pp. 2008–2027.
- Fromm, J. (2005). Types and forms of emergence.
- Fu, Z. (2005). *Swarm-based computation and spatial decision making* Master's Thesis, University of Stuttgart, Germany.
- Fujii, H., Kato, M., and Yoshida, K. (2006). Cooperative action control based on evaluating objective achievements, in I. Noda, A. Jacoff, A. Bredendfeld, and Y. Takahashi (eds.), *RoboCup 2005: Robot Soccer World Cup IX*, Vol. LNAI 4020 (Springer Verlag, Berlin).
- Fujita, M., and Yamaguchi, Y. (2009). Mesoscale modeling for self-organization of colloidal systems, *Curr. Opin. Colloid & Interface Sci.* <http://dx.doi.org/10.1016/j.cocis.2009.06.001>.
- Fukuda, T., Buss, M., Hosokai, H., and Kawauchi, Y. (1991). Cell structured robotic system cebot: control, planning and communication methods, *Robot. Auton. Sys.*, **7(2-3)**, pp. 239–248.
- Fukuda, T., Nakaggawa, S., Kawauchi, Y., and Buss, M. (1989). Structure decision method for self-organizing robots based on cell structure - cebot, in *Proceedings of the International Conference on Robotics and Automation*, IEEE Computer Society Press, pp. 695–700.
- Fukuda, T., and Ueyama, T. (1994). *Cellular Robotics and Micro Robotics Systems* (World Scientific, Singapore).
- Futuyma, D. J., and Slatkin, M. (eds.) (1983). *Coevolution* (Sinauer Associates).
- Gaiarsa, J., O., C., and Y., B.-A. (2002). Long-term plasticity at gabaergic and glycinergic synapses: mechanisms and functional significance, *Trends Neurosci.*, **25**, 11, p. 564–570.
- Galstyan, A., and Lerman, K. (2005). Analysis of a stochastic model of adaptive task allocation in robots, in S. Brueckner, G. D. M. Serugendo, A. Karageorgos, and R. Nagpal (eds.), *Proceedings of the AAMAS-04 Agent Modeling Workshop*, Lecture Notes in Computer Science, Vol. 3464 (New York: Springer Verlag), pp. 167–179.
- Gancet, J., Hattenberger, G., Alami, R., and Lacroix, S. (2005). Task planning and control for a multi-UAV system: architecture and algorithms, in *Proceedings of the IEEE International Conference on Intelligent Robots and Systems* (IEEE Press), pp. 1017–1022.
- Gánti, T. (1971). *The Principle of Life (in Hungarian)* (Budapest: Gondolat).
- Gánti, T. (2003a). *Chemoton Theory* (New York: Kluwer Academic/Plenum Publishers).

- Gánti, T. (2003b). *The Principle of Life* (Oxford: Oxford University Press).
- Gao, J. (2007). Traveling magnetic field for homogeneous wireless power transmission, *IEEE Trans. Power Delivery*, **22(1)**, pp. 507–514.
- Garcla, F. J., Miguel, L. J., and Pern, J. R. (2000). Fault-diagnostic system using analytical fuzzy redundancy, *Eng. Appl. Artif. Intell.*, **13**, pp. 441–450.
- Garnier, S., Jost, C., Gautrais, J., Asadpour, M., Caprari, G., Jeanson, R., Grimal, A., and Theraulaz, G. (2008a). The embodiment of cockroach aggregation behavior in a group of micro-robots, *Artif. Life*, **14(4)**, pp. 387–408.
- Garnier, S., Jost, C., Gautrais, J., Asadpour, M., Caprari, G., Jeanson, R., Grimal, A., and Theraulaz, G. (2008b). The embodiment of cockroach aggregation behavior in a group of micro-robots, *Artif. Life*, **14(4)**, pp. 387–408.
- Garnier, S., Jost, C., Jeanson, R., Gautrais, J., Asadpour, M., Caprari, G., and Theraulaz, G. (2005). Aggregation behaviour as a source of collective decision in a group of cockroach-like-robots, *ADVANCES IN ARTIFICIAL LIFE, PROCEEDINGS*, **3630**, pp. 169–178.
- Garnier, S., Tache, F., Combe, M., Grimal, A., and Theraulaz, G. (2007). Alice in pheromone land: an experimental setup for the study of ant-like robots, in *Proceedings of the Swarm Intelligence Symposium, 2007. SIS 2007. IEEE (Honolulu, HI)* (IEEE Press, Los Alamitos, CA), ISBN 1-4244-0708-7, pp. 37–44, 10.1109/SIS.2007.368024.
- Gasieniec, L., and Lingas, A. (2002). On adaptive deterministic gossiping in ad hoc radio networks, in *Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (SODA '02)* (San Francisco, CA, USA), ISBN 0-89871-513-X, pp. 689–690.
- Gaudio, P., Bonabeau, E., and Shargel, B. (2005). Evolving behaviors for a swarm of unmanned air vehicles, in *Proceedings of the IEEE Swarm Intelligence Symposium* (IEEE Press), pp. 317–324.
- Gaussier, P., Moga, S., Banquet, J., and Quoy, M. (1998). From perception-action loops to imitation processes: a bottom-up approach to learning by imitation, *Appl. Artif. Intell.*, **12(7–8)**, pp. 701–727.
- Gaussier, P., and Zrehen, S. (1994). Avoiding the world model trap: an acting robot does not need to be smart, *Robot. Comp. Integr. Manuf.*, **11**, pp. 279–286.
- Gaweda, A., Setiono, R., and Zurada, J. (2000). Rule extraction from feedforward neural network for function approximation, in *Proceedings of the 5th Conference on Neural Networks and Soft Computing*, Zakopane, Poland, pp. 311–316.

- Gay, S. (2007). *Roombots: Toward Emancipation of Furniture. A Kinematics-Dependent Reconfiguration Algorithm for Chain-Type Modular Robots*, master's thesis, Department of Computer Science, Ecole Polytechnique.
- Gazi, V., and Passino, K. (2004a). A class of attractions/repulsion functions for stable swarm aggregations, *Int. J. Control*, **77(18)**, pp. 1567–1579.
- Gazi, V., and Passino, K. (2004b). Stability analysis of social foraging swarms, *IEEE Trans. Sys. Man Cybern. Part B Cybern.*, **34(1)**, pp. 539–557.
- Geider, R. (2006). *Development of context-based communication protocols for the microrobot 'Jasmine'* (Studienarbeit, University of Stuttgart, Germany).
- Gerkey, B., and Mataric, M. (2004). On role allocation in Robocup, in D. Polani, A. Bonarini, B. Browning, and K. Yoshida (eds.), *RoboCup2003: Robot Soccer World Cup VII* (Springer Verlag, Berlin).
- Gerlach, G., and Dötzel, W. (2008). *Introduction to Microsystem Technology. A Guide for Students*, Microsystem and Nanotechnology Series (John Wiley & Sons).
- Gerstein, M., Bruce, C., Rozowsky, J., Zheng, D., Du, J., and et al (2007). What is a gene, post-encode? History and updated definition, *Genome Res.*, **17**, pp. 669–681.
- Ghadessy, F., Ong, J., and Holliger, P. (2001). Directed evolution of polymerase function by compartmentalized self- replication, *Proc. Natl. Acad. Sci. USA*, **98(8)**, pp. 4552–4557.
- Ghadessy, F., Ramsay, N., Boudsocq, F., Loakes, D., Brown, A., and et al. (2004). Generic expansion of the substrate spectrum of a DNA polymerase by directed evolution, *Nat. Biotechnol.*, **22(6)**, pp. 755–759.
- Ghildiyal, M., and Zamore, P. (2009). Small silencing RNAs: an expanding universe, *Nat. Rev.*, **10**, pp. 94–108.
- Gilbert, N., den Besten, M., Bontovics, A., Craenen, B., Divina, F., Eiben, A., Griffioen, A. R., Hévézi, G., Lörincz, A., Paechter, B., Schuster, S., Schut, M., Tzolov, C., Vogt, P., and Yang, L. (2006). Emerging artificial societies through learning, *J. Artif. Soc. Soc. Simulat.*, **9(2)**.
- Gilbert, W. (1986). The RNA world, *Nature*, **319**, p. 618.
- Gillespie, D. T. (2007). Stochastic simulation of chemical kinetics, *Ann. Rev. Phys. Chem.*, **58**, pp. 35–55.
- Gilpin, K., Kotay, K., Rus, D., and Vasilescu, I. (2008). Miche: Modular shape formation by self-disassembly, *Int. J. Robot. Res.*, **27(3–4)**, pp. 345–372.
- Girko, V. (1974). On the distribution of solutions of systems of linear equations with random coefficients, *Theor. Probab. Math. Stat.*, **2**, pp. 41–44.

- Glotzer, S., Solomon, M., and Kotov, N. (2006). Self-assembly: from nanoscale to microscale colloids, *J. Nanosci. Nanotechnol.*, **6**, pp. 2769–2775.
- Gobet, F., and Simon, H. (1996). Templates in chess memory: a mechanism for recalling several boards, *Cognitive Psychol.*, **31**, pp. 1–40.
- Goel, P., Dedeoglu, G., Roumeliotis, S., and Sukhatme, G. (2000). Fault detection and identification in a mobile robot using multiple model estimation and neural network, in *IEEE International Conference on Robotics and Automation*, pp. 2302–2309.
- Goldbarg, E., Goldbarg, M., and de Souza, G. (2008). *Particle Swarm Optimization Algorithm for the Traveling Salesman Problem* (InTech, Croatia).
- Goldberg, D. (1989). *Genetic Algorithms in Search, Optimization and Machine Learning* (Addison-Wesley/Longman Publishing, Boston).
- Goldberg, D., and Matarić, M. J. (1997). Interference as a tool for designing and evaluating multi-robot controllers, in *Proceedings of the 14th National Conference on Artificial Intelligence (AAAI-97)* (MIT Press), pp. 637–642, citeseer.ist.psu.edu/goldberg97interference.html.
- Goldman, C. V., and Zilberstein, S. (2004). Decentralized control of cooperative systems: categorization and complexity analysis, *J. Artif. Intell. Res.*, **22**, pp. 143–174.
- Goldstein, J. (1999). Emergence as a construct: history and issues, *Emergence: Complexity and Organization*, **1(1)**, pp. 49–72.
- Goldstone, R. L., and Gureckis, T. M. (2009). Collective behaviour, *Trends Cogn. Sci.*, **1(3)**, pp. 412–438.
- GOLEM (2006-2009). *Bio-Inspired Assembly of Meso-Scale Components, NMP-2004-3.4.1.2-1, FP6* (European Communities).
- Goodrich, M. A., McLain, T. W., Anderson, J. D., Sun, J., and Crandall, J. W. (2007). Managing autonomy in robot teams: observations from four experiments, in *HRI '07: Proceedings of the ACM/IEEE international conference on Human-robot interaction* (ACM, New York, NY, USA), ISBN 978-1-59593-617-2, pp. 25–32, <http://doi.acm.org/10.1145/1228716.1228721>.
- Gordon, J. (2006). *Principles of helicopter aerodynamics* (Cambridge University Press).
- Gosden, J. A., and Sisson, R. L. (1962). Standardized comparisons of computer performance, in *IFIP Congress*, pp. 57–61.
- Goss, S., Deneubourg, S. A. J., and Pasteels, J. (1989). Self-organized shortcuts in the argentine ant, *Naturwissenschaften*, **76**, pp. 579–581.

- Goth, A., and Evans, C. S. (2004). Social responses without early experience: Australian brush-turkey chicks use visual cues to aggregate with conspecifics, *J. Exp. Biol.*, **207**, pp. 2199–2208.
- Grasse, P.-P. (1959). La reconstruction du nid et les coordinations interindividuelles chez *bellicositermes natalensis* et *cubitermes* sp. la theorie de la stigmergie: essai d'interpretation du comportement des termites constructeurs, *Insect. Soc.*, **6**, p. 41–83.
- Grasse, P.-P. (1967). Nouvelles experiences sur le termite de müller (macrotermes mülleri) et considerations sur la theorie de la stigmergie, *Insect. Soc.*, **14**, p. 73–102.
- Green, D. (1994). Emergent behavior in biological systems, *Complex. Int.*, **1**, pp. 1–12.
- Green, W. E., and Oh, P. Y. (2005). A MAV that flies like an airplane and hovers like a helicopter, in *Proceedings of the IEEE/ASME International Conference on Advanced Intelligent Mechatronics* (IEEE Press), pp. 699–704.
- Green, W. E., and Oh, P. Y. (2006). Autonomous hovering of a fixed-wing micro air vehicle, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 2164–2169.
- Green, W. E., and Oh, P. Y. (2008). Optic flow based collision avoidance on a hybrid MAV, *IEEE Robot. Autom. Mag.*, **15(1)**, pp. 96–103.
- Gribovskiy, A., Halloy, J., Deneubourg, J.-L., Bleuler, H., and Mondada, F. (2010). Towards mixed societies of chickens and robots, in *IEEE/RSJ 2010 International Conference on Intelligent Robots and Systems (IROS 2010)*.
- Gribovskiy, A., and Mondada, F. (2009a). Real-Time Audio-Visual Calls Detection System for a Chicken Robot, in *Proceedings of the 4th International Conference on Advanced Robotics*.
- Gribovskiy, A., and Mondada, F. (2009b). Real-time audio-visual calls detection system for a chicken robot, in *International Conference on Advanced Robotics, 2009*, pp. 1–6.
- Griebel, M., Knapek, S., and Zumbusch, G. (2007). *Numerical Simulation in Molecular Dynamics. Numerics, Algorithms, Paralelization, Applications* (Springer Verlag, Berlin Heidelberg).
- Griffiths, A., and Tawfik, D. (2000). Man-made enzymes-from design to in vitro compartmentalisation, *Curr. Opin. Biotechnol.*, **11(4)**, pp. 338–353.
- Griffiths, A., and Tawfik, D. (2003). Directed evolution of an extremely fast phosphotriesterase by in vitro compartmentalization, *Embo. J.*, **22(1)**, pp. 24–35.

- Griffiths, A., and Tawfik, D. (2006). Miniaturising the laboratory in emulsion droplets, *Trends Biotechnol.*, **24(9)**, pp. 395–402.
- Griffiths, S., Saunders, J., Curtis, A., Barber, B., McLain, T., and Beard, R. (2006). Maximizing miniature aerial vehicles, *IEEE Robot. Autom. Mag.*, **13(3)**, pp. 34–43.
- Griffiths, S., Saunders, J., Curtis, A., McLain, T., and Beard, R. (2007). Obstacle and terrain avoidance for miniature aerial vehicles, in K. Valavanis (ed.), *Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy*, Vol. 33, chapter 7 (Springer), pp. 213–244.
- Groß, R., Bonani, M., Mondada, F., and Dorigo, M. (2006a). Autonomous self-assembly in a swarm-bot, in *Proceedings of the 3rd International Symposium on Autonomous Minirobots for Research and Edutainment (AMiRE 2005)* (Springer, Berlin), pp. 314–322.
- Groß, R., Bonani, M., Mondada, F., and Dorigo, M. (2006b). Autonomous self-assembly in swarm-bots, *IEEE Trans. Robot.*, **22(6)**, pp. 1115–1130.
- Groß, R., and Dorigo, M. (2004a). Cooperative transport of objects of different shapes and sizes, in *Proceedings of the 4th International Workshop on Ant Colony Optimization and Swarm Intelligence (ANTS 2004)*, Lecture Notes in Computer Science, Vol. 3172 (Berlin: Springer Verlag), pp. 106–117.
- Groß, R., and Dorigo, M. (2004b). Evolving a cooperative transport behavior for two simple robots, in P. Liardet, P. Collet, C. Fonlupt, E. Lutton, and M. Schoenauer (eds.), *Artificial Evolution – 6th International Conference, Evolution Artificielle (EA 2003)*, Lecture Notes in Computer Science, Vol. 2936 (Berlin: Springer Verlag), pp. 305–317.
- Groß, R., and Dorigo, M. (2004c). Group transport of an object to a target that only some group members may sense, in *Parallel Problem Solving from Nature – 8th International Conference (PPSN VIII)*, Lecture Notes in Computer Science, Vol. 3242 (Berlin: Springer Verlag), pp. 852–861.
- Groß, R., and Dorigo, M. (2008a). Evolution of solitary and group transport behaviors for autonomous robots capable of self-assembling, *Adapt. Behav.*, **16(5)**, pp. 285–305.
- Groß, R., and Dorigo, M. (2008b). Self-assembly at the macroscopic scale, *Proceedings of the IEEE*, **96(9)**, pp. 1490–1508.
- Groß, R., and Dorigo, M. (2009). Towards group transport by swarms of robots, *Int. J. Bio-Inspired Comput.*, **1(1–2)**, pp. 1–13.
- Groß, R., Dorigo, M., and Yamakita, M. (2006c). Self-assembly of mobile robots—from swarm-bot to super-mechano colony, in *Proceedings of*

- the 9th International Conference on Intelligent Autonomous Systems* (IOS Press, Amsterdam), pp. 487–496.
- Groß, R., Magnenat, S., Küchler, L., Massaras, V., Bonani, M., and Mondada, F. (2009). Towards an autonomous evolution of non-biological physical organisms, in *Advances in Artificial Life. Proceedings of the 10th European Conference on Artificial Life (ECAL 2009), Lecture Notes in Computer Science*, Vol. 5777/5778 (Berlin: Springer Verlag).
- Groß, R., Mondada, F., and Dorigo, M. (2006d). Transport of an object by six pre-attached robots interacting via physical links, in *Proceedings of the 2006 IEEE International Conference on Robotics and Automation* (IEEE Computer Society Press, Los Alamitos, CA), pp. 1317–1323.
- Groß, R., Nouyan, S., Bonani, M., Mondada, F., and Dorigo, M. (2008). Division of labour in self-organised groups, in *Proceedings of the 10th International Conference on Simulation of Adaptive Behavior, Lecture Notes in Artificial Intelligence*, Vol. 5040 (Berlin: Springer Verlag), pp. 426–436.
- Groß, R., Tuci, E., Dorigo, M., Bonani, M., and Mondada, F. (2006e). Object transport by modular robots that self-assemble, in *Proceedings of the 2006 IEEE International Conference on Robotics and Automation* (IEEE Computer Society Press, Los Alamitos, CA), pp. 2558–2564.
- Grzonka, S., Grisetti, G., and Burgard, W. (2009). Towards a navigation system for autonomous indoor flying, in *Proceedings of the International Conference on Robotics and Automation* (IEEE Press), pp. 2878–2883.
- Grzybowski, B. A., and Campbell, C. (2004). Complexity and dynamic self-assembly, *Chem. Eng. Sci.*, **59**(8–9), pp. 1667–1676.
- Guckenheimer, J., and Holmes, P. (1983). *Nonlinear oscillations, dynamical systems, and bifurcations of vector fields* (Springer Verlag, Berlin).
- Guerrier-Takada, C., Gardiner, K., Marsh, T., Pace, N., and Altman, S. (1983). The RNA moiety of ribonuclease P is the catalytic subunit of the enzyme, *Cell*, **35**, pp. 849–857.
- Guglieri, G., Quagliotti, F. B., and Speciale, G. (2008). Optimal trajectory tracking for an autonomous UAV, *Autom. Control Aersp.*, **1**, pp. 1–9. [online journal]
- Guo, S., Fukuda, T., and Asaka, K. (2003). A new type of fish-like underwater microrobot, in *Proceedings of the IEEE/ASME Transactions on Mechatronics*, Vol. 8-1, pp. 136–141.
- Gurdan, D., Stumpf, J., Achtelik, M., Doth, K., Hirzinger, G., and Rus, D. (2006). Energy-efficient autonomous four-rotor flying robot controlled at 1kHz, in *The 2006 International Conference on Robotics and Automation*.

- Gurdan, D., Stumpf, J., Achtelik, M., Doth, K., Hirzinger, G., and Rus, D. (2007). Energy-efficient autonomous four-rotor flying robot controlled at 1 khz, in *Proceedings of the 2007 IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 361–366.
- Gurvis, J., and Calarco, A. (2007). *Adaptability: Responding Effectively to Change* (Pfeiffer).
- Gutiérrez, A., Campo, A., Dorigo, M., Amor, D., Magdalena, L., Monasterio-Huelin, F., and Madrid, S. (2008). An open localisation and local communication embodied sensor, *Sensors*, **8**, pp. 7545–7563.
- Gutig, F., and Sompolinsky, H. (2006). The tempotron: a neuron that learns spike timing-based decisions. *Nat. Neurosci.*, **9(3)**, pp. 420–428.
- Häbe, D. (2007). *Bio-inspired approach towards collective decision making in robotic swarms* Master's Thesis, University of Stuttgart, Germany.
- Haken, H. (1977). *Synergetics: An Introduction* (Springer Verlag, Berlin, Heidelberg).
- Haken, H. (1983). *Advanced synergetics* (Springer Verlag, Berlin).
- Haken, H. (1984). *Laser theory* (Springer Verlag, Berlin).
- Haken, H. (2006). *Information and self-organization: a macroscopic approach to complex systems*, 3rd edn., Springer Series in Synergetics (Berlin: Springer).
- Halloy, J., Sempo, G., Caprari, G., Rivault, C., Asadpour, M., Tache, F., Said, I., Durier, V., Canonge, S., Ame, J. M., Detrain, C., Correll, N., Martinoli, A., Mondada, F., Siegwart, R., and Deneubourg, J.-L. (2007). Social integration of robots into groups of cockroaches to control self-organized choices, *Science*, **318**, pp. 1155–1158.
- Halpern, J., and Moses, Y. (1990). Knowledge and common knowledge in a distributed environment, *J. Association for Comput. Mach.*, **37(3)**, pp. 549–587.
- Halpern, J. Y., Moses, Y., and Waarts, O. (1990). A characterization of eventual byzantine agreement, *SIAM J. Comput.*, **31(3)**, pp. 838–865.
- Hamann, H., Schmickl, T., Wörn, H., and Crailsheim, K. (2010). Analysis of emergent symmetry breaking in collective decision making, *Neural Computing & Applications*, **21(2)**, pp. 207–218.
- Hamann, H., Wörn, H., Crailsheim, K., and Schmickl, T. (2008). Spatial macroscopic models of a bio-inspired robotic swarm algorithm, in *IEEE/RSJ 2008 International Conference on Intelligent Robots and Systems (IROS'08)* (IEEE Press, Los Alamitos, CA), pp. 1415–1420.

- Hamilton, D., Walker, I., and Bennett, J. (1996). Fault tolerance versus performance metrics for robot systems, in *Proceedings of the IEEE International Conference on Robotics and Automation*, pp. 3073–3080.
- Hammond, P. (1966). *Theory of Self Adaptive Control Systems* (Plenum Press).
- Haroun Mahdavi, S., and Bentley, P. J. (2006). Innately adaptive robotics through embodied evolution, *Auton. Robot.*, **20(2)**, pp. 149–163, <http://dx.doi.org/10.1007/s10514-006-5941-6>.
- Hartland, C., and Bredeche, N. (2006). Evolutionary robotics, anticipation and the reality gap, in *ROBIO* (IEEE Press), pp. 1640–1645.
- Harvey, I., Di Paolo, E. A., Wood, R., Quinn, M., and Tuci, E. (2005). Evolutionary robotics: a new scientific tool for studying cognition, *Artif. Life*, **11(1–2)**, pp. 79–98.
- Hashimoto, M., Kawashima, H., and Oba, F. (2003). A multi-model based fault detection and diagnosis of internal sensor for mobile robot, in *IEEE International Conference on Robotics and Automation*, pp. 3787–3792.
- Hauert, S., Leven, S., Zufferey, J.-C., and Floreano, D. (2010a). Beat-based synchronization and steering for groups of fixed-wing flying robots, in *Proceedings of the 10th International Symposium on Distributed Autonomous Robotics Systems*.
- Hauert, S., Leven, S., Zufferey, J.-C., and Floreano, D. (2010b). Communication-based leashing of real flying robots, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press).
- Hauert, S., Winkler, L., Zufferey, J.-C., and Floreano, D. (2008). Ant-based swarming with positionless micro air vehicles for communication relay, *Swarm Intell.*, **2(2–4)**, pp. 167–188.
- Hauert, S., Zufferey, J.-C., and Floreano, D. (2009a). Evolved swarming without positioning information: an application in aerial communication relay, *Auton. Robot.*, **26(1)**, pp. 21–32.
- Hauert, S., Zufferey, J.-C., and Floreano, D. (2009b). Reverse-engineering of artificially evolved controllers for swarms of robots, in *Proceedings of the IEEE Congress on Evolutionary Computation* (IEEE Press), pp. 55–61.
- Hayes, G., and Demiris, J. (1994). Robot controller using learning by imitation, in *Proceedings of the 2nd International Symposium on Intelligent Robotic Systems*.
- Helbing, D. (1997). *Verkehrsdynamik* (Springer Verlag, Berlin, Heidelberg).

- Heran, H. (1952). Untersuchungen über den Temperatursinn der Honigbiene (*Apis mellifica*) unter besonderer Berücksichtigung der Wahrnehmung strahlender Wärme, *Zeitschrift für vergleichende Physiologie*, **34**, pp. 179–206.
- Hereford, J. M. (2010). Analysis of a new swarm search algorithm based on trophallaxis, in *Proceedings of the IEEE Congress on Evolutionary Computation, Barcelona, Spain, July 2010*.
- Hermann, M. (2005). Bionische Ansätze zur Entwicklung energieeffizienter Fluidsysteme für den Wärmetransport.
- Heylighen, F. (1996). The growth of structural and functional complexity during evolution, in F. Heylighen and D. A. (eds.) (eds.), *The Evolution of Complexity* (Kluwer Academic Publishers, (taken from <http://pespmc1.vub.ac.be/papers/>)).
- Hill, M. D. (1990). What is scalability? *SIGARCH Comput. Archit. News*, **18(4)**, pp. 18–21.
- Himmer, A. (1927). Ein Beitrag zur Kenntnis der Wärmehaushaltes im Nestbau sozialer Hautflügler, *Zeitschrift für vergleichende Physiologie*, **5(2)**, pp. 375–389.
- Hinton, G., and Nowlan, S. (1987). How learning can guide evolution, *Complex Sys.*, **1**, pp. 495–502.
- Hirata, T., Akashi, T., Bertholds, A., Gruber, H., Schmid, A., Gretillat, M.-A., Guenat, O., and De Rooij, N. (1998). A novel pneumatic actuator system realized by microelectrodischarge machining, in *IEEE 11th Int. Workshop on Micro Electro Mechanical Systems (MEMS '98)*, pp. 160–165.
- Hirosue, W., Ookura, A., and Sunada, S. (2003). A study of a coaxial helicopter(ii): analysis on effects of a stabilizer bar on fuselage motion, *Proceedings of the 41st Aircraft Symposium of the Japan Society for Aeronautical and Space Sciences*, **41(1)**, pp. 283–286.
- Hodge, A. (2004). The plastic plant: root responses to heterogeneous supplies of nutrients, *New Phytol.*
- Hodge, A. (2006). Plastic plants and patchy soils, *J. Exp. Bot.*, **57(2)**, pp. 401–411.
- Hoffmann, G., Huang, H., Waslander, S. L., and Tomlin, C. J. (2007). Quadrotor helicopter flight dynamics and control: theory and experiment, in *Proceedings of the AIAA Guidance, Navigation, and Control Conference*, pp. 2007–6461.
- Hoffmann, G., Rajnarayan, D., Waslander, S., Dostal, D., Jang, J., and Tomlin, C. (2004). The Stanford testbed of autonomous rotorcraft for multi agent

- control (STARMAC), in *Proceedings of the 23rd Digital Avionics Systems Conference*, Vol. 2 (IEEE Press), pp. 1–10.
- Hoffmann, G., Waslander, S., and Tomlin, C. (2008). Quadrotor helicopter trajectory tracking control, in *Proceedings of the AIAA Guidance, Navigation, and Control Conference*, pp. 1–14.
- Hofstadter, D., and Mitchell, M. (1995). *The Copycat Project: A Model of Mental Fluidity and Analogy-Making. Fluid Concepts and Creative Analogies: computer models of the fundamental mechanisms of thought* (New York, Basic Books).
- Hogg, T. (2008). Distributed control of microscopic robots in biomedical applications, in M. Prokopenko (ed.), *Advances in Applied Self-Organizing Systems* (Springer Verlag, London, U. K.), pp. 147–174.
- Holland, J. H. (1975). *Adaptation in natural and artificial systems* (University of Michigan Press, Ann Arbor, MI).
- Holland, O., Woods, J., De Nardi, R., and Clark, A. (2005). Beyond swarm intelligence: the UltraSwarm, in *Proceedings of the IEEE Swarm Intelligence Symposium* (IEEE Press), pp. 217–224.
- Hollar, S., Flynn, A., Bellew, C., and Pister, K. (2003). Solar powered 10 mg silicon robot, in *Micro Electro Mechanical Systems, 2003. MEMS-03 Kyoto. IEEE The Sixteenth Annual International Conference on*, pp. 706–711.
- Hölldobler, B., and Wilson, E. (2008). *The Superorganism: The Beauty, Elegance, and Strangeness of Insect Societies* (W. W. Norton and Company), ISBN 978-0393067040.
- Hölldobler, B., and Wilson, E. O. (1990). *The ants* (Harvard Univ. Press, Cambridge, MA).
- Hosokawa, K., Shimoyama, I., and Miura, H. (1994). Dynamics of self-assembling systems: analogy with chemical kinetics, *Artif. Life*, **1(4)**, pp. 413–427.
- Hosokawa, K., Tsujimori, T., Fuji, T., Kaetsu, H., Asama, H., Kuroda, Y., and Endo, I. (1998). Self-organizing collective robots with morphogenesis, in a vertical plane, in *Proceedings of the International Conference on Robotics and Automation*, IEEE Computer Society Press, pp. 2858–2863.
- Hou, F., and Shen, W.-M. (2008). Distributed, dynamic, and autonomous reconfiguration planning for chain-type self-reconfigurable robots, in *Proceedings of the IEEE International Conference on Robotics and Automation* (Pasadena, CA), pp. 3135–3140.

- How, J., Bethke, B., Frank, A., Dale, D., and Vian, J. (2008). Real-time indoor autonomous vehicle test environment, *IEEE Control Sys. Mag.*, **28(2)**, pp. 51–64.
- How, J., King, E., and Kuwata, Y. (2004). Flight demonstrations of cooperative control for UAV teams, in *Proceedings of the AIAA 3rd Unmanned Unlimited Technical Conference, Workshop and Exhibit*, September, AIAA paper AIAA-2004-6490.
- Howard, A., Mataric, M. J., and Sukhatme, G. S. (2002). Mobile sensor network deployment using potential fields: a distributed, scalable solution to the area coverage problem, *Distrib. Auton. Robot. Sys.*, **5**, pp. 299–308.
- Howard, A., Matorić, M. J., and Sukhatme, G. S. (2003). Putting the ‘i’ in ‘team’: an ego-centric approach to cooperative localization, in *IEEE International Conference on Robotics and Automation* (Taipei, Taiwan), pp. 868–892, http://cres.usc.edu/cgi-bin/print_pub_details.pl?pubid=24.
- Howard, A., Parker, L., and Sukhatme, G. (2006a). Experiments with a large heterogeneous mobile robot team: Exploration, mapping, deployment and detection, *Int. J. Robot. Res.*, **25(5–6)**, pp. 431–448.
- Howard, A., Parker, L., and Sukhatme, G. (2006b). The sdr experience: experiments with a large-scale heterogeneous mobile robot team, *Exp. Robot. IX*, **21**, pp. 121–130.
- Hsieh, M., Cowley, A., Kumar, V., and Taylor, C. (2008a). Maintaining network connectivity and performance in robot teams, *J. Field Robot.*, **26(1–2)**, pp. 111–131.
- Hsieh, M., Kumar, V., and Chaimowicz, L. (2008b). Decentralized controllers for shape generation with robotic swarms, *Robotics*, **26**, 5, pp. 691–701.
- Huang, J., Zuo, M. J., and Wu, Y. (2000). Generalized multi-state k -out-of- n : G systems, *IEEE Trans. Reliab.*, **48**, 1.
- Hudlická, E., and Lesser, V. R. (1987). Modeling and diagnosing problem-solving system behavior, *IEEE Trans. Sys. Man Cybern.*, **17**, pp. 407–419.
- Huneman, P. (2008). Emergence made ontological? computational versus combinatorial approaches, *Philos. Sci.*, **75**, 5.
- Hunter, R. (1989). *Foundations of Colloid Science* (Oxford University Press).
- Hunter, R. (2001). *Foundations of Colloid Science*, 2nd edn. (Oxford University Press, Oxford).
- Hussain, A., Black, C., Taylor, I., and Roberts, J. (1999). Soil Compaction. A Role for Ethylene in Regulating Leaf Expansion and Shoot Growth in Tomato? *Plant Physiol.*, **121**, pp. 1227–1237.

- Hutton, T. J. (2009). The organic builder: a public experiment in artificial chemistries and self-replication, *Artif. Life*, **15**(1), pp. 21–28, <http://dx.doi.org/10.1162/artl.2009.15.1.15102>.
- I-Swarm (2003–2007). *Intelligent Small World Autonomous Robots for Micromanipulation, 6th Framework Programme Project No FP6-2002-IST-1* (European Communities).
- Iida, F. (2003). Biologically inspired visual odometer for navigation of a flying robot, *Robot. Auton. Sys.*, **44**, pp. 201–208.
- Ijspeert, A., Hallam, J., and Willshaw, D. (1998). From lampreys to salamanders: evolving neural controllers for swimming and walking, in R. Pfeifer, B. Blumberg, J.-A. Meyer, and S. Wilson (eds.), *From Animals to Animats, Proceedings of the Fifth International Conference on Simulation of Adaptive Behavior* (MIT Press, Cambridge, MA, USA), pp. 390–399.
- Ijspeert, A., Martinoli, A., Billard, A., and Gambardella, L. (2001). Collaboration through the exploitation of local interactions in autonomous collective robotics: the stick pulling experiment, *Auton. Robot.*, **11**(2), pp. 149–171.
- Isaac, R., Ham, T.-W., and Chmielewski, J. (2001). The design of self-replicating helical peptides, *Curr. Opin. Struc. Biol.*, **11**(4), pp. 458–436.
- Isakowitz, T., Kamis, A., and Koufaris, M. (1998). Reconciling top-down and bottom-up design approaches in rmm, *SIGMIS Database*, **29**(4), pp. 58–67, <http://doi.acm.org/10.1145/335505.335512>.
- Ishii, H., Ogura, M., Kurisu, S., Komura, A., Takanishi, A., Iida, N., and Kimura, H. (2006). Experimental study on task teaching to real rats through interaction with a robotic rat, in *9th International Conference on Simulation of Adaptive Behavior*.
- Israelashvili, J. (1998). *Intermolecular and Surface Forces*, 2nd edn. (Academic Press, London).
- Izhikevich, E. M. (2007). Solving the distal reward problem through linkage of stdp and dopamine signaling, *Cerebral Cortex*, **17**, pp. 2443–2452.
- Izzo, D. (2005). *Formation flying linear modelling* (Cranfield University; School of Engineering).
- Izzo, D., and Pettazzi, L. (2007). Autonomous and distributed motion planning for satellite swarm, *J. Guid. Control Dynam.*, **30**(2), pp. 449–459.
- Izzo, D., Pettazzi, L., and Ayre, M. (2005). Mission concept for autonomous on orbit assembly of a large reflector in space, (Paper IAC-05-D1.4.03, 56th International Astronautical Congress, Fukuoka, Japan).

- Jablonka, E., and Lamb, M. (2006). The evolution of information in the major transitions, *J. Theor. Biol.*, **239**(2), pp. 236–246.
- Jablonka, E., and Lamb, R. (1995). *Epigenetic Inheritance and Evolution* (Oxford: Oxford University Press).
- Jackson, A. H., Canham, R., and Tyrrell, A. M. (2003). Robot fault-tolerance using an embryonic array, in *NASA/DoD Conference on Evolvable Hardware*, pp. 91–100.
- Jacob, F., and Monod, J. (1961). Genetic regulatory mechanisms in the synthesis of proteins, *J. Mol. Biol.*, **3**, pp. 318–356.
- Jakuba, M. V., and Yoerger, D. R. (2008). Autonomous search for hydrothermal vent fields with occupancy grid maps, in *Proceedings of the Australasian Conference on Robotics and Automation*, <http://www.araa.asn.au/acra/acra2008/papers/pap152s1.pdf>.
- Jalics, P. J. (1978). Gaining an awareness of the performance of cobol programs, in *Int. CMG Conference*, pp. 61–65.
- Jang, J. S., and Tomlin, C. G. (2001). Autopilot Design for the Stanford DragonFly UAV: validation through Hardware-in-the-Loop Simulation, in *Proceedings of the AIAA Guidance, Navigation and Control Conference (GNC)* (Montreal), AIAA paper AIAA-2001-4179.
- Jeanson, R., and Deneubourg, J. (2007). Conspecific attraction and shelter selection in gregarious insects, *Am. Nat.*, **170**(1), pp. 47–58.
- Jeanson, R., Rivault, C., Deneubourg, J., Blanco, S., Fournier, R., Jost, C., and Theraulaz, G. (2005). Self-organized aggregation in cockroaches, *Anim. Behav.*, **69**, pp. 169–180.
- Jebens, K. (2006). *Development of a docking approach for autonomous recharging system for micro-robot 'Jasmine'* (Studienarbeit, University of Stuttgart, Germany).
- Jeffares, D., Poole, A., and Penny, D. (1998). Relics from the RNA world, *J. Mol. Evol.*, **46**(1), pp. 18–36.
- Jeppesen, B., and Cebon, D. (2004). Analytical redundancy techniques for fault detection in an active heavy vehicle suspension, *Vehicle Sys. Dynam.*, **42**, pp. 75–88.
- Jiménez, M. (2006). *Cooperative actuation in a large robotic swarm* Master's Thesis, University of Stuttgart, Germany.
- Jin, H. D., T (2009). *Chemotaxis. Methods and Protocols* (Humana Press, New York).
- Jogalekar, P., and Woodside, M. (2000). Evaluating the scalability of distributed systems, *IEEE Transactions on Parallel and Distributed Systems*, **11**(6), pp. 589–603.

- Johnson, M., and Demiris, Y. (2004). Abstraction in recognition to solve the correspondence problem for robot imitation, in *Proceedings of Towards Autonomous Robotic Systems (TAROS)*, pp. 63–70.
- Johnson, M., and Demiris, Y. (2005). Perspective taking through simulation, in *Proceedings of Towards Autonomous Robotic Systems (TAROS)*.
- Johnston, B., and Richman, F. (1997). *Numbers and Symmetry: An Introduction to Algebra* (CRC Press).
- Johnston, W., Unrau, P., Lawrence, M., Glasen, M., and Bartel, D. (2001). Rna-catalyzed RNA polymerization: accurate and general RNA-templated primer extension, *Science*, **292**(5520), pp. 1319–1325.
- Jorgensen, M. W., Ostergaard, E. H., and Lund, H. H. (2004). Modular atron: modules for a self-reconfigurable robot, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*.
- Joyce, G. (1998). Nucleid acid enzymes: playing with a fuller deck, *Proc. Natl. Acad. Sci. USA*, **95**, pp. 5845–5847.
- Joyce, G. (2002). The antiquity of RNA-based evolution, *Nature*, **418**(6894), pp. 214–220.
- Joyce, G. (2007). Forty years of in vitro evolution, *Angew. Chem. Int. Ed.*, **46**(34), pp. 6420–6436.
- Julian, B., Schwager, M., Angermann, M., and Rus, D. (2009). A location-based algorithm for multi-hopping state estimations within a distributed robot team, in *Proceedings of the 7th International Conference on Field and Service Robotics (FSR 09)* (Cambridge, MA).
- Julier, S. J., and Uhlmann, J. K. (1997). A non-divergent estimation algorithm in the presence of unknown correlations, in *Proceedings of the American Control Conference* (Albuquerque, New Mexico).
- Kabir, J. (2008). *Simulation and visualization of fluid behavior in bio-inspired self-assembly processes* Master's Thesis, University of Stuttgart, Germany.
- Kadrovach, B. A., and Lamont, G. B. (2001). Design and analysis of swarm-based sensor systems, in *Proceedings of the IEEE Midwest Symposium on Circuits and Systems*, Vol. 1 (IEEE Press), pp. 487–490.
- Kaelbling, L., Littman, M., and Moore, A. (1996). Reinforcement learning: a survey, *J. Artif. Intell. Res.*, **4**, pp. 237–285.
- Kalman, R. (1958). Design of a self-optimizing control system, *Transactions of the ASME*, **80**, pp. 468–478.
- Kamimura, A., Kurokawa, H., Yoshida, E., Murata, S., Tomita, K., and Kokaji, S. (2005). Automatic locomotion design and experiments for a modular

- robotic system, *Mechatronics, IEEE/ASME Transactions on*, **10(3)**, pp. 314–325, 10.1109/TMECH.2005.848299.
- Kaminka, G., and Tambe, M. (1998). What is wrong with us? improving robustness through social diagnosis. in *Proceedings of the 15th National Conference on Artificial Intelligence (AAAI-98)*.
- Kamioka, S., Ajami, D., and J., R. (2010). Autocatalysis and organocatalysis with synthetic structures, *Proc. Natl. Acad. Sci. USA*, **107(2)**, pp. 541–544.
- Kancheva, T. (2007). *Adaptive role dynamics in energy foraging behavior of a real micro-robotic swarm* Master's Thesis, University of Stuttgart, Germany.
- Kaneko, K. (1993). *Theory and application of coupled map lattices* (John Wiley & Sons., Chichester, New York, Brisbane, Toronto, Singapore).
- Kannan, B., and Parker, L. E. (2007). Metrics for quantifying system performance in intelligent, fault-tolerant multi-robot systems, in *Proceedings of IEEE International Conference on Intelligent Robots and Systems (IROS)*.
- Karmiloff-Smith, A. (1995). *Beyond Modularity: A Developmental Perspective on Cognitive Science* (MIT Press).
- Karsai, I. (1999). Decentralized control of construction behavior in paper wasps: an overview of the stigmergy approach, *Artif. Life*, **5(2)**, pp. 117–136.
- Karsai, I., and Balázs, G. (2002). Organization of work via a natural substance: regulation of nest construction in social wasps, *J. Theor. Biol.*, **218(4)**, pp. 549–565, DOI: 10.1006/jtbi.2002.3099.
- Karsai, I., and Penzes, Z. (1993). Comb building in social wasps: Self-organization and stigmergic script, *J. Theor. Biol.*, **161**, pp. 505–525.
- Karsai, I., and Penzes, Z. (2000). Optimality of cell arrangements and rules of thumb in cell initiation in *polistes dominulus*: a modeling approach, *Behav. Ecol.*, **11(4)**, pp. 387–395.
- Kassianidis, E., and Philp, D. (2006a). Design and Implementation of a highly selective minimal self-replicating system, *Angew. Chem. Int. Ed.*, **45(38)**, pp. 6344–6348.
- Kassianidis, E., and Philp, D. (2006b). Reciprocal template effects in a simple synthetic system, *Chem. Commun.*, **39**, pp. 4072–4074.
- Kataoka, N., and Kaneko, K. (2000). Functional dynamics I: Articulation process, *Phys. D*, **138**, pp. 255–250.
- Kataoka, N., and Kaneko, K. (2001). Functional dynamics II: syntactic structure, *Phys. D*, **149**, p. 174–196.

- Kauffman, S. (1986). Autocatalytic sets of proteins, *J. Theor. Biol.*, **119**, pp. 1–24.
- Kawakami, T., Kinoshita, M., and Kakazu, Y. (2000). Collective robots navigation by reinforcement learning mechanisms with common knowledge field.
- Kazama, T., Sugawara, K., and Watanabe, T. (2004). Collecting behaviour of interacting robots with virtual pheromone, in *Proceedings of the 7th International Symposium on Distributed Autonomous Robotic Systems (DARS)*, pp. 331–340.
- Kazarian, S., and Chan, K. (2003). "chemical photography" of drug release, *Macromolecules*, **36**, pp. 9866–9872.
- Keijzer, F. (2003). Making decisions does not suffice for minimal cognition, *Adapt. Behav.*, **11(4)**, pp. 266–269.
- Kelley, W., and Peterson, A. (1991). *Difference equations. An introduction with Applications* (B.G. Teubner Stuttgart, Academic Press).
- Kemp, C., and Tenenbaum, J. B. (2008). The discovery of structural form, *Proc. Natl. Acad. Sci. USA*, **105(31)**, pp. 10687–10692.
- Kendoul, F., Zhenyu, Y., and Nonami, K. (2009). Embedded autopilot for accurate waypoint navigation and trajectory tracking: application to miniature rotorcraft UAVs, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 2332–2338.
- Kennedy, J., and Eberhart, R. (2001). *Swarm Intelligence* (Morgan Kaufmann Publishers: San Francisco).
- Kernbach, S. (2008). *Structural Self-organization in Multi-Agents and Multi-Robotic Systems* (Logos Verlag, Berlin).
- Kernbach, S. (2010a). From robot swarm to artificial organisms: self-organization of structures, adaptivity and self-development, in P. Levi, and S. Kernbach (eds.), *Symbiotic Multi-Robot Organisms Reliability, Adaptability, Evolution* (Springer, Berlin), pp. 5–25.
- Kernbach, S. (2010b). Towards application of collective robotics in industrial environment, in G. Rigatos (ed.), *Industrial Systems: Modelling, Automation and Adaptive Behaviour* (IGI Global), pp. 18–49.
- Kernbach, S., Hamann, H., Stradner, J., Thenius, R., Schmickl, T., Crailsheim, K., Rossum, A. C. v., Sebag, M., Bredeche, N., Yao, Y., Baele, G., Peer, Y. V. d., Timmis, J., Mohktar, M., Tyrrell, A., Eiben, A. E., McKibbin, S. P., Liu, W., and Winfield, A. F. T. (2009a). On adaptive self-organization in artificial robot organisms, in *Proceedings of the 2009 Computation World: Future Computing, Service Computation, Cognitive, Adaptive, Content, Patterns*, COMPUTATIONWORLD '09 (IEEE

- Computer Society, Washington, DC, USA), ISBN 978-0-7695-3862-4, pp. 33–43, <http://dx.doi.org/10.1109/ComputationWorld.2009.9>.
- Kernbach, S., and Kernbach, O. (2010). Structural self-organized control, in P. Levi, and S. Kernbach (eds.), *Symbiotic Multi-Robot Organisms: Reliability, Adaptability, Evolution* (Springer Verlag, Berlin, Heidelberg), pp. 306–326.
- Kernbach, S., Levi, P., Meister, E., Schlachter, F., and Kernbach, O. (2009b). Towards self-adaptation of robot organisms with a high developmental plasticity, in *Proceedings of the 2009 Computation World: Future Computing, Service Computation, Cognitive, Adaptive, Content, Patterns*, COMPUTATIONWORLD '09 (IEEE Computer Society, Washington, DC, USA), ISBN 978-0-7695-3862-4, pp. 180–187, <http://dx.doi.org/10.1109/ComputationWorld.2009.11>.
- Kernbach, S., Meister, E., Schlachter, F., and Kernbach, O. (2010). Adaptation and self-adaptation of developmental multi-robot systems, *Int. J. Adv. Intell. Sys.*, **3**(1–2), pp. 121–140.
- Kernbach, S., Nepomnyashchikh, V., Kancheva, T., and Kernbach, O. (2011). Specialization and generalization of robotic behavior in swarm energy foraging, *Math. Comp. Modell. Dyn. Sys.*, **18**(1), pp. 131–152.
- Kernbach, S., Thenius, R., Kernbach, O., and Schmickl, T. (2009c). Re-embodiment of honeybee aggregation behavior in artificial micro-robotic system, *Adapt. Behav.*, **17**(3), pp. 237–259.
- Kessin, R. (2001a). *Dictyostelium: Evolution, Cell Biology, and the Development of Multicellularity* (Cambridge University Press, Cambridge, UK).
- Kessin, R. (2001b). *Dictyostelium: Evolution, Cell Biology, and the Development of Multicellularity* (Cambridge University Press, Cambridge).
- Kim, J., and Sukkarieh, S. (2007). Real-time implementation of airborne inertial-SLAM, *Robot. Auton. Sys.*, **55**(1), pp. 62–71.
- Kim, J.-H., Wishart, S., and Sukkarieh, S. (2006). Real-time navigation, guidance, and control of a uav using low-cost sensors, in *Field and Service Robotics, Springer Tracts in Advanced Robotics*, Vol. 24 (Berlin: Springer), pp. 299–309.
- Kim, S., Knoll, T., and Scholz, O. (2007). Feasibility of inductive communication between millimeter-sized wireless robots, *IEEE Trans. Robot.*, **23**(3), pp. 605–609.
- Kim, Y.-K., Katsurai, M., and Fujita, H. (1990). Fabrication and testing of a micro superconducting actuator using the meissner effect, in *IEEE 3rd Int. Workshop on Micro Electro Mechanical Systems (MEMS '90)*, pp. 61–66.

- Kingston, D. B., and Beard, R. W. (2004). Real-time attitude and position estimation for small uavs using low-cost sensors, in *Proceedings of the AIAA 3rd Unmanned Unlimited Systems Conference and Workshop*, AIAA paper AIAA-2004-6533.
- Kinsey, J. C., Eustice, R. M., and Whitcomb, L. L. (2006). A survey of underwater vehicle navigation: recent advances and new challenges, in *IFAC Conference of Manoeuvring and Control of Marine Craft* (Lisbon, Portugal), invited paper.
- Kirby, B., Campbell, J. D., Aksak, B., Pillai, P., Hoburg, J. F., Mowry, T. C., and Goldstein, S. C. (2005). Catoms: moving robots without moving parts, in *AAAI (Robot Exhibition)* (Pittsburgh, PA).
- Kitano, H. (ed.) (1998). *RoboCup-97: Robot Soccer World Cup I, Lecture Notes in Artificial Intelligence*, Vol. 1395 (Berlin: Springer Verlag), ISBN 978-3-540-64473-6.
- Kitano, H., Asada, M., Kuniyoshi, Y., Noda, I., Osawai, E., and Matsubara, H. (1998). Robocup: a challenge problem for ai and robotics, in *RoboCup-97: Robot Soccer World Cup I*, Vol. Lecture Notes in Computer Science, 1395 (Berlin: Springer Verlag).
- Kiziltan, Z., and Milano, M. (2002). Group-graphs associated with row and column symmetries of matrix models: some observations, in *Proceedings of the CP'02 Workshop on Symmetry in Constraint Satisfaction Problems (SymCon'02)*.
- Kladitis, P. E., and Bright, V. M. (2000). Prototype microrobots for micro-positioning and micro-unmanned vehicles, *Sens. Actuators A, Phys.*, **A80-2**, pp. 132–137.
- Klaptocz, A., Boutinard Rouelle, G., Briod, A., Zufferey, J.-C., and Floreano, D. (2010). An indoor flying platform with collision robustness and self-recovery, in *Proceedings of the IEEE/RSJ International Conference on Robotics and Automation* (IEEE Press), pp. 3349–3354.
- Klavins, E., Ghrist, R., and Lipsky, D. (2006). A grammatical approach to self-organizing robotic systems, *IEEE Trans. Automat. Contr.*, **51(6)**, pp. 949–962.
- Klawonn, F., and Keller, A. (1997). Fuzzy clustering and fuzzy rules, in *7th International Fuzzy Systems Association World Congress*, pp. 193–198.
- Kloetzer, M., and Belta, C. (2010). Automatic deployment of distributed teams of robots from temporal logic motion specifications, *IEEE Trans. Robot.*, **26(1)**, pp. 48–61.
- Knoebel, N. B., Osborne, S. R., Matthews, J. S., Eldredge, A. M., and Beard, R. W. (2006). Computationally simple model reference adaptive control

- for miniature air vehicles, in *Proceedings of the American Control Conference*, pp. 5978–5983.
- Koditschek, D. E., and Rimon, E. (1990). Robot navigation functions on manifolds with boundary, *Advances Appl. Math.*, **11(4)**, pp. 412–442.
- Koenig, L. (2007). *A model for developing behavioral patterns on multi-robot organisms using concepts of natural evolution* Master's Thesis, University of Stuttgart, Germany.
- Koenig, L., Jebens, K., Kernbach, S., and Levi, P. (2007). Stability of on-line and on-board evolving of adaptive collective behavior, in *Proceedings of the EUROS 2008*, Prague.
- Koenig, N., and Howard, A. (2004). Design and use paradigms for gazebo, an open-source multi-robot simulator, in *IEEE/RSJ International Conference on Intelligent Robots and Systems* (Sendai, Japan), pp. 2149–2154, http://cres.usc.edu/cgi-bin/print_pub_details.pl?pubid=394.
- Kok, J. R., Spaan, M. T., and Vlassis, N. (2005). Non-communicative multi-robot coordination in dynamic environments, *Robot. Auton. Sys.*, **5(2–3)**, pp. 99–114.
- Kornienko, O., Kornienko, S., and Levi, P. (2001). Collective decision making using natural self-organization in distributed systems, in *Proceedings of International Conference on Computational Intelligence for Modelling, Control and Automation (CIMCA'2001)*, Las Vegas, pp. 460–471.
- Kornienko, S., and Kornienko, O. (1999). Control of periodical motion using the synergetic concept, Not published yet.
- Kornienko, S., Kornienko, O., Constantinescu, C., Pradier, M., and Levi, P. (2005a). Cognitive micro-agents: individual and collective perception in microrobotic swarm, in *Proceedings of the IJCAI-05 Workshop on Agents in Real-Time and Dynamic Environments*, Edinburgh, UK.
- Kornienko, S., Kornienko, O., and Levi, P. (2003a). Agent-based handling of exceptional processes in transformable manufacturing systems, Submitted to: M.Beetz, J.Hertzberg, M.Ghallab, and M.Pollack (Edts.), *Plan-Based Control of Robotic Agents*, World Scientific.
- Kornienko, S., Kornienko, O., and Levi, P. (2003b). Application of distributed constraint satisfaction problem to the agent-based planning in manufacturing systems, in *Proceedings of IEEE International Conference on AI Systems (AIS'03)*, Divnomorsk, Russia, pp. 124–140.
- Kornienko, S., Kornienko, O., and Levi, P. (2003c). Flexible manufacturing process planning based on the multi-agent technology, in *Proceedings of the 21st IASTED International Conference on AI and Applications (AIA 2003)*, Innsbruck, Austria, pp. 156–161.

- Kornienko, S., Kornienko, O., and Levi, P. (2004a). About nature of emergent behavior in micro-systems, in *Proceedings of the International Conference on Informatics in Control, Automation and Robotics (ICINCO 2004)*, Setubal, Portugal, pp. 33–40.
- Kornienko, S., Kornienko, O., and Levi, P. (2004b). Generation of desired emergent behavior in swarm of micro-robots, in *Proceedings of the 16th European Conference on AI (ECAI 2004)*, Valencia, Spain.
- Kornienko, S., Kornienko, O., and Levi, P. (2004c). Multi-agent repairer of damaged process plans in manufacturing environment, in *Proceedings of the 8th Conference on Intelligent Autonomous Systems (IAS-8)*, Amsterdam, pp. 485–494.
- Kornienko, S., Kornienko, O., and Levi, P. (2005b). Collective ai: context awareness via communication, in *Proceedings of the IJCAI 2005*, Edinburgh, UK.
- Kornienko, S., Kornienko, O., and Levi, P. (2005c). Ir-based communication and perception in microrobotic swarms, in *Proceedings of the IROS 2005*, Edmonton, Canada.
- Kornienko, S., Kornienko, O., and Levi, P. (2005d). Minimalistic approach towards communication and perception in microrobotic swarms, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. 4005–4001.
- Kornienko, S., Kornienko, O., and Levi, P. (2005e). Swarm embodiment - a new way for deriving emergent behaviour in artificial swarms, in P. et al. (ed.), *Autonome Mobile Systeme (AMS'05)*, pp. 25–32.
- Kornienko, S., Kornienko, O., Nagarathinam, A., and Levi, P. (2007). From real robot swarm to evolutionary multi-robot organism, in *Proceedings of the CEC 2007*, Singapore, pp. 1483–1490.
- Kornienko, S., Kornienko, O., and Priese, J. (2004d). Application of multi-agent planning to the assignment problem, *Comput. Industry*, **54**(3), pp. 273–290.
- Korst, P. J. A. M., and Velthuis, H. H. W. (1982). The nature of trophallaxis in honeybees, *Insect. Soc.*, **29**(2), pp. 209–221, 10.1007/BF02228753.
- Kotay, K., Rus, D., Vona, M., and McGray, C. (1998). The self-reconfiguring robotic molecule, in *Proceedings of the IEEE International Conference on Robotics and Automation*, pp. 424–431.
- Kottege, N., and Zimmer, U. (2008a). Acoustical methods for azimuth, range and heading estimation in underwater swarms, in *Proceedings of Acoustics '08, Palais des Congress, Paris, France, 29 June-4 July 2008* (Paris, France), p. 5.

- Kottege, N., and Zimmer, U. R. (2008b). Cross-correlation tracking for maximum length sequence based acoustic localisation, in *Proceedings of the Australasian Conference on Robotics and Automation (ACRA '08)* (Canberra, ACT, Australia), ISBN 978-2-9521105-4-9.
- Kouptsov, K. (2008). Production-rule complexity of recursive structures, in A. Minai, and Y. Bar-Yam (eds.), *Unifying Themes in Complex Systems IV, Proceedings of the 4th International Conference on Complex Systems* (Springer Verlag, Berlin), pp. 149–157.
- Kovac, M., Germann, J. M., Huerzeler, C., Siegart, R., and Floreano, D. (2010). A perching mechanism for micro aerial vehicles, *J. Micro-Nano Mechatron.*, **5(3–4)**, pp. 77–91.
- Kovacina, M., Palmer, D., Yang, G., and Vaidyanathan, R. (2002). Multi-agent control algorithms for chemical cloud detection and mapping using unmanned air vehicles, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and System*, Vol. 3 (IEEE Press), pp. 2782–2788.
- Koza, J. (1992). *Genetic programming: on the programming of computers by means of natural selection* (MIT Press, Cambridge, Massachusetts, London, England).
- Krasnogor, N. (2002). *Studies on the Theory and Design Space of Memetic Algorithms*, Ph.D. thesis, University of the West of England, <http://www.cs.nott.ac.uk/~nxk/PAPERS/thesis.pdf>, supervisor: Dr. J.E. Smith.
- Krieger, M., and Billeter, J.-B. (2000). The call of duty: Self-organised task allocation in a population of up to twelve mobile robots, *J. Robot. Auton. Sys.*, **30**, pp. 65–84.
- Kristiansen, R., and Nicklasson, P. J. (2009). Spacecraft formation flying: a review and new results on state feedback control, *Acta Astronautica*, **65(11–12)**, pp. 1537–1552.
- Kruger, K., Grabowski, P., Zaugg, A., Sands, J., Gottschling, D., and *et al.* (1982). Self-splicing RNA: autoexcision and autocyclization of the ribosomal RNA intervening sequence of *Tetrahymena*, *Cell*, **31**, pp. 147–157.
- Kube, C. R., and Bonabeau, E. (2000). Cooperative Transport by Ants and Robots, *Robot. Auton. Sys.*, **30(1–2)**, pp. 85–101.
- Kube, C. R., and Zhang, H. (1997). *Collective robotics: from local perception to global action*, Ph.D. thesis, University of Alberta.
- Kubík, A. (2003). Toward a formalization of emergence, *Artif. Life*, **9**, p. 41–65.

- Kubo, M., and Melhuish, C. (2004). Robot trophallaxis: managing energy autonomy in multiple robots, in *Proceedings of Towards Autonomous Robotic Systems*, pp. 77–84.
- Kuiper, E., and Nadjm-Tehrani, S. (2006). Mobility models for UAV group reconnaissance applications, in *Proceedings of the IEEE International Conference on Wireless and Mobile Communications* (IEEE Press), p. 33.
- KUKA (2006). The KUKA lightweight robot heralds visions of the future for robot technology, *Press release*.
- Kumar, S. (2006). Self-organization of disc-like molecules: chemical aspects, *Chemical Society Reviews*, **35**(1), pp. 83–109.
- Kumar, V., Rus, D., and Sukhatme, G. (2008). Networked robots, in *Springer Handbook of Robotics*, pp. 943–958.
- Kun, A., Papp, B., and Szathmáry, E. (2008). Computational identification of obligatorily autocatalytic replicators embedded in metabolic networks, *Genome Biology*, **9**, p. R51.
- Kundu, A., Jang, J. H., Gil, J. H., Jung, C. R., Lee, H. R., Kim, S. H., Ku, B., and Oh, Y. S. (2007). Micro-fuel cells—current development and applications, *J. Power Sources*, **170**(1), pp. 67–78.
- Kundu, P., and I., C. (2002). *Fluid Mechanics, 2nd Ed.* (Academic).
- Kuniyoshi, Y., and Sangawa, S. (2006). Early motor development from partially ordered neural-body dynamics: experiments with a cortico-spinal-musculo-skeletal model, *Biol. Cybern.*, **95**(6), pp. 589–605.
- Kurokawa, H., Tomita, K., Kamimura, A., Kokaji, S., Hasuo, T., and Murata, S. (2008). Distributed self-reconfiguration of m-tran iii modular robotic system, *Int. J. Robot. Res.*, **27**(3–4), pp. 373–386.
- Kurokawa, H., Tomita, K., Kamimura, A., Yoshida, E., Kokaji, S., and Murata, S. (2005). Distributed self-reconfiguration control of modular robot m-tran, in *Proceedings of the (IEEE) International Conference on Mechatronics and Automation*, (Niagara Falls, Canada), pp. 254–259.
- Kusiak, A. (1990). *Intelligent manufacturing systems* (Prentice-Hall, Englewood Cliffs, NJ).
- Kusy, B., Sallai, J., G. Balogh, A. L., and J. Tolliver, V. P., DeNap, F., and Parang, M. (2007). Radio interferometric tracking of mobile wireless nodes, in *ACM MobiSys*, pp. 139–151.
- Labella, T. H., Dorigo, M., and Deneubourg, J.-L. (2006). Division of labour in a group of robots inspired by ants' foraging behaviour, *ACM Transactions on Autonomous and Adaptive Systems*, **1**(1), pp. 4–25.

- Lagzi, I., Soh, S., Wesson, P., Browne, K., and Grzybowski, B. (2010). Maze solving by chemotactic droplets, *J. Am. Chem. Soc.*, **132**, pp. 1198–1199.
- Laidler, K. (1987). *Chemical Kinetics* (Harper Collins Publishers).
- Lakshmikantham, V., and Rao, M. R. M. (1995). *Theory of Integro-Differential Equations (Stability and Control: Theory, Methods and Applications)* (Gordon and Breach Science, Lausanne, Switzerland).
- Lamarck, J. B. (1809). *Philosophie zoologique, ou Exposition des considérations relatives à l'histoire naturelle des animaux* (H.R. Engelmann).
- Lampert, L., Shostak, R., and Pease, M. (1982). The byzantine generals problem, *ACM Transactions on Programming Languages and Systems*, **4**, pp. 382–401.
- Lancet, D., and Shenhav, B. (2009). Compositional Lipid Protocells: Reproduction without Polynucleotides, in S. Rasmussen, M. Bedau, L. Chen, D. Deamer, D. Krakauer, and et al. (eds.), *Protocells* (The MIT Press, Cambridge), pp. 233–252.
- Landau, L., and Lifshitz, E. (1976). *Course of theoretical physics. Volume 1. Mechanics* (Butterworth-Heinemann, Oxford).
- Landau, L., and Lifshitz, E. (1981). *Course of theoretical physics. Volume 3. Quantum Mechanics: Non-Relativistic Theory* (Butterworth-Heinemann, Oxford).
- Landweber, L., Simon, P., and Wagner, T. (1998). Ribozyme engineering and early evolution, *Bio. Sci.*, **48(2)**, pp. 94–103.
- Lanzisera, S., Lin, D. T., and Pister, K. S. J. (2006). RF time of flight ranging for wireless sensor network localization, in *Proceedings of the 4th Workshop on Intelligent Solutions in Embedded Systems*, pp. 1–12.
- Larsen, J., Garcia, R., and Stoy, K. (2010). Increased versatility of modular robots through layered heterogeneity, in *Proceedings of the ICRA Workshop on Modular Robots, State of the Art* (Anchorage, Alaska), pp. 24–29.
- Lau, H. Y. K., Ko, A. W. Y., and Lau, T. L. (2008). The design of a representation and analysis method for modular self-reconfigurable robots, *Robot. Comput.-Integr. Manuf.*, **24(2)**, pp. 258–269, <http://dx.doi.org/10.1016/j.rcim.2006.11.003>.
- Lau, N., Lopes, L. S., Corrente, G., and Filipe, N. (2009). Multi-robot team coordination through roles, positionings and coordinated procedures, in *IROS'09: Proceedings of the 2009 IEEE/RSJ international conference on Intelligent robots and systems* (IEEE Press, Piscataway, NJ, USA), ISBN 978-1-4244-3803-7, pp. 5841–5848.

- Laughlin, R. M. (2006). *A Different Universe: Reinventing Physics from the Bottom Down* (Basic Books).
- Lawrence, D., Donahue, R., Mohseni, K., and Han, R. (2004). Information energy for sensor-reactive UAV flock control, in *Proceedings of the AIAA "Unmanned Unlimited" Technical Conference*, AIAA paper AIAA-2004-6530.
- Lawrence, D. A., Frew, E. W., and Pisano, W. J. (2008). Lyapunov vector fields for autonomous unmanned aircraft flight control, *J. Guid. Control Dynam.*, **31(5)**, pp. 1220–1229.
- Ledeczi, A., Karsai, G., and Bapty, T. (2000). Synthesis of self-adaptive software, in *Proceedings of the IEEE Aerospace 2000 Conference* (Big Sky, MT).
- Lee, I. S., Kim, J. T., and Lee, J. W. (2003). Model-based fault detection and isolation method using ART2 neural network, *Int. J. Intell. Sys.*, **18**, pp. 1087–1100.
- Lee, T.-C., and Peterson, A. (1990). Adaptive vector quantization using a self-development neural network, *IEEE J. Select. Areas Commun.*, **8(8)**, pp. 1458–1471.
- Lee, Y., Tawfik, D., and Griffiths, A. (2002). Investigating the target recognition of DNA cytosine-5 methyltransferase Hhal by library selection using in vitro compartmentalisation, *Nucl. Acid Res.*, **30(22)**, pp. 4937–4944.
- Leitner, J. (2009). Multi-robot cooperation in space: a survey, *Advanced Technologies for Enhanced Quality of Life*, pp. 144–151.
- Lentink, D. (2008). *Exploring the Biofluidynamics of Swimming and Flight*, Ph.D. thesis, Experimental Zoology Group, Wageningen University.
- Lentink, D., Jongerius, S., and Bradshaw, N. (2009). The scalable design of flapping micro-air vehicles inspired by insect flight, in D. Floreano, J.-C. Zufferey, M. Srinivasan, and C. Ellington (eds.), *Flying Insects and Robots*, chapter 14 (Springer), pp. 185–205.
- Leonard, N. E., Paley, D. A., Lekien, F., Sepulchre, R., Fratantoni, D. M., and Davis, R. E. (2007). Collective motion, sensor networks, and ocean sampling, *Proceedings of the IEEE*, **95(1)**, pp. 48–74, 10.1109/JPROC.2006.887295.
- Lerman, K., and Galstyan, A. (2002). Mathematical model of foraging in a group of robots: effect of interference, *Auton. Robot.*, **13(2)**, pp. 127–141.

- Lerman, K., and Galstyan, A. (2003). Macroscopic analysis of adaptive task allocation in robots, in *Proceeding of International Conference on Intelligent Robots and Systems (IROS-03)*.
- Lerman, K., Jones, C., Galstyan, A., and Mataric, M. (2006). Analysis of dynamic task allocation in multi-robot systems, *Int. J. Robot. Res.*, **25(3)**, pp. 225–242.
- Lerman, K., Martinoli, A., and Galstyan, A. (2005). A review of probabilistic macroscopic models for swarm robotic systems.
- Leuschen, M. L., Cavallaro, J. R., and Walker, I. D. (2002). Robotic fault detection using nonlinear analytical redundancy, in *IEEE International Conference on Robotics and Automation*, Vol. 1, pp. 456–463.
- Leven, S., Zufferey, J.-C., and Floreano, D. (2009). A Minimalist Control Strategy for Small UAVs, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (IEEE Press), pp. 2873–2878.
- Leven, S., Zufferey, J.-C., and Floreano, D. (2010). Dealing with mid-air collisions in dense collective aerial systems, *J. Field Robot.*, **28(3)**, pp. 405–423.
- Levi, P., and Bräunl, T. (eds.) (1994). *Autonome Mobile Systeme 1994* (Springer, Berlin, Heidelberg).
- Levi, P., and Kernbach, S. (eds.) (2010). *Symbiotic Multi-Robot Organisms: Reliability, Adaptability, Evolution* (Springer Verlag).
- Levi, P., Schanz, M., Kornienko, S., and Kornienko, O. (1999). Application of order parameter equation for the analysis and the control of nonlinear time discrete dynamical systems, *Int. J. Bifurcation and Chaos*, **9(8)**, pp. 1619–1634.
- Levine, W. S. (1996). *Sample-Rate Selection*, Vol. Series II, chapter 16 (CRC & IEEE Press), pp. 313–321.
- Levy, M., Griswold, K., and Ellington, A. (2005). Direct selection of transacting ligase ribozymes by in vitro compartmentalization, *RNA*, **11(10)**, pp. 1555–1562.
- Lewis, M. A., and Tan, K. H. (1997). High precision formation control of mobile robots using virtual structures, *Auton. Robot.*, **4(4)**, pp. 387–403.
- Li, J., Browning, S., Mahal, S., Oelschlegel, A., and C., W. (2009). *Darwinian evolution of prions in cell culture* (Science: DOI: 10.1126/science.1183218).
- Li, M., and Vitanyi, P. (1997). *An Introduction to Kolmogorov Complexity and Its Applications (Graduate Texts in Computer Science)* (Springer Verlag).

- Li, X., and Chmielewski, J. (2003). Challenges in the design of self replicating peptides, *Org. Biomol. Chem.*, **1**, pp. 901–901.
- Li, X., and Parker, L. E. (2007). Sensor analysis for fault detection in tightly-coupled multi-robot team tasks, in *Proceedings of IEEE International Conference on Robotics and Automation (ICRA)*.
- Li, X., and Parker, L. E. (2009). Distributed sensor analysis for fault detection in tightly-coupled multi-robot team tasks, in *Proceedings of IEEE International Conference on Robotics and Automation (ICRA)*.
- Lim, I. S., and Thalmann, D. (2000). Tournament selection for browsing temporal signals, in *Proceedings of the 2000 ACM Symposium on Applied Computing (SAC-00)* (ACM, New York), pp. 570–573, <http://doi.acm.org/10.1145/338407.338499>.
- Lima, P., Bonarini, A., Machado, C., Marchese, F. M., Marques, C., Ribeiro, F., and Sorrenti, D. G. (2001). Omnidirectional catadioptric vision for soccer robots, *Int. J. Robot. Auton. Sys.*, **36(2–3)**, pp. 87–102.
- Lincoln, T., and Joyce, G. (2009). Self-sustained replication of an RNA enzyme, *Science*, **323(5918)**, pp. 1229–1232.
- Lindhé, M., Johansson, K. H., and Bicchì, A. (2007). An experimental study of exploiting multipath fading for robot communications, in *Proceedings of Robotics: Science and Systems*, Atlanta, GA.
- Lindsay, R. K., Buchanan, E. A., Feigenbaum, E. A., and Ledergerg, J. (1980). *Applications of Artificial Intelligence for Organic Chemistry: The Dendral Project* (McGraw-Hill).
- Lipson, H., Bongard, J., Zykov, V., and Malone, E. (2006). Evolutionary robotics for legged machines: from simulation to physical reality, in *Proceedings of the 9th Intl. Conference on Intelligent Autonomous System*, pp. 11–18.
- Lipson, H., and Pollack, J. (2000). Automatic design and manufacture of robotic life forms, *Nature*, **406**, pp. 974–978.
- Lipson, H., White, P., and Zykov, J., V. and Bongard (2005). 3d stochastic reconfiguration of modular robots, in *Proceedings of the Workshop on Self-Reconfigurable Robotics at the Robotics Science and Systems Conference (MIT)*.
- Liu, H., and Coghill, G. M. (2005). A model-based approach to robot fault diagnosis, *Knowledge-Based Systems*, **18(4–5)**, pp. 225–233.
- Liu, W. (2008). *Design and Modelling of Adaptive Foraging in Swarm Robotic Systems*, Ph.D. thesis, University of the West of England, Bristol.

- Liu, W., and Winfield, A. F. T. (2010a). Modelling and Optimisation of Adaptive Foraging in Swarm Robotic Systems, *Int. J. Robot. Res.*, **29**, 14, 10.1177/0278364910375139.
- Liu, W., and Winfield, A. F. T. (2010b). Open-hardware e-puck Linux extension board for experimental swarm robotics research, *Microprocessors and Microsystems*, **35**(1), pp. 60–67.
- Liu, W., Winfield, A. F. T., and Sa, J. (2007a). Modelling swarm robotic systems: a case study in collective foraging, in *Proceedings of Towards Autonomous Robotic Systems*, pp. 25–32.
- Liu, W., Winfield, A. F. T., and Sa, J. (2009). A macroscopic probabilistic model of adaptive foraging in swarm robotics systems, in *Proceedings of the 6th Vienna International Conference on Mathematical Modelling (Mathmod 2009)*, Special Session on Modelling the Swarm.
- Liu, W., Winfield, A. F. T., Sa, J., Chen, J., and Dou, L. (2007b). Towards energy optimisation: emergent task allocation in a swarm of foraging robots, *Adaptive Behaviour*, **15**(3), pp. 289–305.
- Lizarraga, M. I., Ilstrup, D. M., Elkaim, G. H., and Davis, J. (2008). Aerial photography using a nokia N95, in *Proceedings of the World Congress on Engineering and Computer Science*.
- Lo, Y. T., and Lee, S. W. (1993). Antenna theory, in *Antenna Handbook* (Kluwer Academic Publishers).
- Lochmatter, T., and Martinoli, A. (2009). *Experimental Robotics 11*, Vol. 54, chapter Tracking Odor Plumes in a Laminar Wind Field with Bio-Inspired Algorithms, Springer Tracts in Advanced Robotics (Berlin: Springer Verlag), pp. 473–482.
- Lochmatter, T., Roduit, P., Cianci, C., Correll, N., Jacot, J., and Martinoli, A. (2008). Swistrack - a flexible open source tracking software for multi-agent systems, in *Proceedings of the 2008 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2008)*, pp. 4004–4010.
- Long, M., Murphy, R. R., and Parker, L. E. (2003). Distributed multi-agent diagnosis and recovery from sensor failures, in *Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 2506–2513.
- Lopez-Bucio, J., Cruz-Ramirez, A., and Herrera-Estrella, L. (2003). The role of nutrient availability in regulating root architecture, *Curr. Opin. Plant Biol.*, **6**(3), pp. 280–287.
- Lucarelli, D., and Wang, I. J. (2004). Decentralized synchronization protocols with nearest neighbor communication, in *Proceedings of the 2nd*

- International Conference on Embedded Networked Sensor Systems* (ACM), pp. 62–68.
- Ludlow, R., and Otto, S. (2008). Systems chemistry, *Chemical Society Reviews*, **37**, pp. 101–108.
- Luisi, P. (2007). Chemical aspects of synthetic biology, *Chem. Biodivers.*, **4**, pp. 603–621.
- Luna, F., and Stefansson, B. (2000). *Economic Simulations in Swarm: Agent-Based Modelling and Object Oriented Programming* (Kluwer Academic Publishers).
- Lungarella, M., Metta, G., Pfeifer, R., and Sandini, G. (2003). Developmental robotics: a survey, *Connect. Sci.*, **15(4)**, pp. 151–190.
- Lupashin, S., Schoellig, A., Sherback, M., and D'Andrea, R. (2010). A simple learning strategy for high-speed quadcopter multi-flips, in *Proceedings of the International Conference on Robotics and Automation*, pp. 1642–1648.
- Lynch, J. (1995). Root Architecture and Plant Productivity. *Plant Physiol.*, **109(1)**, pp. 7–13.
- Lynch, J., Nielsen, K., Davis, R., and Jabllokow, A. (1997). SimRoot: modelling and visualization of root systems, *Plant and Soil*, **188(1)**, pp. 139–151.
- Lynch, N. (1996). *Distributed Algorithms* (Morgan Kaufman).
- Maczka, D. K., Gadre, A. S., and Stilwell, D. J. (2007). Implementation of a cooperative navigation algorithm on a platoon of autonomous underwater vehicles, in *Proceedings of Oceans 2007*, pp. 1–6, 10.1109/OCEANS.2007.4449404.
- Madou, M. J. (2002). *Fundamentals of Microfabrication: The Science of Miniaturization*, 2nd edn. (CRC Press, Boca Raton).
- Maeda, S., Hara, Y., Sakai, T., Yoshida, R., and Hashimoto, S. (2007). Self-walking gel, *Advanced Materials*, **19**, p. 34803484.
- Magenat, S., Waibel, M., and Beyeler, A. (2007). Enki: The fast 2d robot simulator; <http://lis.epfl.ch/resources/enki>.
- Mahon, I., Williams, S. B., Pizarro, O., and Johnson-Roberson, M. (2008). Efficient view-based SLAM using visual loop closures, *IEEE Trans. Robot.*, **24(5)**, pp. 1002–1014, 10.1109/TRO.2008.2004888.
- Maley, C. (1999). Four steps toward open-ended evolution, in *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-99)* (Morgan Kaufmann), pp. 1336–1343.
- Mallouk, T., and Sen, A. (2009). Powering nanorobots, *Scientific American*, **94(6)**, pp. 74–79.

- Mamei, M., and Zambonelli, F. (2007). Pervasive pheromone-based interaction with rfid tags, *Trans. Auton. Adapt. Sys.*, **2**, 2.
- Mandelbrot, B. (1982). *The fractal geometry of nature* (W.H. Freeman, San Francisco).
- Manseur, R., and Doty, K. L. (1992). A complete kinematic analysis of four-revolute-axis robot manipulators, *ASME Mechanisms and Machines*, **27(5)**, pp. 575–586.
- Marchese, F. M., and Sorrenti, D. G. (2002). Mirror design of a prescribed accuracy omni-directional vision system, in *3rd workshop on Omnidirectional Vision, co-located with 7th ECCV* (IEEE Computer Society).
- Marcus, G. (2001). *The Algebraic Mind: Integrating Connectionism and Cognitive Science* (MIT Press).
- Marins, J. L., Yun, X., Bachmann, E. R., McGhee, R. B., and Zyda, M. J. (2001). An extended kalman filter for quaternion-based orientation estimation using MARG sensors, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (IEEE Press), pp. 2003–2011.
- Marocco, D., and Nolfi, S. (2006). Origins of communication in evolving robots, in N. S. et al. (ed.), *From animals to animats 9: Proceedings of the 9th International Conference on Simulation of Adaptive Behaviour, LNAI*, Vol. 4095 (Springer Verlag), pp. 789–803.
- Maroti, M., Volgyesi, P., Dora, S., Branislav, K., and A. Ledecz, A. N., Balogh, G., and Molnar, K. (2005). Radio interferometric geolocation, in *Proceedings of the 3rd international conference on Embedded networked sensor systems ACM SenSys*, pp. 1–12.
- Marshall, J. A. R., and Franks, N. R. (2009). Colony-level cognition, *Current Biology*, **19(10)**, pp. 395–396.
- Martel, S. (2006). Targeted delivery of therapeutic agents with controlled bacterial carriers in the human blood vessels, in *Bio Micro and Nanosystems Conference, 2006. BMN '06*, pp. 9–9.
- Martel, S., Andre, W., Mohammadi, M., and Lu, Z. (2009a). Towards swarms of communication-enabled and intelligent sensotaxis-based bacterial microrobots capable of collective tasks in an aqueous medium, in *The 2009 IEEE International Conference on Robotics and Automation ICRA*.
- Martel, S., Felfoul, O., Mathieu, J.-B., Chanu, A., Tamaz, S., Mohammadi, M., Mankiewicz, M., and Tabatabaei, N. (2009b). Mri-based medical nanorobotic platform for the control of magnetic nanoparticles and flagellated bacteria for target interventions in human capillaries, *Int. J. Rob. Res.*, **28(9)**, pp. 1169–1182.

- Martel, S., Mathieu, J.-B., Felfoul, O., Chanu, A., Aboussouan, E., Tamaz, S., Pouponneau, P., Yahia, L., Beaudoin, G., Soulez, G., and Mankiewicz, M. (2007). Automatic navigation of an untethered device in the artery of a living animal using a conventional clinical magnetic resonance imaging system, *Appl. Phys. Lett.*, **90**, 11, 114105.
- Martel, S., and Mohammadi, M. (2010). Using a swarm of self-propelled natural microrobots in the form of flagellated bacteria to perform complex micro-assembly tasks, in *Robotics and Automation (ICRA), 2010 IEEE International Conference on*, pp. 500–505, 10.1109/ROBOT.2010.5509752.
- Martel, S., Mohammadi, M., Felfoul, O., Zhao, L., and Pouponneau, P. (2009c). Flagellated magnetotactic bacteria as controlled mri-trackable propulsion and steering systems for medical nanorobots operating in the human microvasculature, *Int. J. Rob. Res.*, **28**(4), pp. 571–582, <http://dx.doi.org/10.1177/0278364908100924>.
- Martel, S., Olague, L. C., Ferrando, J. C., Riebel, S., Koker, T., Suurkivi, J., Fofonoff, T., Sherwood, M., Dyer, R., and Hunter, I. (2001). General description of the wireless miniature nanowalker robot designed for atomic-scale operations, in *Proc. SPIE: Microrobotics and Microassembly*, Vol. 4568, pp. 231–240.
- Martel, S., Tremblay, C., Ngakeng, S., and Langlois, G. (2006). Controlled manipulation and actuation of micro-objects with magnetotactic bacteria, *Appl. Phys. Lett.*, **89**, pp. 233804–6.
- Martin, C. E., Barber, K. S., and Barber, K. S. (1999). Agent autonomy: Specification, measurement, and dynamic adjustment, in *In Proceedings of the Autonomy Control Software Workshop, Agents '99*, pp. 8–15.
- Martinoia, S., Sanguineti, V., Cozzi, L., Berdondini, L., van Pelt, J., Tomas, J., Masson, G. L., and Davide, F. (2004). Towards an embodied in vitro electrophysiology: the NeuroBIT project, *Neucomputing*, **58-60**, pp. 1065–1072, 316.
- Martinoli, A., and Easton, K. (2003). Modeling swarm robotic systems, *Springer Tracts in Advanced Robotics*, **5**, pp. 297–306, <http://www.springerlink.com/content/tfr2jkdaje89r2c0>.
- Martinoli, A., Easton, K., and Agassounon, W. (2004). Modeling swarm robotic systems: A case study in collaborative distributed manipulation, *Int. J. Robot. Res.*, **23**(4), pp. 415–436.
- Martinoli, A., Franzi, E., and Matthey, O. (1997). Towards a reliable set-up for bio-inspired collective experiments with real robots, in *In Proceedings of the 5th International Symposium on Experimental Robotics (ISER '97)*, Lecture Notes in Control and Informatic Sciences, pp. 597–608.

- Martinoli, A., Ijspeert, A., and Gambardella, L. (1999a). A probabilistic model for understanding and comparing collective aggregation mechanisms, in *ECAL '99: Proceedings of the 5th European Conference on Advances in Artificial Life* (Springer Verlag, London, UK), pp. 575–584.
- Martinoli, A., Ijspeert, A., and Mondada, F. (1999b). Understanding collective aggregation mechanisms: From probabilistic modelling to experiments with real robots, *Robot. Auton. Sys.*, **29(1)**, pp. 51–63.
- Martins, A., Almeida, J. M., and Silva, E. (2003). Coordinated maneuver for gradient search using multiple AUVs, in *Proceedings of MTS/IEEE Oceans 2003* (San Diego, CA, USA), ISBN 0-933957-30-0, pp. 347–352, 10.1109/OCEANS.2003.178583.
- Maslow, A. (1998). *Toward a Psychology of Being* (Wiley, Hoboken, NJ).
- Mastrobattista, E., Taly, V., Chanudet, E., Treacy, P., Kelly, B., and et al. (2005). High-throughput screening of enzyme libraries: In vitro evolution of a beta-galactosidase by fluorescence-activated sorting of double emulsions, *Chem. Biol.*, **12(12)**, pp. 1291–1300.
- Mataric, M. (1992). Designing emergent behaviors: From local interactions to collective intelligence, in H. R. J-A. Meyer, and e. S. Wilson (eds.), *Proceedings of the 2nd International Conference on Simulation of Adaptive Behavior (SAB-92)* (MIT Press), pp. 432–441.
- Mataric, M. (1995a). Issues and approaches in the design of collective autonomous agents, *Robot. Auton. Sys.*, **16**, pp. 321–331, cite-seer.ist.psu.edu/article/mataric95issues.html.
- Mataric, M. (2002). Situated robotics, *Encyclopedia of Cognitive Science* (Nature Publishers Group, Macmillian Reference Ltd.).
- Mataric, M. J. (1995b). Issues and approaches in the design of collective autonomous agents, *Robot. Auton. Sys.*, **16(2-4)**, pp. 321–331.
- Mataric, M. J. (2000). Getting humanoids to move and imitate, *IEEE Intelligent Systems and their Applications*, **15(4)**, pp. 18–24.
- Matarić, M. J., and Marjanovic, M. J. (1993). Synthesizing complex behaviors by composing simple primitives, in *Self Organisation and Life: From Simple Rules to Global Complexity*, Proceedings of the 2nd European Conference on Artificial Life (ECAL-93), Brussels, pp. 698–707.
- Mataric, M. J., Nilsson, M., and Simsarian, K. T. (1995). Cooperative multi-robot box-pushing, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. 556–561.
- Mathews, N., Christensen, A. L., O'Grady, R., and Dorigo, M. (2010). Cooperation in a heterogeneous robot swarm through spatially targeted communication, in *Proceedings of the 7th International Conference on*

- Swarm Intelligence (ANTS 2010)* (Springer Verlag, Berlin, Germany), pp. 400–407.
- Mathieu, C., and Weigel, A. (2005). Assessing The Flexibility Provided By An On-Orbit Infrastructure Of Fractionated Spacecraft, (56th International Astronautical Congress, Fukuoka, Japan).
- Matsue, A., Hirose, W., Tokutake, A., Sundada, S., and Ohkura, A. (2005). Navigation of small and lightweight helicopter, *Transactions of the Japan Society for Aeronautical and Space Sciences*, **48**, pp. 177–179.
- Matsuura, J. P., and Yoneyama, T. (2004). Learning Bayesian networks for fault detection, in *Proceedings of the IEEE Signal Processing Society Workshop*, pp. 133–142.
- Matthey, L., Berman, S., and Kumar, V. (2009). Stochastic strategies for a swarm robotic assembly system, in *Proceedings of the 2009 IEEE International Conference on Robotics and Automation (ICRA 2009)*, pp. 1953–1958.
- Matyka, M., Khalili, A., and Koza, Z. (2008). Tortuosity-porosity relation in the porous media flow, *Phys. Rev. E*, **78**, p. 026306.
- Mayley, G. (1996). Landscapes, learning costs, and genetic assimilation: Modeling the evolution of motivation, *Evolutionary Computation*, **4(3)**, pp. 213–234, citeseer.ist.psu.edu/mayley96landscapes.html.
- Maynard Smith, J. (1987). How to model evolution, in Dupré (ed.), *The Latest on the Best* (MIT Press, Cambridge).
- Maynard Smith, J., and Szathmáry, E. (1995). *The Major Transition in Evolution* (Oxford, UK: W. H. Freeman).
- Mazzolai, B., Mattoli, V., Laschi, C., Salvini, P., Ferri, G., Ciaravella, G., and Dario, P. (2008). Networked and cooperating robots for urban hygiene: the eu funded dustbot project, in *The 5th International Conference on Ubiquitous Robots and Ambient Intelligence (URAI 2008)*.
- MBARI (2009). CANON: Controlled, Agile and Novel Observing Network, <http://www.mbari.org/canon/default.htm>.
- McColm, L. G. (2004). On the structure of random unlabelled acyclic graphs, pp. 147–170.
- McCormack, J. (1993). Interactive evolution of l-system grammars for computer graphics modelling, in D. Green, and T. Bossomaier (eds.), *Complex Systems: From Biology to Computation* (IOS Press), pp. 118–130.
- McFarland, G. (1986). The benefits of bottom-up design, *SIGSOFT Softw. Eng. Notes*, **11(5)**, pp. 43–51, <http://doi.acm.org/10.1145/382298.382368>.

- McKee, G. T. (2006). What is networked robotics? in J. Andrade-Cetto, J.-L. Ferrier, J. D. Pereira, and J. Filipe (eds.), *ICINCO-ICSO* (INSTICC Press), ISBN 972-8865-59-7.
- McLean, K., Pasupathi, M., and Pals, J. (2007). Selves creating stories creating selves: A process model of self-development, *Personality and Social Psychology Review*, **11**(3), pp. 262–278.
- McLurkin, J. (1995). *The Ants: A Community of Microrobots*, Ph.D. Thesis, Massachusetts Institute of Technology.
- McLurkin, J., and Smith, J. (2004). Distributed algorithms for dispersion in indoor environments using a swarm of autonomous mobile robots, in *Proceedings of the Distributed Autonomous Robotic Systems Conference*.
- McLurkin, J., and Smith, J. (2007). Distributed algorithms for dispersion in indoor environments using a swarm of autonomous mobile robots, in R. Alami, R. Chatila, and H. Asama (eds.), *Distributed Autonomous Robotic Systems 6* (Springer Japan), pp. 399–408.
- McLurkin, J., and Yamins, D. (2005). Dynamic task assignment in robot swarms, in *The 2005 Robotics: Science and Systems Conference*.
- McNew, J. M., and Klavins, E. (2006). Locally interacting hybrid systems with embedded graph grammars, in *Proceedings of the 45th IEEE Conference on Decision and Control*, pp. 6080–87.
- McNew, J. M., and Klavins, E. (2008). Non-deterministic reconfiguration of tree formations, in *Proceedings of the American Control Conference*, pp. 690–697.
- Mei, Y., Lu, Y.-H., Hu, Y. C., and Lee, C. S. G. (2004). Energy-efficient motion planning for mobile robots, in *Proceedings of the International Conference on Robotics and Automation*, Vol. 5 (IEEE Press), pp. 4344–4349.
- Mei, Y., Lu, Y.-H., Hu, Y. C., and Lee, C. S. G. (2005). A case study of mobile robot's energy consumption and conservation techniques, in *Proceedings of the 12th International Conference on Advanced Robotics* (IEEE Press), pp. 492–497.
- Melhuish, C. (1999). Employing secondary swarming with small scale robots: a biologically inspired collective approach, in *Proceedings of the 2nd International Conference on Climbing & Walking Robots (CLAWAR)*.
- Melhuish, C., Holland, O., and Hoddell, S. (1998). Collective sorting and segregation in robots with minimal sensing, in *Proceedings of the fifth international conference on simulation of adaptive behavior on From animals to animats 5* (MIT Press, Cambridge, MA, USA), ISBN 0-262-66144-6, pp. 465–470.

- Melhuish, C., and Welsby, J. (2002). Gradient ascent with a group of minimalist real robots: Implementing secondary swarming, in *Proceedings of the IEEE International Conference on Systems, Man and Cybernetics*, Vol. 2 (IEEE Press), pp. 509–514.
- Meli, M., Albert-Fournier, B., and Maurel, M. (2001). Recent findings in the modern RNA world, *International Microbiology*, **4(1)**, pp. 5–11.
- Menczer, F., and Belew, R. (1996). From complex environments to complex behaviors, *Adapt. Behav.* **4**, pp. 317–363, citeseer.ist.psu.edu/menczer96from.html.
- Merino, L., Caballero, F., Martínez-de Dios, J. R., Ferruz, J., and Ollero, A. (2006). A cooperative perception system for multiple UAVs: application to automatic detection of forest fires, *J. Field Robot.*, **23**, pp. 165–184.
- Merkle, F. (2004). *Kinematic Self-Replicating Machines* (Landes Bioscience, Georgetown, TX, USA).
- Merlein, J., Kahl, M., Zuschlag, A., Sell, A., Halm, A., Boneberg, J., Leiderer, P., Leitenstorfer, A., and Bratschitsch, R. (2008). Nanomechanical control of an optical antenna, *Nature Photonics*, **2(4)**, pp. 230–233.
- Mermoud, G., Brugger, J., and Martinoli, A. (2009). Towards multi-level modeling of self-assembling intelligent micro-systems, *AAMAS '09: Proceedings of The 8th International Conference on Autonomous Agents and Multiagent Systems*, **1**, pp. 89–96.
- Mermoud, G., Matthey, L., Evans, C., and Martinoli, A. (2010). Aggregation-mediated collective perception and action in a swarm of miniature robots, in M. Luck, S. Sen, W. van der Hoewk, and G. Kaminka (eds.), *Proceedings of the 9th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2010)* (Toronto, Canada), pp. 599–606.
- Meyer, J.-A., and Filliat, D. (2003). Map-based navigation in mobile robots: II. a review of map-learning and path-planning strategies, *Cognit. Sys. Res.*, **4(4)**, pp. 283–317.
- Michael, N., Fink, J., and Kumar, V. (2008). Experimental testbed for large multirobot teams, *IEEE Robot. Autom. Mag.*, **15(1)**, pp. 53–61.
- Michael, N., Fink, J., and Kumar, V. (2009). Cooperative manipulation and transportation with aerial robots, in *Proceedings of Robotics: Science and Systems* (Seattle, WA).
- Michel, O. (2004). Webots: Professional mobile robot simulation, *J. Adv. Robot. Sys.*, **1(1)**, pp. 39–42.
- Michelsen, A., Andersen, B. B., Storm, J., Kirchner, W. H., and Lindauer, M. (1992). How honeybees perceive communication dances, studied by

- means of a mechanical model, *Behav. Ecol. Sociobiol.*, **30(3/4)**, pp. 143–150, <http://www.jstor.org/stable/4600669>.
- MICRoN (2002–2005). *Miniaturised Co-operative Robots advancing towards the Nano range, 6th Framework Programme IST-2001 Project Contract No 33567* (European Community).
- Miki, N., and Shimoyama, I. (2003). Soft-magnetic rotational microwings in an alternating magnetic field applicable to microflight mechanisms, *J. Microelectromech. Sys.*, **12(2)**, pp. 221–227.
- Millonas, M. M. (1994). Swarms, phase transitions, and collective intelligence, in C. G. Langton (ed.), *Artificial Life III* (Addison-Wesley, Reading, MA).
- Milutinovic, D., and Lima, P. (2006). Modeling and optimal centralized control of a large-size robotic population, *Robotics, IEEE Transactions on*, **22(6)**, pp. 1280–1285.
- Minsky, M. (1977). Frame-system theory, in P. N. Johnson-Laird, and P. C. Wason (eds.), *Thinking: Readings in Cognitive Science* (Cambridge: Cambridge University Press).
- Minsky, M. (1985). Communication with alien intelligence, in E. Regis (ed.), *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press).
- Miranda, E. R., Bull, L., Gueguen, F., and Uroukov, I. S. (2009). Computer music meets unconventional computing: Towards sound synthesis with in vitro neuronal networks, *Comput. Music J.*, **33(1)**, pp. 9–18, <http://dx.doi.org/10.1162/comj.2009.33.1.9>.
- Mirolli, M., and Parisi, D. (2008). How producer biases can favor the evolution of communication: An analysis of evolutionary dynamics, *Adapt. Behav.*, **16(1)**, pp. 27–52.
- Mirollo, R. E., and Strogatz, S. H. (1990). Synchronization of pulse-coupled biological oscillators, *SIAM J. Appl. Math.*, **50(6)**, pp. 1645–1662.
- MIT, S. (2004). Spheres - synchronized position hold engage and reorient experimental satellites, <http://ssl.mit.edu/spheres/>, Space Systems Laboratory, MIT,USA.
- Mitchell, M., and Forrest, S. (1994). Genetic algorithms and artificial life, *Artif. Life*, **1(3)**, pp. 267–289, citeseer.ist.psu.edu/mitchell93genetic.html.
- Mitchell, T. M. (1997). *Machine Learning* (McGraw-Hill, New York).
- Miura, H., Yasuda, T., Fujisawa, Y. K., and Shimoyama, I. (1995). Insect-model based microrobot, *Transducers*, pp. 392–395.
- Miyasaka, S., and Hawes, M. (2001). Possible role of root border cells in detection and avoidance of aluminum toxicity, *Plant Physiol.*

- Miyashita, S., Kessler, M., and Lungarella, M. (2008). How morphology affects self-assembly in a stochastic modular robot, *Proceedings of the 2008 IEEE International Conference on Robotics and Automation (ICRA 2008)*, pp. 3533–3538.
- Mletzko, F. (2006a). *Creating emergent behavior in a group of micro-robots* Master's Thesis, University of Stuttgart, Germany.
- Mletzko, F. (2006b). *Testing and Re-Implementation of Communication Protocols for the Microrobot 'Jasmine'* (Studienarbeit, University of Stuttgart, Germany).
- Moga, S. (2000). *Apprendre par imitation: une nouvelle voie d'apprentissage pour les robots autonomes*, Ph.D. Thesis, Université de Cergy-Pontoise.
- Moga, S., and Gaussier, P. (1999). A neuronal structure for learning by imitation, in D. Floreano, J.-D. Nicoud, and F. Mondada (eds.), *Lecture Notes in Artificial Intelligence - European Conference on Artificial Life ECAL99*, pp. 314–318.
- Mohan, S., Saenz-Otero, A., Nolet, S., Miller, D., and Sell, S. (2009). SPHERES flight operations testing and execution, *Acta Astronautica*, **65(7–8)**, pp. 1121–1132.
- Mohebbi, M. H., Terry, M. L., Bhringer, K. F., Kovacs, G. T. A., and Suh, J. W. (2001). Omidirectional walking microrobot realized by thermal microactuator arrays, in *Proceedings of the ASME International Mechanical Engineering Congress and Exposition*, pp. 1–7.
- Momma, H., and Tsuchiya, T. (1976). Underwater communication by electric current, in *OCEANS*.
- Monahan, G. (1982). A survey of partially observable markov decision processes: Theory, models, and algorithms, *Management Science*, **28(1)**, pp. 1–16.
- Mondada, F., Bonani, M., Guignard, A., Magnenat, S., Studer, C., and Floreano, D. (2005a). Superlinear physical performances in a SWARM-BOT, in *Proceedings of the 8th European Conference on Artificial Life*, Lecture Notes in Artificial Intelligence, Vol. 3630 (Berlin: Springer Verlag), pp. 282–291.
- Mondada, F., Bonani, M., Magnenat, S., Guignard, A., and Floreano, D. (2004a). Physical connections and cooperation in swarm robotics, in *Proceedings of the 8th International Conference on Intelligent Autonomous Systems* (IOS Press, Amsterdam), pp. 53–60.
- Mondada, F., Bonani, M., Raemy, X., Pugh, J., Cianci, C., Klaptocz, A., Magnenat, S., Zufferey, J.-C., Floreano, D., and Martinoli, A. (2009). The e-puck, a robot designed for education in engineering, in *Proceedings of*

- the 9th Conference on Autonomous Robot Systems and Competitions, pp. 59–65.
- Mondada, F., Gambardella, L. M., Floreano, D., Nolfi, S., Deneubourg, J.-L., and Dorigo, M. (2005b). The cooperation of swarm-bots: Physical interactions in collective robotics, *IEEE Robot. Autom. Mag.*, **12(2)**, pp. 21–28.
- Mondada, F., Pettinaro, G. C., Guignard, A., Kwee, I. W., Floreano, D., Deneubourg, J.-L., Nolfi, S., Gambardella, L. M., and Dorigo, M. (2004b). Swarm-bot: a new distributed robotic concept, *Auton. Robot.*, **17**, pp. 193–221.
- Montesano, L., Montano, L., and Burgard, W. (2004). Relative localization for pairs of robots based on unidentifiable moving features, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, Vol. 2 (IEEE Press), pp. 1537–1543.
- Moore, D., Leonard, J. J., Rus, D., and Teller, S. (2004). Robust distributed network localization with noisy range measurements, in *Proceedings of the ACM International Conference on Embedded Networked Sensor Systems (SenSys '04)* (Baltimore, MD, USA), ISBN 1-58113-879-2, pp. 50–61, 10.1145/1031495.1031502.
- Moore, M. J., Suda, T., and Oiwa, K. (2009). Molecular communication: Modeling noise effects on information rate, **8(2)**, pp. 169–180.
- Moore, P., and Steitz, T. (2002). The involvement of RNA in ribosome function, *Nature*, **418(6894)**, pp. 229–235.
- Morrison, J., and Kumar, P. (1998). On guaranteed throughput and efficiency of closed reentrant lines, *Queueing Systems*, **28**, pp. 33–54.
- Morton, K., and Mayers, D. (2005). *Numerical Solution of Partial Differential Equations*, 2nd edn. (Cambridge University Press, Cambridge).
- Moscato, P. (1999). A gentle introduction to memetic algorithms, in D. Corne, F. Glover, and M. Dorigo (eds.), *New Ideas in Optimisation* (McGraw-Hill), p. Chapter 14.
- Moshtagh, N., Michael, N., Jadbabaie, A., and Daniilidis, K. (2009). Vision-based, distributed control laws for motion coordination of nonholonomic robots, *IEEE Trans. Robot.*, **25(4)**, pp. 851–860.
- Mostéfaoui, S. K. (2003). Emergence in collective robotics: A case study, *Int. Arab J. Inf. Technol.*, **1**, 0.
- Mostofi, Y., Gonzalez-Ruiz, A., Ghaffarkhah, A., and Li, D. (2009). Characterization and modeling of wireless channels for networked robotic and control systems — a comprehensive overview, in *Proceedings of the International Conference on Intelligent Robots and Systems (IROS)* (St. Louis, MO).

- Munack, A. (2002). Agriculture and the environment: new challenges for engineers, *CIGR J. Sci. Res. Dev.*, **IV**.
- Munroe, S., and Cangelosi, A. (2002). Learning and the evolution of language: the role of cultural variation and learning costs in the baldwin effect, *Artif. Life*, **8(4)**, pp. 311–339, <http://dx.doi.org/10.1162/106454602321202408>.
- Murata, S., Hurokawa, H., Yoshida, E., Tomita, K., and Kokaji, S. (1998). A 3d self-reconfigurable structure, in *Proceedings of the IEEE International Conference on Robotics and Automation*, pp. 432–439.
- Murata, S., Kakomura, K., and Kurokawa, H. (2006). Docking experiments of a modular robot by visual feedback, in *Proceedings of the IEEE/RSJ06 International Conference on Intelligent Robots and Systems (IEEE, Beijing, China)*, pp. 625–630.
- Murata, S., Kamimura, A., Kurokawa, H., Yoshida, E., Tomita, K., and Kokaji, S. (2004). Self-reconfigurable robots: Platforms for emerging functionality, in *Lecture Notes in Artificial Intelligence* (Berlin: Springer Verlag), pp. 312–330.
- Murata, S., Kurokawa, H., and Kokaji, S. (1994). Self-assembling machine, in *Proceedings of the IEEE International Conference on Robotics and Automation*, pp. 442–448.
- Murphey, R. (2002). *An Introduction to Collective and Cooperative Systems, Applied Optimization*, Vol. 66, pp. 171–197.
- Murphy, R. R., and Hershberger, D. (1999). Handling sensing failures in autonomous mobile robots, *Int. J. Robot. Res.*, **18**, pp. 382–400.
- Murphy, R. R., Pratt, K. S., and Burke, J. L. (2008). Crew roles and operational protocols for rotary-wing micro-UAVs in close urban environments, in *Proceedings of the 3rd ACM/IEEE International Conference on Human Robot Interaction* (ACM Press, New York, USA), pp. 73–80.
- Murray, J. (1977). *Lecture on Nonlinear-differential-equation models in biology* (Clarendon Press, Oxford).
- Muscholl, M. (2001). *Interaction und Kooperation in Multiagentsystemen* Ph.D. Thesis, University of Stuttgart, Stuttgart.
- Mytilinaios, E., Desnoyer, M., Marcus, D., and Lipson, H. (2004). Designed and evolvable blueprints for physical self-replicating machines, in J. Pollack, M. Bedeau, P. Husband, J. Ikegami, and R. A. Watson (eds.), *Artificial Life IX. Proeceeding of the Ninth International Conference on the Simulation and Synthesis of Living Systems* (MIT Press, Cambridge, MA), pp. 15–20.
- Nääs, I. (2002). Application of mechanotronics to animal production, *CIGR J. Sci. Res. Dev.*, **IV**.

- Nagarathinam, A. (2007). *Development of a Software Framework for Jasmine Robots using ZigBee Communication Protocol* Master's Thesis, University of Stuttgart, Germany.
- Nagpal, R., Shrobe, H., and Bachrach, J. (2003). Organizing a global coordinate system from local information on an ad hoc sensor network, in *International Conference on Information Processing in Sensor Networks (IPSN)*.
- Nagpal, R., Zambonelli, F., Siner, E., Chaouchi, H., and Smirnov, M. (2006). Interdisciplinary research: roles for self-organization, *IEEE Intelligent Systems*, **21(2)**, pp. 50–58.
- Nagy, Z., Oung, R., Abbott, J., and Nelson, B. (2008). Experimental investigation of magnetic self-assembly for swallowable modular robots, in *Proceedings of the 2008 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2008)*, pp. 1915–1920.
- Nakamura, T., Oohara, M., Ogasawara, T., and Ishiguro, H. (2003). Fast self-localization method for mobile robots using multiple omnidirectional vision sensors, *Machine Vision and Applications*, **14(2)**, pp. 129–138.
- Nakanishi, R., Bruce, J., Murakami, K., Naruse, T., and Veloso, M. (2006). Cooperative 3-robot passing and shooting in the robocup small size league, in G. Lakemeyer, E. Sklar, D. G. Sorrenti, and TomoichiTakahashi (eds.), *RoboCup 2006: Robot Soccer World Cup X*, Vol. LNCS 4434 (Springer Verlag, Berlin), pp. 418–425.
- Nakasuka, S., Sugawara, Y., Sahara, H., Koyama, K., Okada, T., and Kobayashi, C. (2006). Panel extension satellite (petsat) - a novel satellite concept consisting of modular, functional and plug-in panels, *Acta Futura*, **2**, pp. 85–92.
- Narahari, Y., and Khan, L. (1995). Performance analysis of scheduling policies in reentrant manufacturing systems, *Computers and Operations Research*, **23(1)**, pp. 37–51.
- Narendra, K., and Annaswamy, A. (1989). *Stable Adaptive Systems* (Prentice Hall).
- Narins, P. M., Grabul, D. S., Soma, K. K., Gaucher, P., and Hodl, W. (2005). Cross-modal integration in a dart-poison frog, *Proc. Natl. Acad. Sci. USA*, **102(7)**, pp. 2425–2429.
- Nehaniv, C., and Dautenhahn, K. (eds.) (2007). *Imitation and Social Learning in Robots, Humans and Animals* (Cambridge University Press).
- Nehaniv, C. L., and Dautenhahn, K. (2002a). The correspondence problem, in *Imitation in animals and artifacts* (MIT Press, Cambridge, MA, USA), ISBN 0-262-04203-7, pp. 41–61.

- Nehaniv, C. L., and Dautenhahn, K. (eds.) (2002b). *Imitation in Animals and Artefacts* (MIT Press).
- Neiger, G., and Bazzi, R. A. (1993). Using knowledge to optimally achieve coordination in distributed systems, in *In Fourth TARK* (Morgan Kaufmann), pp. 43–59.
- Nelson, A. L., Barlow, G. J., and Doitsidis, L. (2009). Fitness functions in evolutionary robotics: A survey and analysis, *Robot. Auton. Sys.*, **57**(4), pp. 345–370.
- Nelson, B., Dong, L., and Arai, F. (2008). Micro/nanorobotics, in O. K. Bruno Siciliano (ed.), *Springer Handbook of Robotics*, pp. 411–450.
- Nelson, C. (2003). *A framework for self-reconfiguration planning for unit-modular robots*, Ph.D. thesis, Department of Mechanical Engineering, Purdue University.
- Nelson, D., Barber, D., McLain, T., and Beard, R. (2007). Vector field path following for miniature air vehicles, *IEEE Trans. Robot.*, **23**(3), pp. 519–529.
- Nembrini, J., Reeves, N., Poncet, E., Martinoli, A., and Winfield, A. F. T. (2005). Mascarillon: Flying swarm intelligence for architectural research, in *Proceedings of the IEEE Swarm Intelligence Symposium* (IEEE Press), pp. 225–232.
- Nepomnyashchikh, V., and Podgornyj, K. (2003). Emergence of adaptive searching rules from the dynamics of a simple nonlinear system, *Adapt. Behav.*, **11**, pp. 245–265.
- Ness, F., Ferreira, P., Cox, B., and Tuite, M. (2002). Guanidine hydrochloride inhibits the generation of prion “seeds” but not prion protein aggregation in yeast, *Mol. Cell. Biol.*, **22**(15), pp. 5593–5605.
- Nettleton, E., Thrun, S., and Durrant-Whyte, H. (2003). Decentralised SLAM with low-bandwidth communication for teams of airborne vehicles, in *Proceedings of the International Conference on Field and Service Robotics*.
- Neubert, J., Cantwell, A., Constantin, S., Kalontarov, M., Erickson, D., and Lipson, H. (2010). 3d stochastic reconfiguration of modular robots, in *Proceedings of the International Conference on Robotics and Automation* (Anchorage, AK).
- Nicolis, S., and Deneubourg, J.-L. (1999). Emerging patterns and food recruitment in ants: an analytical study, *J. Theor. Biol.*, **198**, pp. 575–592.
- Nicolis, S., Detrain, C., Demolin, D., and Deneubourg, J. (2003). Optimality of collective choices: A stochastic approach, *Bull. Math. Biol.*,

- 65, pp. 795–808, [http://dx.doi.org/10.1016/S0092-8240\(03\)00040-5](http://dx.doi.org/10.1016/S0092-8240(03)00040-5), 10.1016/S0092-8240(03)00040-5.
- Nitschke, J. R. (2009). Systems chemistry: Molecular networks come of age, *Nature*, **462(7274)**, pp. 736–738.
- Noldus, L. P., Spink, A. J., and Tegelenbosch, R. A. (2002). Computerised video tracking, movement analysis and behaviour recognition in insects, *Comput. Electron. Agric.*, **35**, pp. 201–227.
- Nolet, S., Saenz-Otero, A., Miller, D., and Fejzic, A. (2006). SPHERES operations aboard the ISS: Maturation of GN&C algorithms in microgravity, in *Proceedings of the AAS Guidance and Control Conference*, aAS 07–042.
- Nolet, S., Saenz-Otero, A., Miller, D., and Fejzic, A. (2007). SPHERES operations aboard the ISS: Maturation of GN&C algorithms in microgravity, in *30th Annual AAS Guidance and Control Conference*, pp. 07–042.
- Nolfi, S. (2005). Emergence of communication in embodied agents: Adapting communicative and non-communicative behaviours, *Connect. Sci.*, **17(3–4)**, pp. 231–248.
- Nolfi, S., and Floreano, D. (1999). Learning and evolution, *Auton. Robot.*, **7(1)**, pp. 89–113, <http://dx.doi.org/10.1023/A:1008973931182>.
- Nolfi, S., and Floreano, D. (2000). *Evolutionary Robotics: The Biology, Intelligence, and Technology of Self-Organizing Machines* (The MIT Press, Cambridge, MA. / London).
- Nolfi, S., and Floreano, D. (2004). *Evolutionary Robotics: The Biology, Intelligence, and Technology of Self-Organizing Machines* (MIT Press/Bradford Book, Massachusetts).
- Nolfi, S., and Parisi, D. (1995). Learning to adapt to changing environments in evolving neural networks, Tech. Rep. 95-15, Institute of Psychology, National Research Council, Rome, Italy, citeseer.ist.psu.edu/nolfi96learning.html.
- Noth, A., Engel, W., and Siegwart, R. (2006a). Design of an ultra-lightweight autonomous solar airplane for continuous flight, in P. Corke, and S. Sukkariah (eds.), *Field and Service Robotics, Springer Tracts in Advanced Robotics*, Vol. 25 (Berlin: Springer), pp. 441–452.
- Noth, A., Engel, W., and Siegwart, R. (2006b). Flying solo and solar to mars, *IEEE Robot. Autom. Mag.*, **13(3)**, pp. 44–52.
- Nouyan, S., Campo, A., and Dorigo, M. (2008). Path formation in a robot swarm: Self-organized strategies to find your way home, *Swarm Intelligence*, **2(1)**, pp. 1–23.

- Nouyan, S., Groß, R., Bonani, M., Mondada, F., and Dorigo, M. (2009). Teamwork in self-organized robot colonies, *IEEE Trans. Evol. Comput.*, **13(4)**, pp. 695–711.
- Novellino, A., D'Angelo, P., Cozzi, L., Chiappalone, M., Sanguineti, V., and Martinoia, S. (2007). Connecting neurons to a mobile robot: an in vitro bidirectional neural interface, *Intell. Neurosci.*, **2007**, Article ID 12725, 13 pages, <http://dx.doi.org/10.1155/2007/12725>.
- Nowick, J., Feng, Q., Tjivikua, T., Ballester, P., and Rebek, J. (1991). Kinetic studies and modeling of a self-replicating system, *J. Am. Chem. Soc.*, **113(23)**, pp. 8831–8839.
- NRF (2010). NRF – Network Robot Forum, Last accessed on 2010-01-27.
- O'Grady, R., Christensen, A. L., and Dorigo, M. (2009a). SWARMORPH: Multi-robot morphogenesis using directional self-assembly, *IEEE Trans. Robot.*, **25(3)**, pp. 738–743, <http://dx.doi.org/10.1109/TRO.2008.2012341>.
- O'Grady, R., Christensen, A. L., Pinciroli, C., and Dorigo, M. (2010a). Robots autonomously self-assemble into dedicated morphologies to solve different tasks (extended abstract), in *Proceedings of the 9th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2010)*, pp. 1517–1518.
- O'Grady, R., Groß, R., Christensen, A. L., and Dorigo, M. (2010b). Self-assembly strategies in a group of autonomous mobile robots, *Auton. Robot.*, **28(4)**, pp. 439–455.
- O'Grady, R., Pinciroli, C., Groß, R., Christensen, A. L., Mondada, F., Bonani, M., and Dorigo, M. (2009b). Swarm-bots to the rescue, in *Advances in Artificial Life. Proceedings of the 10th European Conference on Artificial Life (ECAL 2009), Lecture Notes in Computer Science*, Vol. 5777/5778 (Berlin: Springer Verlag).
- Oh, P. Y., Green, W. E., and Barrows, G. (2004). Neural nets and optic flow for autonomous micro-air-vehicle navigation, in *Proceedings of the ASME International Mechanical Engineering Congress and Exposition*, pp. 1279–1285.
- Oh, P. Y., Joyce, M., and Gallagher, J. (2005). Designing an aerial robot for hover-and-stare surveillance, in *Proceedings of the IEEE International Conference on Advanced Robotics* (IEEE Press), pp. 303–308.
- O'Hara, K. J., Nathuji, R., Raj, H., Schwan, K., and Balch, T. (2006). Autopower: toward energy-aware software systems for distributed mobile robots, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 2757–2762.

- Ohata, K., Maruhashi, K., Ito, M., and Nishiumi, T. (2005). Millimeter-wave broadband transceivers, *NEC J. Adv. Technol.*, **2(3)**, pp. 211–216.
- Ohkura, A., Tokutake, A., and Sundada, S. (2005). Autonomous hovering of a small helicopter, *Transactions of the Japan Society for Aeronautical and Space Sciences*, **53**, pp. 376–378.
- O'Neill, M., and Ryan, C. (2001). Grammatical evolution, *IEEE Trans. Evol. Comput.*, **5(4)**, pp. 349–358.
- Orgel, L. (1992). Molecular replication, *Nature*, **358(6383)**, pp. 203–209.
- Osbourne, P., Whitaker, H., and Kezer, A. (1961). New developments in the design of model reference adaptive control systems, *Inst Aeronautical Services*, paper 61–39.
- Oudeyer, P.-Y., and Kaplan, F. (2004). Intelligent adaptive curiosity: a source of self-development, in *Lund University Cognitive Studies*, pp. 127–130.
- Oung, R., Bourgault, F., Donovan, M., and D'Andrea, R. (2010a). The distributed flight array, in *Proceedings of the 2010 IEEE International Conference on Robotics and Automation (ICRA)* (IEEE), pp. 601–607.
- Oung, R., Bourgault, F., Donovan, M., and D'Andrea, R. (2010b). The Distributed Flight Array, in *Proceedings of the IEEE Conference on Robotics and Automation* (IEEE Press), pp. 601–607.
- Oyekan, J., and Huosheng, H. (2009). Toward bacterial swarm for environmental monitoring, in *Proceedings of the IEEE International Conference on Automation and Logistics*, August (IEEE Press), pp. 399–404.
- Ozier-Lafontaine, H., Lecompte, F., and Sillon, J. (1999). Fractal analysis of the root architecture of *Gliricidia sepium* for the spatial prediction of root branching, size and mass: model development and evaluation in agroforestry, *Plant and Soil*, **209(2)**, pp. 167–179, 10.1023/A:1004461130561.
- Özkucur, N. E., and Akin, H. L. (2010). Cooperative multi-robot map merging using fast-SLAM, *RoboCup 2009: Robot Soccer World Cup XIII*, **5949**, pp. 449–460.
- Pagello, E., D'Angelo, A., and Menegatti, E. (2006). Cooperation issues and distributed sensing for multirobot systems, *Proceedings of the IEEE*, **94(7)**, pp. 1370–1383.
- Pagello, E., D'Angelo, A., Montesello, F., Garelli, F., and Ferrari, C. (1999). Cooperative behaviors in multi-robot systems through implicit communication, *Robot. Auton. Sys.*, **29(1)**, pp. 65–77.
- Pagès, L., Jordan, M., and Picard, D. (1989). A simulation model of the three-dimensional architecture of the maize root system, *Plant and Soil*, **119(1)**, pp. 147–154.

- Paley, D. A., Zhang, F., and Leonard, N. E. (2008). Cooperative control for ocean sampling: The glider coordinated control system, *IEEE Trans. Control Sys. Technol.*, **16(4)**, pp. 735–744.
- Pamecha, A., Chiang, C.-J., Stein, D., and Chirikjian, G. S. (1996). Design and implementation of metamorphic robots, in *Proceedings of the ASME Design Engineering Technical Conference and Computers and Engineering Conference*, pp. 1–10.
- Pamecha, A., Ebert-Uphoff, I., and Chirikjian, G. S. (1997). Useful metrics for modular robot motion planning, *IEEE Trans. Robot. Autom.*, **13(4)**, pp. 531–545.
- Park, C.-S., Tahk, M., and Bang, H. (2003). Multiple aerial vehicle formation using swarm intelligence, in *Proceedings of the AIAA Guidance, Navigation, and Control Conference and Exhibit*, AIAA paper AIAA-2003-5729.
- Park, M., and Yim, M. (2009). Distributed control and communication fault tolerance for the ckbob, in *Proceedings of the (ASME/IFToMM) International Conference on Reconfigurable Mechanisms and Robots* (London, UK), pp. 682–688.
- Parker, L. (2008a). Multiple mobile robot systems, in *Springer Handbook of Robotics*, pp. 921–941.
- Parker, L. E. (1994). ALLIANCE: an architecture for fault tolerant, cooperative control of heterogeneous mobile robots, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. 776–783.
- Parker, L. E. (1998). ALLIANCE: An architecture for fault-tolerant multi-robotcooperation, *IEEE Trans. Robot. Autom.*, **14(2)**, pp. 220–240.
- Parker, L. E. (2000). Lifelong adaptation in heterogeneous teams: Response to continual variation in individual robot performance, *Auton. Robot.*, **8**, 3.
- Parker, L. E. (2001). Evaluating success in autonomous multi-robot teams: Experiences from ALLIANCE architecture implementations, *J. Theor. Exp. Artif. Intell.*, **13**, pp. 95–98.
- Parker, L. E. (2008b). Multiple mobile robot systems, in *Springer Handbook of Robotics* (Springer Berlin Heidelberg), p. Chapter 40.
- Parker, L. E., and Kannan, B. (2006). Adaptive causal models for fault diagnosis and recovery in multi-robot teams, in *Proceedings of IEEE International Conference on Intelligent Robots and Systems (IROS)*.
- Parpinelli, R., Lopes, H., and Freitas, A. (2002). An ant colony algorithm for classification rule discovery, in H. Abbas, and R. S. RA (eds.), *Data*

- Mining: A Heuristic Approach* (Idea Group Publishing, London), pp. 190–208.
- Parravano, A., and Cosenza, M. (1998). Driven maps and emergence of ordered collective behavior in globally coupled maps, *Phys. Rev. E*, **58(2)**, p. 1665.
- Parrish, J., and Edelstein-Keshet, L. (1999). Complexity, pattern, and evolutionary trade-offs in animal aggregation, *Science*, **284(5411)**, pp. 99–101.
- Parsons, D., and Canny, J. (1990). A motion planner for multiple mobile robots, in *Proceedings of the IEEE International Conference on Robotics and Automation*, Vol. 1, pp. 8–13.
- Parunak, H. V. D., Brueckner, S. A., and Sauter, J. (2005). Digital pheromones for coordination of unmanned vehicles, in D. Weyns, H. V. D. Parunak, and F. Michel (eds.), *Environments for Multi-Agent Systems, Lecture Notes in Computer Science*, Vol. 3374 (Berlin/Heidelberg: Springer), pp. 246–263.
- Pasparakis, G., Krasnogor, N., Cronin, L., Davis, B. G., and Alexander, C. (2010). Controlled polymer synthesis—from biomimicry towards synthetic biology, *Chem. Soc. Rev.*, **39(1)**, pp. 286–300, 10.1039/b809333b.
- Pasteels, J. M., Deneubourg, J.-L., and Goss, S. (1987). Self-organization mechanisms in ant societies (i): trail recruitment to newly discovered food sources. *Exp. Suppl.*, **54**, p. 155–175.
- Patricelli, G. L., Coleman, S. W., and Borgia, G. (2006). Male satin bowerbirds, *ptilonorhynchus violaceus*, adjust their display intensity in response to female startling: an experiment with robotic females, *Anim. Behav.*, **71(1)**, pp. 49–59.
- Patricelli, G. L., Uy, J. A. C., Walsh, G., and Borgia, G. (2002). Sexual selection: Male displays adjusted to female's response, *Nature*, **415**, pp. 279–280.
- Patzke, V., and von Kiedrowski, G. (2007). Self replicating systems, *ARKIVOC*, pp. 293–310.
- Paul, N., and Joyce, G. (2002). A self-replicating ribozyme, *Proc. Natl. Acad. Sci. USA*, **99(20)**, pp. 12733–12740.
- Paul, N., and Joyce, G. (2003). Self-replication, *Curr. Biol.*, **13(2)**, pp. R46–R46.
- Paul, N., and Joyce, G. (2004). Minimal self-replicating systems, *Curr. Opinion Chem. Biol.*, **8**, pp. 634–639.
- Paul, T., Krogstad, T., and Gravidahl, J. (2008). Modelling of UAV formation flight using 3D potential field, *Simulation Modelling Practice and Theory*, **16(9)**, pp. 1453–1462.

- Paushkin, S., Kushnirov, V., Smirnov, V., and Ter-Avanesyan, M. (1996). Propagation of the yeast prion-like [psi⁺] determinant is mediated by oligomerization of the sup35-encoded polypeptide chain release factor, *EMBO J.*, **15**(12), pp. 3127–2134.
- Payne, K., Salemi, B., Will, P., and Shen, W.-M. (2004). Sensor-based distributed control for chain-typed self-reconfiguration, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (Sendai, Japan).
- Payton, D., Daily, M., Estkowski, R., Howard, M., and Lee, C. (2001). Pheromone robots, *Auton. Robot.*, **11**, pp. 319–324.
- Payton, D., Estkowski, R., and Howard, M. (2004). Pheromone robotics and the logic of virtual pheromones, in E. Şahin, and W. Spears (eds.), *Swarm Robotics, Lecture Notes in Computer Science*, Vol. 3342 (Berlin: Springer), pp. 45–57.
- Payton, D. W., Keirse, D., Kimble, D. M., Krozel, J., and Rosenblatt, J. K. (1992). Do whatever works: A robust approach to fault-tolerant autonomous control, *J. Appl. Intell.*, **2**(3), pp. 225–250.
- Pearce, J. L., Rybski, P. E., Stoeter, S. A., and Papanikolopoulos, N. (2003). Dispersion behaviors for a team of multiple miniature robots, in *Proceedings of the 2003 IEEE International Conference on Robotics and Automation*, Vol. 1, pp. 1158–1163.
- Pearson, H. (2006). Genetics: What is a gene? *Nature* 441:398-401, *Nature*, **441**, pp. 398–401.
- Pedersen, M., and Phillips, A. (2009). Towards programming languages for genetic engineering of living cells, *J. R. Soc. Interface*, **6**(suppl. 4), pp. S437–S450, 10.1098/rsif.2008.0516.focus, <http://dx.doi.org/10.1098/rsif.2008.0516.focus>.
- Peebles, C., Perlman, P., Mecklenburg, K., Pertillo, M., and Tabor, J. *et al.* (1986). A self-splicing RNA excises an intron lariat, *Cell*, **44**, pp. 213–223.
- Peng, H., Li, Y., Wang, L., and Shen, L. (2008). Hormone-inspired cooperative control for multiple UAVs wide area search, in *Proceedings of the 4th International Conference on Intelligent Computing: Advanced Intelligent Computing Theories and Applications-with Aspects of Theoretical and Methodological Issues, Lecture Notes in Computer Science*, Vol. 5226 (Berlin: Springer), pp. 808–816.
- Pennisi, E. (2007). Dna study forces rethink of what It means to be a gene, *Science*, **316**, pp. 1556–1557.
- Penrose, L. S. (1959). Self-reproducing machine, *Sci. Am.*, **200**(6), pp. 105–114.

- Penrose, L. S., and Penrose, R. (1957). A self-reproducing analogue, *Nature*, **179**, 4571, p. 1183.
- Pfeifer, R., Iida, F., and Gomez, G. (2006). Morphological computation for adaptive behavior and cognition, *Inter. Congr. Ser.*, 1292.
- Pfeifer, R., Lungarella, M., and Iida, F. (2007). Self-organization, embodiment, and biologically inspired robotics, *Science*, **318(5853)**, pp. 1088–1093.
- Pierret, A., Doussan, C., Capowicz, Y., Bastardie, F., and Pagès, L. (2007). Root Functional Architecture: A Framework for Modeling the Interplay between Roots and Soil, *Vadose Zone J.*, **6(2)**, pp. 269–281, 10.2136/vzj2006.0067.
- Pinciroli, C., Birattari, M., Tuci, E., Dorigo, M., del Rey Zapatero, M., Vinko, T., and Izzo, D. (2008). Self-organizing and scalable shape formation for a swarm of pico satellites, (Proceedings of the NASA/ESA Conference on Adaptive Hardware and Systems, AHS-2008), pp. 57–61.
- Pine, B. J. (1999). *Mass Customization. The New Frontier in Business Competition* (Harvard Business School Press, Boston, Mass).
- Piner, R., Zhu, J., Xu, F., Hong, S., and Mirkin, C. A. (1999). Dip pen nanolithography, *Science*, **283(4)**, pp. 661–663.
- Pinheiro, P., and Lima, P. (2004). Bayesian sensor fusion for cooperative object localization and world modeling, in *Proceedings of the 8th Conference on Intelligent Autonomous Systems* (IOS Press, Amsterdam, NL).
- Pisano, W. J., and Lawrence, D. A. (2007). Autonomous UAV control using a 3-sensor autopilot, in *Proceedings of the AIAA Infotech@Aerospace Conference and Exhibit*, AIAA paper AIAA-2007-2756.
- Pizka, M., and Bauer, A. (2004). A brief top-down and bottom-up philosophy on software evolution, in *IWPSE '04: Proceedings of the Principles of Software Evolution, 7th International Workshop* (IEEE Computer Society, Washington, DC, USA), ISBN 0-7695-2211-4, pp. 131–136, <http://dx.doi.org/10.1109/IWPSE.2004.1>.
- Pradhan, S., and Damodaran, P. (2009). Performance characterization of complex manufacturing systems with general distributions and job failures, *Eur. J. Oper. Res.*, 197, p. 588598.
- Pradier, M. (2005). *Collective Classification in a Swarm of Microrobots* Master's Thesis, University of Stuttgart, Germany.
- Pratt, R. W. (2000). *Flight Control Systems*, Vol. 57, 1st edn. (The Institution of Electrical Engineers (IEE)).

- Pregitzer, K., DeForest, J., Burton, A., Allen, M. F., Ruess, R. W., and Hendrick, R. L. (2002). Fine root architecture of nine North American trees, *Ecol. Monogr.*, **72**(2), pp. 293–309.
- Preisig, J. (2006). Acoustic propagation considerations for underwater acoustic communications network development, in *Proceedings of the ACM International Workshop on Underwater Networks (WUWNet '06)* (Los Angeles, CA, USA), ISBN 1-59593-484-7, 10.1145/1161039.1161053.
- Press, W., Teukolsky, S., Vetterling, W., and Flannery, B. (2007). *Numerical Recipes. The Art of Scientific Computing*, 3rd edn. (Cambridge University Press, Cambridge).
- Price, T., Qvarnström, A., and Irwin, D. (2003). The role of phenotypic plasticity in driving genetic evolution, *Proc. Biol. Sci.*, **270**(1523), pp. 1433–40.
- Prieto, V. (2006). *Development of cooperative behavioural patterns for swarm robotic scenarios* Master's Thesis, University of Stuttgart, Germany.
- Prigogine, I. (1996). *The End of Certainty: Time, Chaos, and the New Laws of Nature* (The Free Press, New York, NY).
- Prigogine, I., and Nicolis, G. (1977). *Self-Organization in Non-Equilibrium Systems: From Dissipative Structures to Order Through Fluctuations* (J. Wiley & Sons, New York).
- Prigogine, I., and Stengers, I. (1984). *Order out of chaos* (Heinemann, London).
- Priyantha, N., Chakraborty, A., and Balakrishnan, H. (2000). The cricket location-support system, in *Proceedings of the 6th annual international conference on Mobile Computing and Networking*, pp. 32–43.
- Prokopenko, M., Gerasimov, V., and Tanev, I. (2006). Evolving spatiotemporal coordination in a modular robotic system, in S. Nolfi, G. Baldassarre, R. Calabretta, J. Hallam, D. Marocco, J. Meyer, O. Miglino, and D. Parisi (eds.), *From Animals to Animats 9: 9th International Conference on the Simulation of Adaptive Behavior (SAB 2006)* (Springer Verlag, Berlin, Germany), pp. 558–569.
- Prusiner, S. (2004). *Prion biology and diseases* (Cold Spring Harbour Laboratory Press).
- Prusinkiewicz, P., and Hanan, J. (1980). *Lindenmayer Systems, Fractals, and Plants* (Springer Verlag, Berlin, Heidelberg, New York).
- Pugh, J., Raemy, X., Favre, C., Falconi, R., and Martinoli, A. (2009). A fast on-board relative positioning module for multi-robot systems, *IEEE*

- Transactions on Mechatronics, Focused Section on Mechatronics in Multi-Robot Systems*, **14(2)**, pp. 151–162.
- Pujol, J., Vendrell, P., Junque, C., Marti'-Vilalta, J. L., and Capdevila, A. (1994). When does human brain development end? evidence of corpus callosum growth up to adulthood, *Ann. Neurol.*, **34(1)**, pp. 71–75.
- Puterman, M. (1994). *Markov Decision Processes: Discrete Stochastic Dynamic Programming* (Wiley-Interscience), ISBN 0471619779.
- Qu, Z. (2009). *Cooperative Control of Dynamical Systems: Applications to Autonomous Vehicles* (Springer).
- Ramp, S. R., Davis, R. E., Leonard, N. E., Shulman, I., Chao, Y., Robinson, A. R., Marsden, J., Lermusiaux, P. F. J., Fratantoni, D. M., Paduan, J. D., Chavez, F. P., Bahr, F. L., Liang, S., Leslie, W., and Li, Z. (2008). Preparing to predict: The second autonomous ocean sampling network (AOSN-II) experiment in the monterey bay, *Deep Sea Res. Part II*, **56(3–5)**, pp. 68–86, 10.1016/j.dsr2.2008.08.013.
- Rana, O., and Stout, K. (2000). What is scalability in multi-agent systems? in *Proc. of the 4th International Conference on Autonomous Agents* (ACM Press), pp. 56–63, <http://doi.acm.org/10.1145/336595.337033>.
- Rasmussen, S., Bedau, M., Chen, L., Deamer, D., Krakauer, D., and et al. (2008). *Protocells: Bridging nonliving and living matter* (Cambridge: MIT Press).
- Rasmussen, S., Chen, L., Deamer, D., Krakauer, D., Packard, N., Stadler, P., and Bedau, M. (2004). Evolution: Transitions from nonliving to living matter, *Science*, **303(5660)**, pp. 963–965, 10.1126/science.1093669.
- Ratnieks, F. L. W., and Anderson, C. (1999). Task partitioning in insect societies II: Use of queueing delay information in recruitment, *Am. Nat.*, **154(5)**, pp. 536–548.
- Reger, B. D., Fleming, K. M., Sanguineti, V., Alford, S., and Mussa-Ivaldi, F. A. (2000). Connecting brains to robots: an artificial body for studying the computational properties of neural tissues, *Artif. Life*, **6(4)**, pp. 307–324, <http://dx.doi.org/10.1162/106454600300103656>.
- Reif, J. H., and Slee, S. (2007). Optimal kinodynamic motion planning for 2d reconfiguration of self-reconfigurable robots, in *Proceedings of the Robotics: Science and Systems Conference*, Vol. IX (Georgia Institute of Technology, Atlanta, GA), pp. 27–30.
- Reiser, M. (2009). The ethomics era? *Nat. Meth.*, **6(6)**, pp. 413–414, <http://dx.doi.org/10.1038/nmeth0609-413>.
- Rentschler, M., Platt, S., Berg, K., Dumpert, J., Oleynikov, D., and Farritor, S. (2008). Miniature in vivo robots for remote and harsh environments, *IEEE Trans. Infor. Technol. Biomed.*, **12(1)**, pp. 66–75.

- REPLICATOR (2008–2012). *Robotic Evolutionary Self-Programming and Self-Assembling Organisms, 7th Framework Programme Project No FP7-ICT-2007.2.1* (European Communities).
- Requicha, A. A. G. (2003). Nanorobots, NEMS, and nanoassembly, *Proceedings of the IEEE*, **91(11)**, pp. 1922–1933.
- Requicha, A. A. G. (2008). Nanomanipulation with the atomic force microscope, in R. Waser (ed.), *Nanotechnology, Volume 3: Information Technology* (Weinheim, Germany: Wiley-VCH Verlag, Berlin), pp. 239–273.
- Requicha, A. A. G., Arbuckle, D. J., Mokaberi, B., and Yun, J. (2009). Algorithms and software for nanomanipulation with atomic force microscopes, *Int. J. Rob. Res.*, **28(4)**, pp. 512–522.
- Restelli, M., Sorrenti, D. G., and Marchese, F. M. (2002). A robot localization method based on evidence accumulation and multi-resolution, in *proceedings of 2002(IEEE/RSJ) Int. Conf. on Intelligent Robots and Systems (IROS2002)*.
- Reynolds, C. W. (1987). Flocks, herds and schools: a distributed behavioral model, in *Proceedings of the 14th Annual Conference on Computer Graphics and Interactive Techniques*, Vol. 21 (ACM Press), pp. 25–34.
- Reynolds, R. G. (1999). Cultural algorithms: Theory and applications, in D. Corne, M. Dorigo, and F. Glover (eds.), *New Ideas in Optimization* (McGraw-Hill, London), pp. 367–377.
- Richards, A., Bellingham, J., Tillerson, M., and How, J. (2002). Co-ordination and control of multiple UAVs, in *Proceedings of the AIAA Guidance, Navigation and Control Conference*, AIAA Paper AIAA-2002-4588.
- Richards, M. D., Whitley, D., and Beveridge, J. R. (2005). Evolving cooperative strategies for UAV teams, in *Proceedings of the Genetic and Evolutionary Computation Conference*, Vol. 2 (ACM Press), pp. 1721–1728.
- Richerson, P., and Boyd, R. (2005). *Not by genes alone: how culture transformed human evolution* (University of Chicago Press).
- Riley, P., and Veloso, M. (2002). Recognizing probabilistic opponent movement models, in A. Birk, S. Coradeschi, and S. Tadokoro (eds.), *RoboCup 2001: Robot Soccer World Cup V*, no. 2377 in *Lecture Notes in Artificial Intelligence* (Springer Verlag, Berlin), pp. 453–458.
- Rivard, F., Bisson, J., Michaud, F., and Letourneau, D. (2008). Ultrasonic relative positioning for multi-robot systems, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 323–328.

- Roberts, J. F., Stirling, T. S., Zufferey, J.-C., and Floreano, D. (2009). 2.5D infrared range and bearing system for collective robotics, in *Proceedings of the International Conference on Intelligent Robots and Systems* (IEEE Press), pp. 3659–3664.
- Roberts, J. F., Zufferey, J.-C., and Floreano, D. (2008). Energy management for indoor hovering robots, in *Proceedings of the International Conference on Intelligent Robots and Systems* (IEEE Press), pp. 1242–1247.
- Robertson, M., and Scott, W. (2007). The structural basis of ribozyme-catalyzed RNA assembly, *Science*, **315**, pp. 1549–1553.
- Rogers, J., and Joyce, G. (2001). The effect of cytidine on the structure and function of an RNA ligase ribozym, *RNA*, **7**, pp. 395–404.
- Rohrs, C., Valavani, L., Athans, M., and Stein, G. (1985). Robustness of continuous-time adaptive control algorithms in the presence of unmodeled dynamics, *IEEE Trans. Autom. Control*, **30(9)**, pp. 881–889.
- Roma, G.-C., Gamble, R. F., and Ball, W. E. (1993). Formal derivation of rule-based programs, *IEEE Trans. Softw. Eng.*, **19(3)**, pp. 277–296, <http://dx.doi.org/10.1109/32.221138>.
- Romero, H., Salazar, S., Sanchez, A., and Lozano, R. (2007). A new UAV configuration having eight rotors: Dynamical model and real-time control, in *Proceedings of the 46th IEEE Conference on Decision and Control* (IEEE Press), pp. 6418–6423.
- Ronald, E. M. A., and Sipper, M. (2001). Surprise versus unsurprise: Implications of emergence in robotics, *Robot. Auton. Sys.*, **37(1)**, pp. 19–24.
- Root-Bernstein, R. (1983). Protein replication by amino acid pairing, *J. Theor. Biol.*, **100(1)**, pp. 99–106.
- Rosenfeld, A., Kaminka, G. A., and Kraus, S. (2006). A study of scalability properties in robotic teams, in P. Scerri, R. Vincent, and R. Mailler (eds.), *Coordination of Large-Scale Multiagent Systems* (Springer US), pp. 27–51.
- Ross, E., Baxa, U., and Wickner, R. (2004). Scrambled prion domains form prions and amyloid, *Mol. Cell. Biol.*, **24(16)**, pp. 7206–7213.
- Rosslenbroich, B. (2009). The theory of increasing autonomy in evolution: a proposal for understanding macroevolutionary innovations, *Biology & Philosophy* 10.1007/s10539-009-9167-9.
- Roth, M., Vail, D., and Veloso, M. (2003). A real-time world model for multi-robot teams with high-latency communication, in *Proceedings of the 2003 IEEE/RSJ Intl. Conference on Intelligent Robots and Systems* (IEEE Computer Press, Piscataway, NJ), pp. 2494–2499.

- Rothemund, P. W. K. (2006). Folding DNA to create nanoscale shapes and patterns, *Nature*, **440(7082)**, pp. 297–302.
- Roumeliotis, S., and Bekey, G. (2000). Synergetic localization for groups of mobile robots, in *Proceedings of the 39th IEEE Conference on Decision and Control* (Sydney, Australia), pp. 3477–3482.
- Roumeliotis, S., and Bekey, G. (2002). Distributed multirobot localization, *IEEE Trans. Robot. Autom.*, **18(5)**, pp. 781–795.
- Rubenstein, M., Payne, K., Will, P., and Shen, W.-M. (2004). Docking among independent and autonomous CONRO self-reconfigurable robots, in *Proceedings of the 2004 IEEE International Conference on Robotics and Automation*, Vol. 3 (IEEE Computer Society Press, Los Alamitos, CA), pp. 2877–2882.
- Rudnick, D. L., Davis, R. E., Eriksen, C. C., Fratantoni, D. M., and Perry, M. J. (2004). Underwater gliders for ocean research, *Marine Technol. Soc. J.*, **38(1)**, pp. 48–59.
- Ruffieux, D. (1999). A low power asic for the control of a mobile micro-actuator array, in *Proceedings of the 25th European Solid-State Circuits Conference, ESSCIRC'99*, pp. 90–93.
- Ruffieux, D., and Rooij, N. F. (1999). A 3-dof bimorph actuator array capable of locomotion, in *Proceedings of 13th European Conference on Solid-State Transducers (Euroensors XIII)*, pp. 725–728.
- Ruini, F., and Cangelosi, A. (2009). Extending the evolutionary robotics approach to flying machines: An application to MAV teams, *Neural Networks*, **22(5–6)**, pp. 812–821.
- Ruiz-Mirazo, K., Umerez, J., and Moreno, A. (2008). Enabling conditions for 'open-ended evolution', *Biol. Philos.*, **23(1)**, pp. 67–85.
- Ruppin, E. (2002). Evolutionary autonomous agents: A neuroscience perspective, *Nat. Rev. Neurosci.*, **3**, pp. 132–141, citeseer.ist.psu.edu/ruppin02evolutionary.html.
- Rus, D., and Vona, M. (1999). Self-reconfiguration planning with compressible unit modules, in *Proceedings of the IEEE International Conference on Robotics and Automation* (Detroit, MI), pp. 2513–2520.
- Rus, D., and Vona, M. (2001). Crystalline robots: Self-reconfiguration with compressible unit modules, *Auton. Robot.*, **10(1)**, pp. 107–124.
- Russell, R. A. (1997). Heat trails as short-lived navigational markers for mobile robots, *Robot. Autom.*, **4**, pp. 3534–3597.
- Russell, R. A. (1999). Ant trails - an example for robots to follow? in *Proceedings of the 1999 IEEE International Conference on Robotics and Automation*, Vol. 4, pp. 2698–2703.

- Russell, S. (1995). *Artificial intelligence: a modern approach* (Prentice-Hall).
- Rutishauser, S., Correll, N., and Martinoli, A. (2009). Collaborative coverage using a swarm of networked miniature robots, *Robot. Auton. Sys.*, **57**(5), pp. 517–525.
- Rybski, P., Larson, A., Lindahl, M., and Gini, M. (1998). Performance evaluation of multiple robots in a search and retrieval task, in *Proceedings of the Workshop on Artificial Intelligence and Manufacturing* (AAAI Press, Menlo Park), pp. 153–160.
- Sadeghi, M. H., Raflee, J., and Arvani, F. (2005). A fault detection and identification system for gearboxes using neural networks, in *International Conference on Neural Networks and Brain*, pp. 964–969.
- Saenz-Otero, A., Katz, J., and Miller, D. (2009). SPHERES Demonstrations of Satellite Formations aboard the ISS.
- Safar, J., Wille, H., Itri, V., Groth, D., Serban, H., and et al. (1998). Eight prion strains have prpsc molecules with different conformations, *Nat. Med.*, **4**, pp. 685–696.
- Saffiotti, A., Broxvall, M., Gritti, M., LeBlanc, K., Lundh, R., Rashid, J., Seo, B., and Cho, Y. (2008). The PEIS-ecology project: vision and results, in *Proc of the IEEE/RSJ Int Conf on Intelligent Robots and Systems (IROS)* (Nice, France), pp. 2329–2335, online at <http://www.aass.oru.se/~asaffio/>.
- Sahin, E. (2004). *Swarm Robotics: From sources of inspiration to domains of application* (Springer Verlag, Heidelberg, Germany).
- Sahin, E. (2005). Swarm robotics: From sources of inspiration to domains of application, in *Swarm Robotics, Lecture Notes in Computer Science*, Vol. 3342 (Berlin: Springer), pp. 10–20.
- Şahin, E., and Winfield, A. (2008). Special issues on swarm robotics, *Swarm Intelligence*, **2**(2–4), pp. 69–72.
- Said, I., Durier, V., and Rivault, C. (2004). European project leurre deliverable d2.1:2 report and demonstration on insbot-cockroach interaction. Part I: chemical communication, Tech. rep., EVE group, Université de Rennes I.
- Salazar, S., Romero, H., Lozano, R., and Castillo, P. (2009). Modeling and real-time stabilization of an aircraft having eight rotors, *J. Intell. Robot. Sys.*, **57**, pp. 455–470.
- Salemi, B., and Shen, W.-M. (2004). Distributed behavior collaboration for self-reconfigurable robots, in *ICRA-04* (New Orleans, USA), pp. 4178–4183.
- Sammut, C. (2010). Robot soccer, *Wiley Interdiscip. Rev. Cognit. Sci.*, **1**(6), pp. 824–833, 10.1002/wcs.86.

- Sandefur, J. (1990). *Discrete dynamical systems. Theory and Application* (Calarendon Press, Oxford).
- Sandia (2001). Mini autonomous robot vehicle.
- SAP (2005). *Adaptive Manufacturing: enabling the lean six sigma enterprises* (SAP).
- Sastry, S., and Bodson, M. (1989). *Adaptive Control* (Prentice Hall).
- Sato, A. (2003). *Introduction to Molecular-Microsimulation of Colloidal Dispersions* (Elsevier Science, Amsterdam).
- Sauter, J. A., Matthews, R., Parunak, H. V. D., and Brueckner, S. A. (2005). Performance of digital pheromones for swarming vehicle control, in *Proceedings of the International Joint Conference on Autonomous Agents and Multi-Agent Systems* (ACM Press), pp. 903–910.
- Saville, B., and Collins, R. (1990). A site-specific self-cleavage reaction performed by a novel RNA in *Neurospora* mitochondria, *Cell*, **61**, pp. 685–696.
- Sayama, H. (2009). Swarm chemistry, *Artif. Life*, **15(1)**, pp. 105–114, <http://dx.doi.org/10.1162/artl.2009.15.1.15107>.
- Scassellati, B. (1999). Knowing what to imitate and knowing when you succeed, in *Proceedings of the AISB'99 Symposium on Imitation in Animals and Artefacts*, pp. 105–113.
- Scherer, S., Singh, S., Chamberlain, L., and Elgersma, M. (2008). Flying fast and low among obstacles: Methodology and experiments, *Int. J. Robot. Res.*, **27(5)**, pp. 549–574.
- Schill, F. (2007). *Distributed Communication in Swarms of Autonomous Underwater Vehicles*, Ph.D. thesis, The Australian National University, Canberra, ACT, Australia.
- Schill, F., Trumpf, J., and Zimmer, U. R. (2005). Towards optimal TDMA scheduling for robotic swarm communication, in *Proceedings of Towards Autonomous Robotic Systems (TAROS '05)* (London, UK), ISBN 0-905247-03-5.
- Schill, F., and Zimmer, U. (2007a). Pruning local schedules for efficient swarm communication, in *Proceedings of the IEEE International Symposium on Underwater Technology (UT '07)* (Tokyo, Japan).
- Schill, F., and Zimmer, U. R. (2006). Distributed dynamical omnicast routing, *Complex Sys.*, **16(4)**, pp. 299–316.
- Schill, F., and Zimmer, U. R. (2007b). Pruning local schedules for efficient swarm communication, in *Proceedings of the IEEE International Symposium on Underwater Technology (UT '07)* (Tokyo, Japan), ISBN 1-4244-1207-2, pp. 594–600, 10.1109/UT.2007.370781.

- Schill, F., Zimmer, U. R., and Trumpf, J. (2004). Visible spectrum optical communication and distance sensing for underwater applications, in *Proceedings of the Australasian Conference on Robotics and Automation (ACRA '04)* (Canberra, ACT, Australia), ISBN 0-9587583-6-0.
- Schmickl, T., and Crailsheim, K. (2006). Trophallaxis among swarm-robots: A biologically inspired strategy for swarm robotics, in *Proceedings of the 1st IEEE/RAS-EMBS International Conference on Biomedical Robotics and Biomechanotronics*.
- Schmickl, T., and Crailsheim, K. (2008a). Analysing honeybees' division of labour in broodcare by a multi-agent model, in S. Bullock, J. Noble, R. Watson, and M. A. Bedau (eds.), *Artificial Life XI: Proceedings of the Eleventh International Conference on the Simulation and Synthesis of Living Systems* (MIT Press, Cambridge, MA), pp. 529–536.
- Schmickl, T., and Crailsheim, K. (2008b). Taskselism: a model of the self-organization of the division of labour in honeybees, *Math. Comp. Modell. Dyn. Sys.*, **14**, pp. 101–125.
- Schmickl, T., and Crailsheim, K. (2008c). Trophallaxis within a robotic swarm: bio-inspired communication among robots in a swarm, *Auton. Robot.*, **25(1-2)**, pp. 171–188, <http://dx.doi.org/10.1007/s10514-007-9073-4>.
- Schmickl, T., Hamann, H., Wörn, H., and Crailsheim, K. (2009). Two different approaches to a macroscopic model of a bio-inspired robotic swarm, *Robot. Auton. Sys.*, **57(9)**, pp. 913–921.
- Schmickl, T., Möslinger, C., and Crailsheim, K. (2007a). Collective perception in a robot swarm, in E. Şahin, W. M. Spears, and A. F. T. Winfield (eds.), *Swarm Robotics - Second SAB 2006 International Workshop, LNCS*, Vol. 4433.
- Schmickl, T., Möslinger, C., Thenius, R., and Crailsheim, K. (2007b). Bio-inspired navigation of autonomous robots in heterogenous environments, *Int. J. Factory Autom. Robot. Soft Comput.*, **3**, pp. 164–170.
- Schmickl, T., Möslinger, C., Thenius, R., and Crailsheim, K. (2007c). Individual adaptation allows collective path-finding in a robotic swarm, *Int. J. Factory Automat. Robot. Soft Comput.*, **4**, pp. 102–108.
- Schmickl, T., Thenius, R., and Crailsheim, K. (2005). Simulating swarm intelligence in honey bees: Foraging in differently fluctuating environments, in *Proceedings of GECCO'05* (ACM, New York), pp. 273–274, <http://doi.acm.org/10.1145/1068009.1068052>.
- Schmid, G. (2004). *Nanoparticles* (Wiley-VCH Verlag, Weinheim).

- Schmitt, T., Hanek, R., Beetz, M., Buck, S., and Radig, B. (2002). Cooperative probabilistic state estimation for vision-based autonomous mobile robots, in G. Lakemeyer, E. Sklar, D. G. Sorrenti, and TomoichiTakahashi (eds.), *RoboCup 2001: Robot Soccer World Cup V*, Vol. LNCS 2377 (Springer Verlag, Berlin), pp. 63–133.
- Schore, A. N. (1994). *Affect Regulation And The Origin Of The Self: The Neurobiology of Emotional Development* (Lawrence Erlbaum Associates, Publishers).
- Schraft, R., and Schmierer, G. (2000). *Service Robots* (AK Peters).
- Schwager, M., Detweiler, C., Vasilescu, I., Anderson, D. M., and Rus, D. (2008). Data-driven identification of group dynamics for motion prediction and control, *J. Field Robot.*, **25(6–7)**, pp. 305–324.
- Schwager, M., Julian, B., and Rus, D. (2009a). Optimal coverage for multiple hovering robots with downward-facing cameras, in *Proceedings of the International Conference of Robotics and Automation* (Kobe, Japan).
- Schwager, M., Rus, D., and Slotine, J. J. (2009b). Decentralized, adaptive coverage control for networked robots, *Int. J. Robot. Res.*, **28(3)**, pp. 357–375.
- Schwarzer, C. (2008). *Investigation of Evolutionary Reproduction in a Robot Swarm* Master's Thesis, University of Stuttgart, Germany.
- Schwefel, H.-P. (1981). *Numerical Optimization of Computer Models* (John Wiley & Sons, New York, NY).
- Sears, A., and Jacko, J. A. (2007). *Handbook for human computer interaction*, (CRC).
- Sedgewick, R. (1998). *Algorithms in C++* (Addison-Wesley).
- Sedgewick, R., and Flajolet, P. (1996). *An introduction to the analysis of algorithms* (Addison-Wesley, Reading, MA).
- Seeley, T. D. (1989). Social foraging in honey bees: how nectar foragers assess their colony's nutritional status, *Behav. Ecol. Sociobiol.*, **24**, pp. 181–199.
- Seeley, T. D. (1992). The tremble dance of the honey bee: message and meanings, *Behav. Ecol. Sociobiol.*, **31**, pp. 375–383.
- Seeley, T. D. (1995). *The wisdom of the hive: the social physiology of honey bee colonies* (Harvard University Press, Cambridge, Massachusetts, London, England), ISBN 0674953762.
- Segré, D., Ben-Eli, D., and Lancet, D. (2000). Compositional genomes: Prebiotic information transfer in mutually catalytic noncovalent assemblies, *Proc. Natl. Acad. Sci. USA*, **97(8)**, pp. 4112–4117.

- Sempo, G., Depickere, S., Ame, J., Detrain, C., Halloy, J., and Deneubourg, J. (2006). Integration of an autonomous artificial agent in an insect society: Experimental validation, *FROM ANIMALS TO ANIMATS 9, PROCEEDINGS*, **4095**, pp. 703–712.
- Sepp, A., and Choo, Y. (2005). Cell-free selection of zinc finger DNA-binding proteins using in vitro compartmentalization, *J. Mol. Biol.*, **354(2)**, pp. 212–219.
- Sepp, A., Tawfik, D., and Griffiths, A. (2002). Microbead display by in vitro compartmentalisation: selection for binding using flow cytometry, *FEBS Lett*, **532(3)**, pp. 455–458.
- Seybold, J. S. (2005). *Chapter 7: Near Earth Propagation Models*, Vol. 1 (John Wiley & Sons), pp. 134–146.
- Seyfried, J., Szymanski, M., Bender, N., Estana, R., Thiel, M., and Wörn, H. (2005). The i-swarm project: Intelligent small world autonomous robots for micro-manipulation, *Swarm Robotics, LNCS 3342, Springer*, pp. 70–83.
- Shakernia, O., Chen, W.-Z., and Raska, V. M. (2005). Passive ranging for UAV sense and avoid applications, in *Proceedings of Infotech@Aerospace*, AIAA paper AIAA-2005-7179.
- Shannon, C. E. (1948). A mathematical theory of communication, *Bell Sys. Tech. J.*, **27**, pp. 79–423.
- Sharma, R. K., and Ghose, D. (2009). Collision avoidance between UAV clusters using swarm intelligence, *Int. J. Sys. Sci.*, **40(5)**, pp. 521–538.
- Sharmeen, L., Kuo, M., Dinner-Gottlieb, G., and Taylor, J. (1988). Antigenomic RNA of human Hepatitis delta viruses can undergo self-cleavage, *J. Virol.*, **62**, pp. 2674–2679.
- Shechner, D., Grant, R., Bagby, S., Koldobskaya, Y., Piccirilli, J., and et al (2009). Crystal structure of the catalytic core of an RNA-polymerase ribozyme, *Science*, **326(5957)**, pp. 1271–1275.
- Shen, J., Moh, S., and Chung, I. (2008). Routing protocols in delay tolerant networks: A comparative survey, in *Proceedings of the 23rd International Technical Conference on Circuits/Systems, Computers and Communications*, pp. 1577–1580.
- Shen, W.-M., B., S., and Will, P. (2002). Hormone-inspired adaptive communication and distributed control for conro self-reconfigurable robots, *IEEE Trans. Robot. Autom.*, **18(5)**, pp. 700–712.
- Shen, W.-M., Krivokon, M., Chiu, H., Everist, J., Rubenstein, M., and Venkatesh, J. (2006). Multimode locomotion for reconfigurable robots, *Auton. Robot.*, **20(2)**, pp. 165–177.

- Shiomi, M., Kanda, T., Glas, D., Satake, S., Ishiguro, H., and Hagita, N. (2009). Field trial of networked social robots in a shopping mall, in *Proceedings of the 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems* (St. Louis, MO).
- Shore, D., and Bodson, M. (2004). Flight testing of a reconfigurable control system on an unmanned aircraft, in *Proceedings of the American Control Conference*, Vol. 6, pp. 3747–3752.
- Shorter, J., and Lindquist, S. (2005). Prions as adaptive conduits of memory and inheritance, *Nat. Rev. Genet.*, **6**, pp. 435–450.
- Shoval, S., and Borenstein, J. (2001). Measuring the relative position and orientation between two mobile robot with binaural sonar, in *Proceedings of the ANS 9th International Topical Meeting on Robotics and Remote Systems*, pp. 1–12.
- Sibley, G., Rahimi, M., and Sukhatme, G. (2002). Robomote: a tiny mobile robot platform for large-scale ad-hocsensor networks, *Robotics and Automation, 2002. Proceedings of ICRA'02 IEEE International Conference*, **2**.
- Siciliano, B., and Khatib, O. (eds.) (2008). *Springer Handbook of Robotics* (Springer), ISBN 978-3-540-23957-4.
- Siegel, M., and King, R. W. P. (1973). Electromagnetic propagation between antennas submerged in the ocean, *IEEE Trans. Antennas Propag.*, **21(4)**, pp. 507–513.
- Siegwart, R., and Nourbakhsh, I. R. (2004). *Introduction to Autonomous Mobile Robots* (MIT Press, Cambridge).
- Sievers, D., and Von Kiedrowski, G. (1994). Self-replication of complementary nucleotide-based oligomers, *Nature*, **369**, pp. 221–224.
- Sigurd, K., and How, J. (2003). UAV trajectory design using total field collision avoidance, in *Proceedings of the AIAA Guidance, Navigation and Control Conference*, AIAA paper AIAA-2003-5728.
- Simoes, L., Cruz, C., Ribeiro, R., Correia, L., Seidl, T., C., A., and D., I. (2010). Path planning strategies inspired by swarm behaviour of plant root apices, Tech. Rep. 09/6401, European Space Agency, the Advanced Concepts Team, available online at www.esa.int/act.
- Sims, K. (1994a). Evolving 3d morphology and behavior by competition, in R. Brooks, and P. Maes (eds.), *Artificial Life IV* (MIT Press, Cambridge, MA), pp. 28–39.
- Sims, K. (1994b). Evolving Virtual Creatures, in *Proceedings of the 1994 ACM Conference on Computer Graphics (SIGGRAPH '94)* (ACM, New York, USA), pp. 15–22.

- Simu, U., and Johansson, S. (2001). A monolithic piezoelectric miniature robot with 5 dof, in *Proceedings of the 11th International Conference Solid-State Sensors and Actuators (Transducers 2001, Eurosensors XV)*, pp. 690–693.
- Singh, S., Grund, M., Bingham, B., Eustice, R., Singh, H., and Freitag, L. (2006). Underwater acoustic navigation with the WHOI micro-modem, in *Proceedings of MTS/IEEE Oceans 2006* (Boston, MA, USA), ISBN 1-4244-0114-3, 10.1109/OCEANS.2006.306853.
- Slee, S. (2005). A survey of motion planning for self-reconfigurable robots.
- Smith, R., Bonacina, C., Kearney, P., and Merlat, W. (2000). Embodiment of Evolutionary Computation in General Agents, *Evol. Comput.*, **8(4)**, pp. 475–493.
- Smith, R. G. (1980). The Contract Net Protocol: high-level communication and control in a distributed problem solver, *IEEE Trans. Comput.*, **C-29**, 12.
- Snook, I. (2007). *The Langevin and Generalised Langevin Approach to the Dynamics of Atomic, Polymeric and Colloidal Systems*, 1st edn. (Elsevier, Amsterdam).
- Solé, R. (2009). Evolution and self-assembly of protocells, *Int. J. Biochem. Cell Biol.*, **42(2)**, pp. 274–284.
- Somaraju, R., and Schill, F. (2007). A communication module and TDMA scheduling for a swarm of small submarines, *Turk. J. Electr. Eng. Comput. Sci.* (special issue on Swarm Robotics) **15(2)**, pp. 283–306.
- Somaraju, R., and Trumpf, J. (2006). Frequency, temperature and salinity variation of the permittivity of seawater, *IEEE Trans. Antennas Propag.*, **54(11)**, pp. 3441–3448, 10.1109/TAP.2006.884290.
- Song, P., and Kumar, V. (2002). A potential field based approach to multi-robot manipulation, in *Proceedings of the 2002 IEEE International Conference on Robotics and Automation (ICRA 2002)*, Vol. 2 (IEEE, Washington DC), pp. 1217–1222.
- Spears, W. M., Spears, D. F., Heil, R., Kerr, W., and Hettiarachchi, S. (2005). An overview of physicomimetics, in *Swarm Robotics, Lecture Notes in Computer Science*, Vol. 3342 (Berlin: Springer), pp. 84–97.
- Spector, L., Klein, J., and Feinstein, M. (2007). Division blocks and the open-ended evolution of development, form, and behavior, in *Proceedings of the 9th Annual Conference on Genetic and Evolutionary Computation (GECCO-07)* (ACM, New York), pp. 316–323, 10.1145/1276958.1277019, <http://dx.doi.org/10.1145/1276958.1277019>.

- Speidel, G. (2008). *Artificial cell differentiation in a multi-robot organisms through gene regulation* Master's Thesis, University of Stuttgart, Germany.
- Spencer, J., Thomas, M. S., and McClelland, J. L. (2008). *Toward a Unified Theory of Development: Connectionism and Dynamic Systems Theory Re-Considered* (Oxford University Press).
- Sperati, V., Trianni, V., and Nolfi, S. (2008). Evolving coordinated group behaviours through maximization of mean mutual information, *Swarm Intelligence*, **2**(2-4), pp. 73-95.
- Spirin, A. (2002). Omnipotent RNA, *FEBS Lett.*, **530**(1-3), pp. 4-8.
- Spletzer, J., Das, A., Fierro, R., Taylor, C., Kumar, V., and Ostrowski, J. (2001). Cooperative localization and control for multi-robot manipulation, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (IEEE Press), pp. 631-636.
- Spollen, W., LeNoble, M., and Samuels, T. (2000). Abscisic Acid Accumulation Maintains Maize Primary Root Elongation at Low Water Potentials by Restricting Ethylene Production, *Plan Physiol.*, **122**, pp. 967-976.
- Squyres, S. (2005). *Roving Mars: Spirit, Opportunity, and the exploration of the red planet* (Hyperion, New York).
- Stabentheiner, A., Schmaranzer, S., Heran, H., and Ressler, R. (1988). Verändertes Thermopräferendum von Jungbienen durch Intoxikation mit Roxion-S (Dimethoat), *Mitteilungen der Deutschen Gesellschaft für allgemeine und angewandte Entomologie*, **6**, pp. 514-520.
- Stancliff, S., Dolan, J., and Trebi-Ollennu, A. (2006). Mission reliability estimation for multi-robot team design, in *Proceedings of IEEE International Conference on Intelligent Robots and Systems (IROS)*.
- Standish, R. (2003). Open-ended artificial evolution, *Int. J. Comput. Intell. Appl.*, **3**, p. 167, <http://www.citebase.org/abstract?id=oai:arXiv.org:nlin/0210027>.
- Stanley, K., and Miikkulainen, R. (2002). Evolving neural networks through augmenting topologies, *Evol. Comput.*, **10**(2), pp. 99-127.
- Steder, B., Grisetti, G., Stachniss, C., and Burgard, W. (2008). Visual SLAM for flying vehicles, *IEEE Trans. Robot.*, **24**(5), pp. 1088-1093.
- Steels, L., and Szathmáry, E. (2008). Replicator dynamics and language processing, in A. Smith, K. Smith, and R. Ferrer i Cancho (eds.), *The Evolution of Language* (World Scientific Press), p. 503.
- Steitz, T., and Moore, P. (2003). RNA, the first macromolecular catalyst: the ribosome is a ribozyme, *Trends Biochem. Sci.*, **28**, pp. 411-418.

- Stepney, S., Polack, F., and Turner, H. (2006). Engineering emergence, in *ICECCS 2006: 11th IEEE International Conference on Engineering of Complex Computer Systems, Stanford, CA, USA, August 2006* (IEEE), pp. 89–97.
- Stevens, B. L., and Lewis, F. L. (2003). *Aircraft Control and Simulation*, 2nd edn. (Wiley).
- Stirling, T., and Floreano, D. (2010a). Energy Efficient Swarm Deployment for Search in Unknown Environments, in M. Dorigo (ed.), *Proceedings of the 7th International Conference on Swarm Intelligence (ANTS 2010)*, Lecture Notes in Computer Science (LNCS) (Berlin: Springer Verlag), pp. 562–563.
- Stirling, T., and Floreano, D. (2010b). Energy-time efficiency in aerial swarm deployment, in *Proceedings of the 10th International Symposium on Distributed Autonomous Robotics Systems*.
- Stirling, T., Wischmann, S., and Floreano, D. (2010). Energy-efficient indoor search by swarms of simulated flying robots without global information, *Swarm Intelligence*, **4**(2), pp. 117–143.
- Stoica, I., Morris, R., Karger, D., and Balakrishnan, M. F. K. H. (2001). Chord: A scalable peer-to-peer lookup service for internet applications, in *Proceedings of the ACM SIGCOMM '01 Conference* (San Diego, California).
- Stojanovic, M. (1996). Recent advances in high-speed underwater acoustic communications, *IEEE J. Ocean. Eng.*, **26**(2), pp. 125–136, doi:10.1109/48.486787.
- Stomp, M., Huisman, J., Stal, L., and Matthijs, H. (2007). Colorful niches of phototrophic microorganisms shaped by vibrations of the water molecule, *ISME J. Multidiscipl. J. Microbiol. Ecol.*, **1**, pp. 271–282.
- Stone, P., and Veloso, M. (1999). Task decomposition, dynamic role assignment, and low-bandwidth communication for real-time strategic teamwork, *Artif. Intell.*, **110**(2), pp. 241–273.
- Stoy, K. (2006a). How to construct dense objects with self-reconfigurable robots, in H. Christensen (ed.), *European Robotics Symposium 2006*, Springer Tracts in Advanced Robotics 22 (Berlin: Springer Verlag), pp. 27–37.
- Stoy, K. (2006b). Using cellular automata and gradients to control self-reconfiguration, *Robot. Auton. Sys.*, **54**(2), pp. 135–141.
- Stoy, K., Christensen, D. J., Brandt, D., Bordignon, M., and Schultz, U. P. (2008). Exploit morphology to simplify docking of self-reconfigurable robots, in *Proceedings of the 9th International Symposium on Distributed Autonomous Robotic Systems (DARS'08)* (Tsukuba, Japan), pp. 441–452.

- Strogatz, S. H. (2003). *Sync: The Emerging Science of Spontaneous Order* (Hyperion Press, New York, NY).
- Sugawara, K., Kazama, T., and Watanabe, T. (2004). Foraging behavior of interacting robots with virtual pheromone, in *Proceedings of 2004 IEEE/RSJ International Conference on Intelligent Robots and Systems* (IEEE Press, Los Alamitos, CA), pp. 3074–3079.
- Suh, J. W., Glander, S. F., Darling, R. B., Storment, C. W., and Kovac, G. T. A. (1997). Organic thermal and electrostatic ciliary microactuator array for object manipulation, *Sensors and Actuators A (Physical)*, **58**, pp. 51–60.
- Sumpter, D. (2006). The principles of collective animal behaviour, *Philosophical Transactions of the Royal Society B: Biological Sciences*, **361(1465)**, pp. 5–22, 10.1098/rstb.2005.1733.
- Suthakorn, J., Cushing, A., and Chirikjian, G. (2003). An autonomous self-replicating robotic system, *Proceedings of the IEEE/ASME International Conference on Advanced Intelligent Mechatronics*.
- Sutton, R., and Barto, A. (1998). *Reinforcement Learning: An Introduction* (MIT Press, Cambridge, MA).
- Svennebring, J., and Koenig, S. (2004). Building terrain-covering ant robots: A feasibility study, *Auton. Robot.*, **16**, pp. 313–332.
- SWARMROBOT (2004–2010). *SWARMROBOT – Large-Scale Robotic Swarm Jasmine* (University of Stuttgart).
- Sweeney, J. D., Li, H., Grupen, R. A., and Ramamritham, K. (2003). Scalability and schedulability in large, coordinated, distributed robot systems, in *In Proceedings of the International Conference on Robotic Applications (ICRA (IEEE))*, pp. 4074–4079.
- SYMBRION (2008–2012). *Symbiotic Evolutionary Robot Organisms, 7th Framework Programme Project No FP7-ICT-2007.8.2* (European Communities).
- Szathmáry, E. (1989). The emergence, maintenance, and transitions of the earliest evolutionary units, *Oxf. Surv. Evol. Biol.* **6**, pp. 169–205.
- Szathmáry, E. (1990). Towards the evolution of ribozymes, *Nature*, **344**, 115.
- Szathmáry, E. (1991). Simple growth laws and selection consequences, *Trends Ecol. Evol.*, **6**, pp. 366–370.
- Szathmáry, E. (1999). Chemes, genes, memes: A revised classification of replicators. *Lectures on Mathematics in the Life Sciences*, **26**, pp. 1–10.
- Szathmáry, E., and Maynard Smith, J. (1993). The origin of genetic systems, *Abstr. Bot.*, **17(1-2)**, pp. 197–206.

- Szathmáry, E., and Maynard Smith, J. (1995). The major evolutionary transitions, *Nature*, **374**, pp. 227–232.
- Szewczyk, R., Osterweil, E., Polastre, J., Hamilton, M., Mainwaring, A., and Estrin, D. (2004). Habitat monitoring with sensor networks, *Communications of the ACM*, **47(6)**, pp. 34–40.
- Tanenbaum, A. (2002). *Computer Networks* (Prentice Hall).
- Tangchoopong, T., and Requicha, A. A. G. (2009). An empirical study of the performance of active self-assembly, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '09)*, pp. 1838–1842.
- Tawfik, D., and Griffiths, A. (1998). Man-made cell-like compartments for molecular evolution, *Nat. Biotechnol.*, **16(7)**, pp. 652–656.
- Taylor, R. C., Klein, B. A., Stein, J., and Ryan, M. J. (2008). Faux frogs: multimodal signalling and the value of robotics in animal behaviour, *Anim. Behav.*, **76(3)**, pp. 1089–1097.
- Tennekes, H. (1997). *The simple science of flight: from insects to jumbo jets* (The MIT Press).
- ter Beek, M. (2003). *Team Automata - A Formal Approach to the Modeling of Collaboration Between System Components*, Ph.D. thesis (Leiden Institute of Advanced Computer Science, Leiden University).
- Terfort, A., and von Kiedrowski, G. (1992). Self-replication by condensation of 3-aminobenzamidines and 2-formylphenoxyacetic acids, *Angew. Chem. Int. Ed. Engl.*, **31(5)**, pp. 654–656.
- Tesauro, G. J. (1995). Temporal difference learning and td-gammon. *Communications of the ACM*, **38**, pp. 58–68.
- Tews, A. D., Mataric, M. J., and Sukhatme, G. S. (2003). A scalable approach to human-robot interaction, in *In ICRA-03*, pp. 1665–1670.
- Thenius, R., Schmickl, T., and Crailsheim, K. (2008a). How to know without having been there? investigating communication channels in the nectar collecting system of a honeybee colony (abstract), in S. Bullock, J. Noble, R. Watson, and M. A. Bedau (eds.), *Artificial Life XI: Proceedings of the Eleventh International Conference on the Simulation and Synthesis of Living Systems* (MIT Press, Cambridge, MA), p. 807.
- Thenius, R., Schmickl, T., and Crailsheim, K. (2008b). Optimisation of a honeybee-colony's energetics via social learning based on queuing delays, *Connect. Sci.*, **20(2)**, pp. 193–210.
- Theraulaz, G., and Bonabeau, E. (1999). A brief history of stigmergy, *Artif. Life*, **5(2)**, pp. 97–116.

- Thompson, J. (1989). *Empirical Model Building* (Wiley).
- Thompson, J. (1999). *Simulation: A Modeler's Approach* (Wiley).
- Thompson, W. (1992). *Computing for Scientists and Engineers: A Workbook of Analysis, Numerics, and Applications* (Wiley-Interscience).
- Thrun, S., Montemerlo, M., Dahlkamp, H., Strohband, S., Dupont, C., Bradski, G., Davies, B., and Mahoney, P. (2006). Stanley: The robot that won the darpa grand challenge, *Field Robot.*, **23(9)**, pp. 661–692.
- Thrun, S., Montemerlo, M., Koller, D., Wegbreit, B., Nieto, J., and Nebot, E. (2004). FastSLAM: An efficient solution to the simultaneous localization and mapping problem with unknown data association, *J. Mach. Learn. Res.*, **4(3)**, pp. 380–407.
- Tian, B., Kempa, T. J., and Lieber, C. M. (2009). Single nanowire photovoltaics, *Chem. Soc. Rev.*, **38(1)**, pp. 16–24.
- Tian, B., Zheng, X., Kempa, T. J., Fang, Y., Yu, N., Yu, G., Huang, J., and Lieber, C. M. (2007). Coaxial silicon nanowires as solar cells and nanoelectronic power sources, *Nature*, **449(7164)**, pp. 885–889.
- Timcenko, V., Stojanovic, M., and Rakas, S. B. (2009). Manet routing protocols vs. mobility models: performance analysis and comparison, *Proceedings of the 9th WSEAS international conference on Applied informatics and communications*, pp. 271–276.
- Timko, B. P., Cohen-Karni, T., Qing, Q., Tian, B., and Lieber, C. M. (2010). Design and implementation of functional nanoelectronic interfaces with biomolecules, cells and tissue using nanowire device arrays, *IEEE Trans. Nanotechnol.*, **9(3)**, pp. 269–280.
- Timmis, J., Knight, T., Castro, L. D., and Hart, E. (2004). An overview of artificial immune systems, in *Computation in Cells and Tissues: Perspectives and Tools for Thought. Natural Computation Series* (Springer), pp. 51–86.
- Tinbergen, N. (1951). *The study of instinct* (Oxford UP, Oxford).
- Tinbergen, N. (1953). *The herring gull's world* (Collins, London).
- Tjivikua, T., Ballester, P., and Rebek, J. (1990). Self-replicating system, *J. Am. Chem. Soc.*, **112(3)**, pp. 1249–1250.
- Todd, P. M., and Miller, G. F. (1990). Exploring adaptive agency ii: simulating the evolution of associative learning, in *Proceedings of the first international conference on simulation of adaptive behavior on From animals to animats* (MIT), ISBN 0-262-63138-5, pp. 306–315.
- Tomita, K., Murata, S., Kurokawa, H., Yoshida, E., and Kokaji, S. (1999). Self-assembly and self-repair method for a distributed mechanical system, *IEEE Trans. Robot. Autom.*, **15**, 6.

- Törnqvist, D., Schön, T., Karlsson, R., and Gustafsson, F. (2009). Particle filter SLAM with high dimensional vehicle model, *J. Intell. Robot. Sys.*, **55(4)**, pp. 249–266.
- Tozer, T., Grace, D., Thompson, J., and Baynham, P. (2000). UAVs and HAPs-potential convergence for military communications, *IEEE Seminar Digests*, **2000(24)**, pp. 10/1–10/6.
- Trianni, V. (2008). *Evolutionary Swarm Robotics. Evolving Self-Organising Behaviours in Groups of Autonomous Robots*, *Studies in Computational Intelligence*, Vol. 108 (Berlin: Springer Verlag).
- Trianni, V., Ampatzis, C., Christensen, A. L., Tuci, E., Dorigo, M., and Nolfi, S. (2007). From solitary to collective behaviours: Decision making and cooperation, in F. A. et al. (ed.), *Advances in Artificial Life. Proceedings of the 9th European Conference on Artificial Life (ECAL 2007)*, *Lecture Notes in Artificial Intelligence*, Vol. 4648 (Berlin: Springer Verlag), pp. 575–584.
- Trianni, V., and Dorigo, M. (2006). Self-organisation and communication in groups of simulated and physical robots, *Biol. Cybern.*, **95**, pp. 213–231.
- Trianni, V., and Nolfi, S. (2009). Self-organising sync in a robotic swarm. A dynamical system view, *IEEE Trans. Evol. Comput. Special Issue on Swarm Intelligenence*, **13(4)**, pp. 722–741.
- Trianni, V., Nolfi, S., and Dorigo, M. (2006). Cooperative hole avoidance in a swarm-bot, *Robot. Auton. Sys.*, **54(2)**, pp. 97–103.
- Trianni, V., Nolfi, S., and Dorigo, M. (2008). Evolution, self-organisation and swarm robotics, in C. Blum and D. Merkle (eds.), *Swarm Intelligence. Introduction and Applications*, *Natural Computing Series* (Springer Verlag, Berlin, Germany), pp. 163–192.
- Trianni, V., and Tuci, E. (2009). Swarm cognition and artificial life, in *Advances in Artificial Life. Proceedings of the 10th European Conference on Artificial Life (ECAL 2009)*.
- Truszkowski, W., Hallock, H., Rouff, C., Karlin, J., Rash, J., Hinchey, M., and Sterritt, R. (2009). Swarms in space missions, in *Autonomous and Autonomic Systems: With Applications to NASA Intelligent Spacecraft Operations and Exploration Systems*, *NASA Monographs in Systems and Software Engineering* (Springer), pp. 207–221.
- Tuci, E., Groß, R., Trianni, V., Mondada, F., Bonani, M., and Dorigo, M. (2006). Cooperation through self-assembly in multi-robot systems, *ACM Trans. Auton. Adapt. Sys.*, **1(2)**, pp. 115–150.
- Turchin, V. (1977). *The Phenomenon of Science, a cybernetic approach to human evolution* (Columbia University Press, New York).

- Turner, P. J., and Jennings, N. R. (2000). Improving the scalability of multi-agent systems, in T. Wagner, and O. Rana (eds.), *Infrastructure for Agent, Multi-Agent Systems, and Scalable Multi-Agent Systems*, Lecture Notes in Artificial Intelligence Vol 1887 (Springer Verlag), pp. 246–262, proceedings of the First International Workshop on Infrastructure for Scalable Multi-Agent Systems, Barcelona, Spain, June 2000, (Revised papers published 2001).
- Turner, P. J., and Jennings, N. R. (2001). Improving the scalability of multi-agent systems, in *Revised Papers from the International Workshop on Infrastructure for Multi-Agent Systems* (Springer Verlag, London, UK), ISBN 3-540-42315-X, pp. 246–262.
- Turney, P., Whitley, D., and (eds.), R. A. (1996). Evolution, learning, and instinct: 100 years of the baldwin effect, *Special Issue of Evolutionary Computation*, 4(3).
- Unrau, P., and Bartel, D. (1998). Rna-catalysed nucleotide synthesis, *Nature*, **395(6699)**, pp. 260–263.
- Unsal, C., and Khosla, P. K. (2000a). Self-reconfiguration for task-oriented modular robotic systems, in *Proceedings of the 4th Multiconference on Systemics, Cybernetics, and Informatics*, Vol. IX, pp. 682–687.
- Unsal, C., and Khosla, P. K. (2000b). Solutions for 3-d self-reconfiguration in a modular robotic system: Implementation and motion planning, in *Proceedings of Sensor Fusion and Decentralized Control in Robotic Systems III*.
- Unsal, C., and Khosla, P. K. (2001). A multi-layered planner for self-reconfiguration of a uniform group of i-cube modules, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (Maui, HI), pp. 598–605.
- Urien, R. S. (2009). *Application and improvement of a simulation of bio-inspired self-assembly process* Master's Thesis, University of Stuttgart, Germany.
- Utt, J., McCalmont, J., and Deschenes, M. (2005). Development of a sense and avoid system, in *Proceedings of Infotech@Aerospace*, AIAA paper AIAA-2005-7177.
- Uzol, O., Yavrucuk, I., and Sezer-Uzol, N. (2008). Collaborative target tracking for swarming MAVs using potential fields and panel methods, in *Proceedings of the AIAA Guidance, Navigation and Control Conference*, AIAA paper AIAA-2008-7167.
- Vaario, J. (1994). Modelling adaptive self-organization, in *In Proceedings of the Fourth International Workshop on the Synthesis of Living Systems*, p. 314.

- Valdastri, P., Corradi, P., Menciasci, A., Schmickl, T., Crailsheim, K., Seyfried, J., and Dario, P. (2006). Micromanipulation, communication and swarm intelligence issues in a swarm microrobotic platform, *Robot. Auton. Sys.*, **54**, p. 789–804.
- Valenti, M., Bethke, B., How, J.-P., Farias, D.-P., and Vian, J. (2007). Embedding health management into mission tasking for UAV teams, in *Proceedings of the American Control Conference* (IEEE Press), pp. 5777–5783.
- van der Vecht, B., and Lima, P. (2005). Formulation and implementation of relational behaviours for multi-robot cooperative systems, in D. N. et al. (ed.), *RoboCup 2004*, Vol. LNAI 3276 (Springer Verlag, Berlin), pp. 516–523.
- Van Der Zwaan, S., Bernardino, A., and Santos-Victor, J. (2002). Visual station keeping for floating robots in unstructured environments, *Robot. Auton. Sys.*, **39**(3–4), pp. 145–155.
- Vasas, V., Szathmáry, E., and Mauro, S. (2010). Lack of evolvability in self-sustaining autocatalytic networks: A constraint on metabolism-first path to the origin of life, *Proc. Natl. Acad. Sci. USA*, doi: 10.1073/pnas.0912628107.
- Vasilash, G. (2006). “Safe” & cooperative robots, *Automotive Design & Production*, June 30, 2006.
- Vasilescu, I., Detweiler, C., Doniec, M., Gurdan, D., Sosnowski, S., Stumpf, J., and Rus, D. (2010). AMOUR V: A hovering energy efficient underwater robot capable of dynamic payloads, *Int. J. Robot. Res.*, **29**, pp. 547–570.
- Vasilescu, I., Detweiler, C., and Rus, D. (2007). Aquanodes: an underwater sensor network, in *Proceedings of the ACM International Workshop on Underwater Networks (WUWNet '07)* (Montreal, Quebec, Canada), ISBN 978-1-59593-736-0, pp. 85–88, 10.1145/1287812.1287830.
- Vasilescu, I., Varhavskaya, P., Kotay, K., and Rus, D. (2005). Autonomous modular optical underwater robot (amour) design, prototype and feasibility study, in *In Proceedings of the International Conference on Robotics and Automation (ICRA)* (Barcelona, Spain), pp. 1603–1609.
- Vassilvitskii, S., Kubica, J., Rieffel, E. G., Suh, J. W., and Yim, M. (2002a). On the general reconfiguration problem for expanding cube style modular robots, in *Proceedings of the IEEE International Conference on Robotics and Automation*.
- Vassilvitskii, S., Yim, M., and Suh, J. W. (2002b). A complete, local and parallel reconfiguration algorithm for cube style modular robots, in *Proceedings of the IEEE International Conference on Robotics and Automation*.

- Vaughan, R., Sumpter, N., Henderson, J., Frost, A., and Cameron, S. (2000). Experiments in automatic flock control, *Robot. Auton. Sys.*, **31**, pp. 109–117.
- Čejková, J. (2010). *Design, Synthesis and Characterization of Structured Particles for Chemical Robots* (Ph.D. Thesis, Institute of Chemical Technology, Prague).
- Čejková, J., Hanuš, J., and Štěpánek, F. (2010). Investigation of internal microstructure and thermo-responsive properties of composite pni-pam/silica microcapsules, *J. Colloid Interface Sci.*, **346**, pp. 352–360.
- Ventana Systems (2010). Vensim™, <http://www.vensim.com>.
- Verma, V., and Simmons (2006). Scalable robot fault detection and identification, *Robot. Auton. Sys.*, **54**, pp. 184–191.
- Vincent, P., and Rubin, I. (2004). A framework and analysis for cooperative search using UAV swarms, in *Proceedings of the ACM Symposium on Applied Computing* (ACM Press), pp. 79–86.
- Viquerat, A., Blackhall, L., Reid, A., and Sukkarieh, S. (2007). Reactive collision avoidance for unmanned aerial vehicles using doppler radar, in C. Laugier, and R. Siegwart (eds.), *Proceedings of the 6th Conference on Field and Service Robotics, Springer Tracts in Advanced Robotics*, Vol. 42 (Berlin: Springer), pp. 245–254.
- Visinsky, M. L., Cavallaro, J. R., and Walker, I. D. (1994). Robotic fault detection and fault tolerance: a survey, *Reliab. Eng. Sys. Saf.*, **46**, pp. 139–158.
- Vitrenko, Y., Gracheva, E., Richmond, J., and Liebman, S. (2007). Visualization of aggregation of the Rnq1 prion domain and cross-seeding interactions with Sup35nm, *J. Biol. Chem.*, **282**, pp. 1779–1787.
- von Frisch, K. (1965). *Tanzsprache und Orientierung der Bienen* (Springer Verlag, Berlin, Heidelberg, New York).
- von Kiedrowski G (1986). A self-replicating hexadeoxy nucleotide, *Angew. Chem. Int. Ed. Engl.*, **25**, pp. 932–935.
- von Neumann, J. (1966). *Theory of Self-Reproducing Automata* (University of Illinois Press, Edited and completed by A. W. Burks, Illinois).
- Ševčíková, H., Čejková, J., Krausová, L., Příbyl, M., Štěpánek, F., and Marek, M. (2010). A new traveling wave phenomenon of dictyostelium in the presence of camp, *Phys. D*, **239**, pp. 879–888.
- Šišlák, D., Samek, J., and Pěchouček, M. (2008). Decentralized algorithms for collision avoidance in airspace, in *Proceedings of the 7th International Joint Conference on Autonomous Agents and Multiagent Systems*, pp. 543–550.

- Šišlák, D., Volf, P., Komenda, A., Samek, J., and Pěchouček, M. (2007). Agent-based multi-layer collision avoidance to unmanned aerial vehicles, in *Proceedings of the International Conference on Integration of Knowledge Intensive Multi-Agent Systems* (IEEE Press), pp. 365–370.
- Waddington, C. (1969). Paradigm for an evolutionary process, in C. Waddington (ed.), *Towards a Theoretical Biology*, v.2 (Edinburgh University Press), pp. 106–128.
- Wagner, G., and Altenberg, L. (1996). Complex adaptations and the evolution of evolvability, *Evolution*, **50**, pp. 967–976.
- Wagner, I., Lindenbaum, M., and Bruckstein, A. (1999). Distributed covering by ant-robots using evaporating traces, *IEEE Trans. Robot. Autom.*, **15(5)**, pp. 918–933.
- Waibel, M., Keller, L., and Floreano, D. (2009). Genetic team composition and level of selection in the evolution of cooperation, *IEEE Trans. Evol. Computation*, **13(3)**, pp. 648–660.
- Walde, P., Cosentino, K., Engel, H., and Stano, P. (2010). Giant vesicles: Preparations and applications, *Chem. Bio. Chem.*, **11**, pp. 848–865.
- Walter, J., Tsai, E., and Amato, N. (2002a). Choosing good paths for fast distributed reconfiguration of hexagonal metamorphic robots, in *Proceedings of the IEEE International Conference on Robotics and Automation*, Washington DC, pp. 102–109.
- Walter, J., Welch, J., and Amato, N. (2002b). Concurrent metamorphosis of hexagonal robot chains into simple connected configurations, *IEEE Trans. Robot. Autom.*, **18(6)**, pp. 945–956.
- Wang, T., Wang, B., Wei, H., Cao, Y., Wang, M., and Shao, Z. (2008). Staying-alive and energy-efficient path planning for mobile robots, in *Proceedings of the American Control Conference* (IEEE Press), pp. 868–873.
- Wang, Z., and Song, J. (2006). Piezoelectric nanogenerators based on zinc oxide nanowires, *Nature*, **312**, pp. 242–246.
- Warneke, B., Last, M., Liebowitz, B., and Pister, K. (2001). Smart dust: communicating with a cubic-millimeter computer, *Computer*, **34(1)**, pp. 44–51, 10.1109/2.895117.
- Warneke, B., Scott, M., Liebowitz, B., Zhou, L., Bellew, C., Chediak, J., Kahn, J., Boser, B., and Pister, K. (2002). An autonomous 16 mm³ solar-powered node for distributed wireless sensor networks, in *Sensors, 2002. Proceedings of IEEE*, Vol. 2, pp. 1510–1515.
- Warraich, O. A. (2005). *Mechanism of cooperation and functional self-organization in a swarm of micro-robots* Master's Thesis, University of Stuttgart, Germany.

- Waslander, S. L., Hoffmann, G., Jang, J. S., and Tomlin, C. J. (2005). Multi-agent X4-flyer testbed design: Integral sliding mode vs. reinforcement learning, in *Proceedings of the IEEE International Conference on Intelligent Robots and Systems* (IEEE Press).
- Watanabe, M., Furukawa, M., and Kakazu, Y. (2001). Intelligent agv driving toward an autonomous decentralized manufacturing system, *Robot. Comput. Integr. Manuf.*, **17(1-2)**, pp. 57-64.
- Watson, R., Ficici, S., and Pollack, J. (2002). Embodied evolution: Distributing an evolutionary algorithm in a population of robots, *Robot. Auton. Sys.*, **39(1)**, pp. 1-18, <http://eprints.ecs.soton.ac.uk/10620/>.
- Weiss, G. (1999). *Multiagent systems. A modern approach to distributed artificial intelligence* (MIT Press).
- Welsby, J., and Melhuish, C. (2001). Autonomous minimalist following in three dimensions: A study with small-scale dirigibles, in *Proceedings of Towards Intelligent Mobile Robots. Technical*.
- Werfel, J., Bar-Yam, Y., Rus, D., and Nagpal, R. (2006). Distributed construction by mobile robots with enhanced building blocks, in *Proceedings of the 2006 IEEE International Conference on Robotics and Automation (ICRA 2006)*, pp. 2787-2794.
- Werger, B. B., and Mataric, M. J. (2000). Broadcast of local eligibility for multi-target observation, in L. E. Parker, G. Bekey, and J. Barhen (eds.), *Distributed Autonomous Robotic Systems 4* (Springer Verlag, Berlin), pp. 347-356.
- Werger, B. B., and Mataric, M. J. (2001). From insect to internet: Situated control for networked robot teams, *Ann. Math. Artif. Intell.*, **31(1-4)**, pp. 173-197.
- West, P. E., Peress, Y., Tyson, G. S., and McKee, S. A. (2009). Core monitors: monitoring performance in multicore processors, in *Conf. Comput. Front.*, pp. 31-40.
- Westhof, E. (1999). Chemical diversity in RNA cleavage, *Science*, **286(5437)**, pp. 61-62.
- Whitaker, H. (1959). An adaptive system for control of the dynamics performances of aircraft and spacecraft, *Inst. Aeronautical Services*, Paper 59-100.
- White, J. (1979). The plant as a metapopulation, *Ann. Rev. Ecol. Sys.*, **10(1)**, pp. 109-145.
- White, P., Zykov, V., Bongard, J., and Lipson, H. (2005). Three dimensional stochastic reconfiguration of modular robots, in *Proceedings of Robotics Science and Systems* (MIT, Cambridge, MA).

- Whitesides, G., and Grzybowski, B. A. (2002). Self-assembly at all scales, *Science*, **295**(5564), pp. 2418–2421.
- Whitesides GM, S. C., Mathias JP (1991). Molecular self-assembly and nanochemistry: A chemical strategy for the synthesis of nanostructures, *Science*, **254**, pp. 1312–1319.
- Wibowo, S. B., Klepal, M., and Pesch, D. (2009). Time of flight ranging using off-the-self IEEE802.11 WiFi tags, in *Proceedings of the International Conference on Positioning and Context-Awareness*.
- Wickenheiser, A., and Garcia, E. (2008). Optimization of perching maneuvers through vehicle morphing, *J. Guid. Control Dynam.*, **31**(4), pp. 815–823.
- Wickner, R., Edskes, H., Shewmaker, F., and Nakayashiki, T. (2007). Prions of fungi: Inherited structures and biological roles, *Nat. Rev. Microbiol.*, **5**(8), pp. 611–618.
- Wie, B. (1998). *Space vehicle dynamics and control* (Aiaa).
- Wiendahl, H.-P. (2002). Wandlungsfähigkeit, *wt Werkstattstechnik*, **92**(4), pp. 122–127.
- Wiggins, S. (1990). *Introduction to applied nonlinear dynamical systems and chaos* (Springer Verlag, New York, Berlin, Heidelberg, Tokyo).
- Wilensky, U. (1998). Netlogo ants model, *Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL*.
- Wilkinson, G. S. (1984). Reciprocal food sharing in the vampire bat, *Nature*, **308**, pp. 181–184.
- Williams, B., and Nayak, P. (1996). A model-based approach to reactive self-configuring systems, in *Proceedings of 13th AAAI'96/8th IAAI'96*, Vol. 2, pp. 971–978.
- Wilson, E. O. (1974). *The Insect Societies (Harvard Paperbacks)* (Belknap Press), ISBN 0674454952.
- Winfield, A., Liu, W., and Bjercknes, J. (2010). Functional and reliability modelling of swarm robotic systems, in P. Levi and S. Kernbach (eds.), *Symbiotic Multi-Robot Organisms Reliability, Adaptability, Evolution* (Springer, Berlin).
- Winfield, A., Liu, W., Nembrini, J., and Martinoli, A. (2008). Modelling a wireless connected swarm of mobile robots, *Swarm Intell.*, **2**(2), pp. 241–266.
- Winfield, A. F. T. (2009). Foraging robots, in R. A. Meyers (ed.), *Encyclopedia of Complexity and System Science* (New York: Springer), pp. 3682–3700.
- Winfield, A. F. T., and Griffiths, F. (2010). Towards the emergence of artificial culture in collective robot systems, in P. Levi, and S. Kernbach (eds.),

- Symbiotic Multi-robot Organisms: Reliability, Adaptability, Evolution* (Springer), pp. 431–439.
- Winfield, A. F. T., Harper, C. J., and Nembrini, J. (2005). Towards dependable swarms and a new discipline of swarm engineering, in *Simulation of Adaptive Behavior Workshop on Swarm Robotics, Lecture Notes in Computer Science 3342* (Springer Verlag Berlin Heidelberg), pp. 126–142.
- Winfield, A. F. T., and Nembrini, J. (2006). Safety in numbers: fault-tolerance in robot swarms, *Int. J. Model. Identificat. Control*, **1(1)**, pp. 30–37.
- Wirsing, M., Banâtre, J.-P., Hölzl, M. M., and Rauschmayer, A. (eds.) (2008). *Software-Intensive Systems and New Computing Paradigms - Challenges and Visions, Lecture Notes in Computer Science*, Vol. 5380 (Berlin: Springer).
- Wischmann, S., Huelse, M., Knabe, J. F., and Pasemann, F. (2006). Synchronization of internal neural rhythms in multi-robotic systems, *Adapt. Behav.*, **14(2)**, pp. 117–127.
- Wischmann, S., and Pasemann, F. (2006). The emergence of communication by evolving dynamical systems, in S. Nolfi, G. Baldassarre, R. Calabretta, J. Hallam, D. Marocco, J.-A. Meyer, and D. Parisi (eds.), *From animals to animats 9: Proceedings of the Ninth International Conference on Simulation of Adaptive Behaviour*, LNAI (Springer Verlag), pp. 777–788.
- Woern, H., Szymanski, M., and Seyfried, J. (2006). The i-swarm project, in *Proceedings of the 15th IEEE International Symposium on Robot and Human Interactive Communication (ROMAN 2006)*, pp. 492–496.
- Wong, T., and Katz, R. (2000). An analysis of multicast forwarding state scalability, *Network Protocols, IEEE International Conference on*, **0**, p. 105, <http://doi.ieeecomputersociety.org/10.1109/ICNP.2000.896296>.
- Wood, J. M. (1999). Osmosensing by Bacteria: Signals and Membrane-Based Sensors, *Microbiol. Mol. Biol. Rev.*, **63(1)**, pp. 230–262.
- Wood, Z., and Galton, A. (2008a). Collectives and how they move: A tale of two classifications, in *BMI*, pp. 57–71.
- Wood, Z., and Galton, A. (2008b). A new classification of collectives, in *Proceeding of the 2008 conference on Formal Ontology in Information Systems* (IOS Press, Amsterdam, The Netherlands, The Netherlands), ISBN 978-1-58603-923-3, pp. 109–120.
- Wood, Z., and Galton, A. (2009). A taxonomy of collective phenomena, *Appl. Ontol.*, **4(3–4)**, pp. 267–292.

- Wu, H., Sun, D., Zhu, H., and Zhou, Z. (2005). An autonomous flight control strategy study of a small-sized unmanned air vehicle, *IEICE Trans. Elect.*, **E88-C**, 10.
- Wyrsh, N., Dunand, S., and Ballif, C. (2008). Micro Photovoltaic Modules for Micro Systems, in *Material Research Society Symposium Proceedings*, Vol. 1066, pp. A10–4, iMT-NE Number: 480.
- Wzorek, M., Landén, D., and Doherty, P. (2006). GSM technology as a communication media for an autonomous unmanned aerial vehicle, in *Proceedings of the 21st Bristol UAV Systems Conference*.
- Xie, X. L., and Beni, G. (1991). A validity measure for fuzzy clustering, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, **13(8)**, pp. 841–847.
- Xuan, P., Lesser, V., and Zilberstein, S. (2001). Communication decisions in multi-agent cooperation: model and experiments, in *Proceedings of the fifth international conference on Autonomous agents*.
- Xue, Z., and Zeng, J. (2009). Formation control numerical simulations of geometric patterns for unmanned autonomous vehicles with swarm dynamical methodologies, in *Proceedings of the International Conference on Measuring Technology and Mechatronics Automation* (IEEE Press), pp. 477–482.
- Yahalom, R. (1993). Optimality of multi-domain protocols, in *CCS '93: Proceedings of the 1st ACM conference on Computer and communications security* (ACM, New York, NY, USA), ISBN 0-89791-629-8, pp. 38–48, <http://doi.acm.org/10.1145/168588.168593>.
- Yairi, T., Kato, Y., and Hori, K. (2001). Fault detection by mining association rules from house-keeping data, in *International Symposium on Artificial Intelligence, Robotics and Automation in Space*.
- Yan, J., Wood, R., Avadhanula, S., Sitti, M., and Fearing, R. (2001). Towards flapping wing control for a micromechanical flying insect, in *Proceedings of the IEEE International Conference on Robotics and Automation*, Vol. 4, pp. 3901–3908.
- Yang, Q., Yin, J., and Ling, C. (2001). Postprocessing decision trees to extract actionable knowledge, in *IEEE International Conference on Data Mining*, pp. 685–688.
- Yang, Y., Minai, A. A., and Polycarpou, M. M. (2005). Evidential map-building approaches for multi-UAV cooperative search, in *Proceedings of the IEEE American Control Conference* (IEEE Press), pp. 116–121.
- Yao, S., Ghosh, I., Zutshi, R., and Chmielewski, J. (1997). A pH-modulated, self-replicating peptide. *J. Am. Chem. Soc.*, **119**, pp. 10559–10560.

- Yao, S., Ghosh, I., Zutshi, R., and Chmielewski, J. (1998a). Selective amplification by auto- and cross-catalysis in a replicating peptide system, *Nature*, **396**, pp. 447–450.
- Yao, S., Ghosh, I., Zutshi, R., and Chmielewski, J. (1998b). A self-replicating peptide under ionic control, *Angew. Chem. Int. Ed.*, **37(4)**, pp. 478–481.
- Yao, X. (1999). Evolving artificial neural networks, *Proceedings of the IEEE*, **87(9)**, pp. 1423–1447.
- Yasuda, T., Shimoyama, I., and Miura, H. (2000). Microrobot actuated by a vibration energy field, *Sens. Actuators A, Phys.*, **43**, pp. 366–370.
- Yeh, R., and Pister, K. (2000). Design of low-power articulated microrobots, in *Proceedings of the International Conference on Robotics and Automation Workshop on Mobile Micro-Robots*, pp. 21–28.
- Yim, M., Babak, S., Sastra, J., Park, M., Dugan, M., and Taylor, C. J. (2007a). Towards robotic self-reassembly after explosion, in *Proceedings of the 2007 IEEE/RSJ International Conference on Intelligent Robots and Systems (IEEE)*, pp. 2767–2772.
- Yim, M., Duff, D. G., Roufas, K., Zhang, Y., and Eldershaw, C. (2001a). Evolution of polybot: A modular reconfigurable robot, in *Proceedings of the COE/Super-Mechano-Systems Workshop* (Tokyo, Japan).
- Yim, M., Lamping, J., Mao, E., and Chase, J. G. (1997). Rhombic dodecahedron shape for self - assembling robots, Tech. Rep. P9710277, Xerox PARC, Palo Alto CA.
- Yim, M., Shen, W.-M., Salemi, B., Rus, D., Moll, M., Lipson, H., Klavins, E., and Chirikjian, G. S. (2007b). Modular self-reconfigurable robot systems - challenges and opportunities for the future, *IEEE Robot. Autom. Mag.*, **14(1)**, pp. 43–52.
- Yim, M., Zhang, Y., Roufas, K., Duff, D., and Eldershaw, C. (2003). Connecting and disconnecting for chain self-reconfiguration with polybot, *IEEE/ASME Transactions on mechatronics, special issue on Information Technology in Mechatronics*.
- Yim, M. H., Zhang, Y., Lamping, J. O., and Mao, E. W. (2001b). Distributed control for 3d metamorphosis, *Autonomous Robots; Special issue on self-reconfiguring robots*, **10(1)**, pp. 41–56.
- Yin, P., Choi, H. M. T., Calvert, C. R., and Pierce, N. A. (2008). Programming biomolecular self-assembly pathways, *Nature*, **451(7176)**, pp. 318–322.
- Yonezawa, M., Doi, N., Higashinakagawa, T., and Yanagawa, H. (2004). DNA display of biologically active proteins for in vitro protein selection, *J. Biochem. (Tokyo)*, **135(3)**, pp. 285–288.

- Yonezawa, M., Doi, N., Kawahashi, Y., Higashinakagawa, T., and Yanagawa, H. (2003). DNA display for in vitro selection of diverse peptide libraries, *Nucl. Acid Res.*, **31(19)**, p. e118.
- York, G. W., and Pack, D. J. (2008). Cooperative persistent surveillance search algorithms using multiple unmanned aerial vehicles, in D. Grundel, R. Murphey, P. Pardalos, and O. Prokopyev (eds.), *Cooperative Networks: Control and Optimization* (Edward Elgar Publishing, Cheltenham), pp. 279–290.
- Yoshida, E., Murata, S., Kamimura, A., Tomita, K., Kurokawa, H., and Kokaji, S. (2002). A self-reconfigurable modular robot: Reconfiguration planning and experiments, *Int. J. Robot. Res.*, **21(10)**, pp. 903–916.
- Yoshida, E., Murata, S., Kurokawa, H., Tomita, K., and Kokaji, S. (1999). A distributed method for reconfiguration of 3-d homogeneous structure, *Adv. Robot.*, **13(4)**, pp. 363–380.
- Yu, H., and Swager, T. (2004). Molecular actuators - designing actuating materials at the molecular level, *IEEE J. Ocean. Eng.*, **29(3)**, pp. 692–695, 10.1109/JOE.2004.833141.
- Yu, N., Blanchard, R., Fan, J., Wang, Q. J., Pflügel, C., Diehl, L., Edamura, T., Furuta, S., Yamanishi, M., Kan, H., and Capasso, F. (2010). Plasmonics for laser beam shaping, *IEEE Trans. Nanotechnol.*, **9(1)**, pp. 11–29.
- Yuan, H., Gottesman, V., Falash, M., Qu, Z., Pollak, E., and Chunyu, J. (2007). Cooperative formation flying in autonomous unmanned air systems with application to training, in P. Pardalos, R. Murphey, D. Grundel, and M. Hirsch (eds.), *Advances in Cooperative Control and Optimization, Lecture Notes in Control and Information Sciences*, Vol. 369 (Berlin: Springer), pp. 203–219.
- Yun, S., Schwager, M., and Rus, D. (2009). Coordinating construction of truss structures using distributed equal-mass partitioning, in *Proceedings of the 14th International Symposium on Robotics Research* (Luzern, Switzerland).
- Zachar, I., and Szathmáry, E. (2010). A New Replicator: A general framework for analyzing replication, *BMC Biol.*, **8**, p. 21.
- Zaher, H., and Unrau, P. (2007). Selection of an improved RNA polymerase ribozyme with superior extension and fidelity, *RNA*, **13(7)**, pp. 1017–1026.
- Zarzhitsky, D., and Spears, D. (2005). Swarm approach to chemical source localization, in *Proceedings of the IEEE International Conference on Systems, Man and Cybernetics* (IEEE Press), p. 1435–1440.

- Zeimpekis, V., Giaglis, G. M., and Lekakos, G. (2003). A taxonomy of indoor and outdoor positioning techniques for mobile location services, *ACM SIGecom Exchange*, **3(4)**, pp. 19–27.
- Zetterström, G. (2006). *Collaborative actuation in microrobotic swarm based on collective decision making and surfacecolor identification* Master's Thesis, University of Stuttgart, Germany.
- Zhang, H., and Ostrowski, J. (1998). Visual servoing with dynamics: Control of an unmanned blimp, in *Proceedings of the IEEE International Conference on Robotics and Automation* (IEEE Press), pp. 618–623.
- Zhang, L., Abbott, J. J., Dong, L., Kratochvil, B. E., Bell, D. J., and Nelson, B. J. (2009). Artificial bacterial flagella: Fabrication and magnetic control, *Appl. Phys. Lett.*, **94**, 6, 064107.
- Zhang, Y., Wang, Q., Zhang, P., Wang, X., and Mei, T. (2004). Dynamic analysis and experiment of a 3mm swimming microrobot, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. 1746–1750.
- Zhou, H., and Sakane, S. (2002). Sensor planning for mobile robot localization using Bayesian network inference, *Adv. Robot.*, **16(8)**, pp. 751–771.
- Zielinski, W., and Orgel, L. (1987). Autocatalytic synthesis of a tetranucleotide analogue, *Nature*, **327**, pp. 346–347.
- Zou, Y., Pagilla, P., and Ratliff, R. (2009). Distributed formation flight control using constraint forces, *J. Guid. Control Dynam.*, **32(1)**, pp. 112–120.
- Zufferey, J.-C. (2008). *Bio-inspired Flying Robots: Experimental Synthesis of Autonomous Indoor Flyers* (EPFL/CRC Press).
- Zufferey, J.-C., Beyeler, A., and Floreano, D. (2009). *Optic Flow to Steer and Avoid Collisions in 3D*, chapter 6 (Springer), pp. 73–86.
- Zufferey, J.-C., Beyeler, A., and Floreano, D. (2010). Autonomous flight at low altitude using light sensors and little computational power, *Int. J. Micro Air Vehicles*, **2(2)**, pp. 107–117.
- Zufferey, J.-C., Guanella, A., Beyeler, A., and Floreano, D. (2006a). Flying over the reality gap: From simulated to real indoor airships, *Auton. Robot.*, **21(3)**, pp. 243–254.
- Zufferey, J.-C., Klapotocz, A., Beyeler, A., Nicoud, J.-D., and Floreano, D. (2006b). A 10-gram microflyer for vision-based indoor navigation, in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (IEEE Press), pp. 3267–3272.

- Zweigle, O., Lafrenz, R., Buchheim, T., Rajaie, H., Schreiber, F., and Levi, P. (2006). Cooperative agent behavior based on special interaction nets, in T. Arai, R. Pfeifer, T. Balch, and H. Yokoi (eds.), *Intell. Auton. Sys. 9* (IOS Press, Amsterdam, NL).
- Zykov, V., Chan, A., and Lipson, H. (2007a). Molecubes: An open-source modular robotics kit, in *Proceedings of IROS 2007 Self-Reconfigurable Robotics Workshop*.
- Zykov, V., Mytilinaios, E., Adams, B., and Lipson, H. (2005a). Self-reproducing machines, *Nature*, **435(7039)**, pp. 163–164.
- Zykov, V., Mytilinaios, E., Desnoyer, M., and Lipson, H. (2007b). Evolved and designed self-reproducing modular robotics, *IEEE Trans. Robot.*, **23(2)**, pp. 308–319.

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In 1888, the title was changed to Zeitschrift für Angewandte Chemie (Journal of Applied Chemistry), and volume numbering started over. This title was kept until the end of 1941 when it was changed to Die Chemie. Until 1920, the journal was published by Springer Verlag and by Verlag Chemie starting in 1921. Due to World War II, the journal did not publish from April 1945 to December 1946. In 1947, publication was resumed under the current title, Angewandte Chemie.[2]. In 1962, the English-language edition was launched as Angewandte Chemie International Edition in English. A self-replicating molecule, by definition, is capable of acting autocatalytically for its own synthesis. Moreover, such autocatalytic molecule acts as a template to bind the precursors by noncovalent forces and organize them in such a way that the reactive groups come in close proximity. A schematic, minimal representation of self-replication is shown in Fig. 1. Self-replication has been achieved in the laboratory using both nucleotide and non-nucleotide model systems as discussed in the following two sections.

14. P. ,-. roximity of the functional groups. 14. T. Achilles, G. von Kiedrowski, *Angew. Chem. Int. Ed. Engl.*, 32, 1198(1993).
15. D. Sievers, G. von Kiedrowski, *Nature*, 369,221, (1994).
16. T. Li, K.C. Nicolaou, *Nature*, 369, 218, (1994).