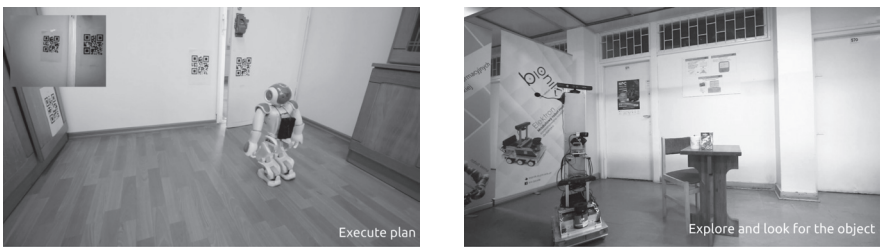
Do chwili powołania do życia agenta a_{dyn} nadzór nad systemem sprawuje agent a_{core}. Po uaktywnieniu agenta a_{dyn} on przejmuje nadzór nad systemem, ponieważ został dobrany dokładnie do realizacji polecenia wydanego przez człowieka. Gdy a_{dyn} poinformuje a_{core} o zakończeniu realizacji zadania, a_{core} likwiduje agenta a_{dyn} i ponownie przejmuje nadzór nad systemem. Tak więc, nie tylko liczba aktywnych agentów w systemie ulega zmianie, ale również łącza komunikacyjne pojawiają się i znikają, a ponadto sprawowanie nadzoru nad systemem jest przenoszone między agentami a_{core} i a_{dyn}. Opisany tu system korzystał z dwóch różnych typów robotów: Nao (rys. 17.11a) i Elektron (rys. 17.11b), a więc powstały dwa różne agenty a_{core}.

a) b)



Rysunek 17.11. (a) Robot Nao, (b) robot Elektron

17.10. Podsumowanie

W rozdziale przedstawiono struktury systemów robotycznych w postaci sieci agentów. Wyróżniono osiem typów agentów. Agent typu CERT jest formą najogólniejszą. Pozostałe typy są jego szczególnymi postaciami. Można tworzyć roboty jednoefektorowe lub wieloefektorowe. Pojedynczy robot może być reprezentowany pojedynczym agentem albo strukturą wieloagentową. Systemy wielorobotowe wymagają wieloagentowej reprezentacji. Dekompozycja systemu na agenty wynika z zadań, które system ma realizować, a często także formy organizacyjnej projektu. Systemy mogą być dekomponowane na wiele sposobów. Forma dekompozycji wynika z doświadczenia projektanta, a jest więc poniekąd sztuką.

Literatura do rozdziału 17

[1] VAL3 Reference Manual. Staübli (2006)
[2] AS *Language Reference Manual*. Kawasaki Heavy Industries, Ltd., 2007.
[3] *Melfa. Mitsibishi Industrial Robot Controller. Instruction Manual (Detailed Explanation of Functions and Operations)*, Mitsibishi Electric, Industrial Automation, 2007.
[4] *TS 3000 Series Robot Controller. Instruction Manual. Robot Language Manual*, Toshiba Machine Co., Ltd., 2009.
[5] *Festo Controller: Programming Instructions CMXR Based on FTL*, Festo AG & Co., 2010.
[6] *KUKA System Software 5.5. Operating and Programming Instructions for System Integrators*, KUKA Robot Group, 2010.

[7] *Comau Robotics Instruction Handbook. PDL2 – Programming Language Manual*, COMAU S.p.A, 2012.
[8] *RAPID Reference Manual*, ABB Flexible Automation, ABB Robotics Products AB, Sweden, 2012.
[9] *The URScript programming language*, Universal Robots, 2012.
[10] Alami R., Chatil R., Fleury S., Ghallab M., Ingrand F.: An architecture for autonomy, *International Journal of Robotics Research*, **17**(4): 315–337, 1998.
[11] Ambler A.P., Corner D.F.: *RAPT1 user's manual*, Department of Artificial Intelligence, University of Edinburgh, 1984.
[12] Arkin R.C.: *Behavior-based robotics*, MIT Press, 1998.
[13] Armbrust C., Kiekbusch L., Ropertz T., Berns K.: Soft robot control with a behaviour-based architecture, [w:] *Soft Robotics*, str. 81–91, Springer, 2015.
[14] Backes P., Hayati S., Hayward V., Tso K.: The kali multi-arm robot programming and control environment, [w:] *NASA Conference on Space Telerobotics*, USA, str. 173–182, 1989.
[15] Billard A., Calinon S., Dillmann R.: Learning from humans, [w:] B. Siciliano, O. Khatib (red.), *Springer Handbook of Robotics*, str. 1995–2014, Springer, 2016.
[16] Billard A., Calinon S., Dillmann R., Schaal S.: Robot programming by demonstration, [w:] B. Siciliano, O. Khatib (red.), *Springer Handbook of Robotics*, str. 1371–1394, Springer, 2008. doi: 10.1007/978-3-540-30301-5_60.
[17] Blume C., Jakob W.: *PASRO: Pascal for robots*, Springer-Verlag, Berlin 1985.
[18] Blume, C., Jakob, W.: *Programming languages for industrial robots*, Springer-Verlag, 1986.
[19] Bonabeau E., Dorigo M., Theraulaz G.: *Swarm intelligence: from natural to artificial systems*, Oxford University Press, Nowy Jork – Oxford, 1999.
[20] Bonarini A., Matteucci M., Restelli M.: MRT: Robotics off-the-shelf with the modular robotic toolkit, [w:] D. Brugali (red.), *Software engineering for experimental robotics*, str. 345–364, Springer-Verlag, 2007.
[21] Bradski G., Kaehler A.: *Learning OpenCV: computer vision with the OpenCV library*, O'Reilly, 2008.
[22] Brooks A., Kaupp T., Makarenko A., Williams S., Orebäck A.: Towards component-based robotics, [w:] *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS'05)*, str. 163–168, 2005.
[23] Brooks A., Kaupp T., Makarenko A., Williams S., Orebäck A.: Orca: a component model and repository, [w:] D. Brugali (red.,) *Software engineering for experimental robotics, Springer Tracts in Advanced Robotics*, tom 30, str. 231–251, Springer, 2007.
[24] Brooks R.A.: A robust layered control system for a mobile robot, *IEEE Journal of Robotics and Automation*, **2**(1): 14–23, 1986.
[25] Brooks R.A.: Intelligence without reason, *Artificial intelligence: critical concepts*, **3**: 107–163, 1991.
[26] Brooks R.A.: Intelligence without representation, *Artificial Intelligence*, **47**(1–3): 139–159, 1991.
[27] Brugali D.: Stable analysis patterns for robot mobility, [w:] D. Brugali (red.), *Software engineering for experimental robotics*, str. 9–30, Springer-Verlag, 2007.
[28] Brugali D.: Model-driven software engineering in robotics, *IEEE Robotics Automation Magazine*, **22**(3): 155–166, 2015.
[29] Brugali D., Agah A., MacDonald B., Nesnas I., Smart W.: Trends in robot software domain engineering, [w:] D. Brugali (red.), *Software engineering for experimental robotics*, str. 3–8, Springer-Verlag, 2007.
[30] Brugali D., Broten G.S., Cisternino A., Colombo D., Fritsch J., Gerkey B., Kraetzschmar G., Vaughan R., Utz H.: Trends in robotic software frameworks, [w:] D. Brugali (red.), *Software engineering for experimental robotics*, str. 259–266, Springer-Verlag, 2007.
[31] Bruyninckx H.: Open robot control software: The OROCOS project, [w:] *International Conference on Robotics and Automation (ICRA)*, tom 3, str. 2523–2528, IEEE, 2001.

[32] Bruyninckx H., Soetens P., Koninckx B.: The real-time motion control core of the OROCOS project. [w:] *Proceedings of the IEEE International Conference on Robotics and Automation*, str. 2766–2771, IEEE, 2003.

[33] Bulter Z., Rizzi A.: Distributed and cellular robots, [w:] O. Khatib, B. Siciliano (red.), *Springer handbook of robotics*, str. 911–920, Springer, 2008.

[34] Chibani A., Amirat Y., Mohammed S., Matson E., Hagita N., Barreto M.: Ubiquitous robotics: Recent challenges and future trends, *Robotics and Autonomous Systems*, **61**(11): 1162–1172, 2013. doi: 10.1016/j.robot.2013.04.003

[35] Collett T., MacDonald B., Gerkey B.: Player 2.0: Toward a practical robot programming framework, [w:] *Proceedings of the Australasian Conference on Robotics and Automation (ACRA)*, 2005. URL http://www.ai.sri.com/ gerkey/papers/acra2005.pdf

[36] Corke P., Kirkham R.: The ARCL robot programming system, [w:] *International Conference on Robots for Competitive Industries*, str. 484–493, 1993.

[37] Coste-Maniere E., Simmons R.: Architecture, the backbone of robotic systems, [w:] *Proceedings of IEEE International Conference on Robotics and Automation ICRA '00*, tom 1, str. 67–72, 2000, doi: 10.1109/ROBOT.2000.844041.

[38] Doriya, R., Mishra, S., Gupta, S.: A brief survey and analysis of multi-robot communication and coordination. [w:] *2015 International Conference on Computing, Communication Automation (ICCCA)*, str. 1014–1021, 2015. doi: 10.1109/CCAA.2015.7148524

[39] Dudek G., Jenkin M.R.M., Milios E., Wilkes D.: A taxonomy for multi-agent robotics, *Autonomous Robots*, **3**(4): 375–397, 1996, doi: 10.1007/BF00240651.

[40] Dudek W., Szynkiewicz W., Winiarski T.: Nao robot navigation system structure development in an agent-based architecture of the RAPP platform, [w:] R. Szewczyk, C. Zieliński, M. Kaliczyńska (red.), *Recent Advances in Automation, Robotics and Measuring Techniques, Advances in Intelligent Systems and Computing (AISC)*, tom 440, str. 623–633, Springer, 2016, doi 10.1007/978-3-319-29357-8_54.

[41] Farinelli A., Iocchi L., Nardi D.: Multirobot systems: a classification focused on coordination, *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)*, **34**(5): 2015–2028, 2004, doi: 10.1109/TSMCB.2004.832155.

[42] Fitzpatrick P., Metta G., Natale L.: Towards long-lived robot genes, *Robotics and Autonomous Systems*, **56**(1): 29–45, 2008.

[43] Fleury S., Herrb M., Chatila R.: GenoM: A tool for the specification and the implementation of operating modules in a distributed robot architecture, *Proceedings of the 1997 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS'97)*, **2**: 842–849, 1997, doi: 10.1109/IROS.1997.655108.

[44] Fritsch J., Wrede S.: An integration framework for developing interactive robots, [w:] D. Brugali (red.) *Software Engineering for Experimental Robotics*, str. 291–305, Springer-Verlag, 2007.

[45] Gagliardi S., Li X., Zoppi M., de Leonardo L., Molfino R.: Adaptable fixturing heads for swarm fixtures: discussion of two designs, [w:] *ASME 2012 11th Biennial Conference on Engineering Systems Design and Analysis (ESDA2012)*, Nantes, Francja, 2012.

[46] Gat E.: On three-layer architectures, [w:] D. Kortenkamp, R.P. Bonnasso, R. Murphy (red.), *Artificial intelligence and mobile robots*, str. 195–210, AAAI Press Cambridge, MA, 1998.

[47] Gerkey B.P., Vaughan R.T., Støy K., Howard A., Sukhatme G.S., Mataric M.J.: Most Valuable Player: A Robot Device Server for Distributed Control, [w:] *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, str. 1226–1231, 2001.

[48] Gordon D.: *Ant encounters: interaction, networks and colony behavior*, *Primers in Complex Systems*, Princeton University Press, 2010.

[49] Halang W.A., Sacha K.M.: Real-Time Systems: *Implementation of industrial computerised process automation*, World Scientific, Singapore, 1992.

[50] Hayward V., Daneshmend L., Hayati S.: An overview of KALI: A system to program and control cooperative manipulators. [w:] K. Waldron (ed.) *Advanced robotics*, str. 547–558, Springer-Verlag, Berlin, 1989.

[51] Hayward V., Hayati S.: Kali: An environment for the programming and control of cooperative manipulators, [w:] *7th American Control Conference*, str. 473–478, 1988.

[52] Hayward V., Paul R.P.: Robot manipulator control under Unix RCCL: A robot control C library, *International Journal of Robotics Research*, **5**(4): 94–111, 1986.

[53] Janiak M., Zieliński C.: Platforma mobilna Rex – struktura układu sterowania, [w:] K. Tchoń, C. Zieliński (red.), *Postępy robotyki. Prace Naukowe – Elektronika* (XIII Krajowa Konferencja Robotyki. Kudowa Zdrój, 2–6 lipca 2014), tom 194, str. 45–54, 2014.

[54] Janiak M., Zieliński C.: Control system architecture for the investigation of motion control algorithms on an example of the mobile platform Rex, *Bulletin of the Polish Academy of Sciences – Technical Sciences*, **63**(3): 667–678, 2015, doi: 10.1515/bpasts-2015-0078.

[55] Kaisler S.: *Software paradigms*, Wiley Interscience, Hoboken 2005.

[56] Kiekbusch L., Armbrust C., Berns K.: Formal verification of behaviour networks including sensor failures, *Robotics and Autonomous Systems*, **74**, 331–339, 2015.

[57] Kiekbusch L., Armbrust C., Berns K.: Formal verification of behaviour networks including hardware failures, [w:] *Intelligent Autonomous Systems 13*, str. 1571–1582, Springer, Cham 2016.

[58] Klotzbücher M., Smits R., Bruyninckx H., De Schutter J.: Reusable hybrid force-velocity controlled motion specifications with executable domain specific languages, [w:] *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 25-30 września 2011, San Francisco, USA, str. 4684–4689, 2011.

[59] Kornuta T., Zieliński C.: Robot control system design exemplified by multi-camera visual servoing, *Journal of Intelligent & Robotic Systems*, **77**(3–4): 499–524, 2013, doi: 10.1007/s10846-013-9883-x.

[60] Kortenkamp D., Simmons R., Brugali D.: Robotic systems architectures and programming, [w:] B. Siciliano, O. Khatib (red.), *Springer handbook of robotics*, wyd. 2, str. 283–306, Springer, 2016.

[61] de Leonardo L., Zoppi M., Li X., Zlatanov D., Molfino R.: Swarmitfix: A multi-robot-based reconfigurable fixture, [w:] *Industrial Robot*, str. 320—-328, 2013.

[62] Leonardo L., Zoppi M., Xiong L., Gagliardi S., Molfino R.: *Developing a new concept of self reconfigurable intelligent swarm fixtures*, str. 321–331, 2012.

[63] Lloyd J., Parker M., McClain R.: Extending the RCCL Programming Environment to Multiple Robots and Processors, [w:] *IEEE International Conference on Robotics and Automation*, Philadelphia, USA, 24–29 kwietnia, str. 465–469, 1988.

[64] Lutz M.: *Programming Python*, O'Reilly Media, Inc., 2010.

[65] Lutz W., Sanderson W., Scherbov S.: The coming acceleration of global population ageing, *Nature*, **451(7179)**, 716–719, 2008, doi: 10.1038/nature06516.

[66] Lyons D.M.: Prerational intelligence,*Studies in cognitive systems*, tom 2: *Adaptive behavior and intelligent systems without symbols and logic*, rozdz. A Schema-Theory Approach to Specifying and Analysing the Behavior of Robotic Systems, str. 51–70, Kluwer Academic, 2001.

[67] Lyons D.M., Arbib M.A.: A formal model of computation for sensory-based robotics, *IEEE Transactions on Robotics and Automation*, **5**(3): 280–293, 1989.

[68] Matarić M.J.: Issues and approaches in the design of collective autonomous agents, *Robotics and Autonomous Systems*, **16**(2): 321–331, 1995, doi: 10.1016/0921-8890(95)00053-4.

[69] Matarić M.J., Michaud F.: *The Handbook of Robotics*, rozdz. Behavior-based systems, str. 891–909, Springer, 2008.

[70] Metta G., Fitzpatrick P., Natale L.: YARP: Yet Another Robot Platform, *International Journal on Advanced Robotics Systems*, **3**(1): 43–48, 2006.

[71] Mitkas P.: Assistive robots as future caregivers: The rapp approach, [w:] R. Szewczyk, C. Zieliński, M. Kaliczyńska (red.), *Progress in Automation, Robotics and Measuring Techniques. Vol. 2 Robotics*, *Advances in Intelligent Systems and Computing (AISC)*, tom 351, str. 171–179, Springer, 2015.
[72] Molfino R., Zoppi M., Zlatanov D.: Reconfigurable swarm fixtures, [w:] *ASME/IFToMM International Conference on Reconfigurable Mechanisms and Robots*, str. 730–735, 2009.
[73] Mujtaba S., Goldman R.: *AL users' manual*, Stanford Artificial Intelligence Laboratory, 1979.
[74] Nesnas I.: The CLARAty project: coping with hardware and software heterogenity, [w:] D. Brugali (ed.), *Software Engineering for Experimental Robotics*, str. 31–70, Springer-Verlag, 2007.
[75] Neumann K.: US patent number 4732525, 1988.
[76] Niederliński A.: *Roboty przemysłowe*, Wydawnictwa Szkolne i Pedagogiczne, Warszawa 1981.
[77] Nilakantan A., Hayward V.: The synchronisation of multiple manipulators in Kali, *Robotics and Autonomous Systems*, **5**(4): 345–358, 1989.
[78] Padgham L., Winikoff M.: *Developing Intelligent Agent Systems: A Practical Guide*, John Wiley & Sons, 2004.
[79] Pan Z., Polden J., Larkin N., Duin S.V., Norrish J.: Recent progress on programming methods for industrial robots, *Robotics and Computer-Integrated Manufacturing*, **28**(2): 87–94, 2012, doi: 10.1016/j.rcim.2011.08.004.
[80] Parker L.E.: Multiple mobile robot systems, [w:] O. Khatib, B. Siciliano (red.), *Springer Handbook of Robotics*, str. 921–941, Springer 2008.
[81] Paul R.: WAVE: A model based language for manipulator control, *The Industrial Robot*, **4**(1): 10–17, 1977, doi: 10.1108/eb004473.
[82] Paul R.: The early stages of robotics, [w:] *IFAC Real Time Digital Control Applications*, Guadalajara, Mexico, str. 19–32, 1983.
[83] Pedersen M.R., Nalpantidis L., Andersen R.S., Schou C., Bøgh S., Krüger V., Madsen O.: Robot skills for manufacturing: From concept to industrial deployment, *Robotics and Computer-Integrated Manufacturing*, **37**, 282–291, 2016, doi: /10.1016/j.rcim.2015.04.002.
[84] Pilone D., Pitman N.: *UML 2.0 in a Nutshell*, O'Reilly, 2005.
[85] Popplestone R.J., Ambler A.P., Bellos I.: RAPT: a language for describing assemblies, *Industrial Robot*, **5**(3): 131–137, 1978.
[86] Psomopoulos F., Tsardoulias E., Giokas A., Zieliński C., Prunet V., Trochidis I., Daney D., Serrano M., Courtes L., Arampatzis S., Mitkas P.: Rapp system architecture, [w:] I*ROS 2014 – Assistance and Service Robotics in a Human Environment*, str. 14–18, Workshop in conjunction with IEEE/RSJ International Conference on Intelligent Robots and Systems, Chicago, Illinois, 14 września 2014.
[87] Quigley M., Conley K., Gerkey B., Faust J., Foote T., Leibs J., Wheeler R., Ng A.Y.: ROS: an open-source Robot Operating System, [w:] *ICRA workshop on open source software*, tom 3, 2009.
[88] Quigley M., Gerkey B., Conley K., Faust J., Foote T., Leib, J., Berger E., Wheeler R., Ng A.: ROS: an open-source Robot Operating System, [w:] *Proceedings of the Open-Source Software workshop at the International Conference on Robotics and Automation (ICRA)*, 2009.
[89] Reppou S., Karagiannis G.: Social inclusion with robots: A RAPP case study using NAO for technology illiterate elderly at ormylia foundation, [w:] R. Szewczyk, C. Zieliński, M. Kaliczyńska (red.), *Progress in Automation, Robotics and Measuring Techniques. Vol. 2 Robotics*, *Advances in Intelligent Systems and Computing (AISC)*, tom 351, str. 233–241, Springer, 2015.
[90] Reppou S., Karagiannis G., Tsardoulias E., Kintsakis A., Symeonidis A., Mitkas P., Psomopoulos F., Zieliński C., Prunet V., Iturburu M., Arampatzis S.: RAPP: A robotic-oriented ecosystem for delivering smart user empowering applications for older people, *International Journal of Social Robotics*, **8**(4): 539–552, 2016, doi: 10.1007/s12369-016-0361-z.
[91] Russell S., Norvig P.: *Artificial intelligence: a modern approach*, Prentice Hall, Upper Saddle River, N.J., 1995.
[92] Sacha K.: *Inżynieria oprogramowania*, Wydawnictwo Naukowe PWN, Warszawa 2010.

[93] Shoham Y.: Agent-oriented programming, *Artificial Intelligence*, **60**(1): 51–92, 1993.

[94] Stefańczyk M., Kornuta T.: Handling of asynchronous data flow in robot perception subsystems, [w:] *Simulation, Modeling, and Programming for Autonomous Robots, Lecture Notes in Computer Science*, tom 8810, str. 509–520, Springer, 2014, doi: 10.1007/978-3-319-11900-7_43.

[95] Stenmark M., Haage M., Topp E.A.: Simplified programming of re-usable skills on a safe industrial robot – prototype and evaluation, [w:] *Proceedings of the IEEE/ACM Conference on Human-Robot Interaction (HRI)*, Vienna, Austria, 2017, URL: http://lup.lub.lu.se/record/3b4d6f5a-068b-42ac-815f-0696843cb08f:

[96] Szynkiewicz W., Zielińska T., Kasprzak W.: Robotized machining of big work pieces: Localization of supporting heads, *Frontiers of Mechanical Engineering in China*, **5**(4): 357–369, 2010.

[97] Tang F., Parker L.: A complete methodology for generating multi-robot task solutions using ASyMTRe-D and market-based task allocation, [w:] *2007 IEEE International Conference on Robotics and Automation*, str. 3351–3358, IEEE, 2007.

[98] Tchoń K., Jakubiak J.: Endogenous configuration space approach to mobile manipulators: A derivation and performance assessment of Jacobian inverse kinematics algorithms, *International Journal of Control*, **76**(14): 1387–1419, 2003.

[99] Trojanek P., Kornuta T., Zieliński C.: Design of asynchronously stimulated robot behaviours, [w:] K. Kozłowski (red.) *9th Workshop on Robot Motion and Control (RoMoCo)*, str. 129–134, 2013, doi: 10.1109/RoMoCo.2013.6614597.

[100] Tsardoulias E., Zieliński C., Kasprzak W., Reppou S., Symeonidis A., Mitkas P., Karagiannis G.: Merging robotics and aal ontologies: The rapp methodology, [w:] R. Szewczyk, C. Zieliński, M. Kaliczyńska (red.), *Progress in Automation, Robotics and Measuring Techniques. Vol. 2 Robotics*, *Advances in Intelligent Systems and Computing (AISC)*, tom 351, str. 285–298, Springer, 2015, doi: 10.1007/978-3-319-15847-1_28.

[101] Tsardoulias E.G., Kintsakis A.M., Panayiotou K., Thallas A.G., Reppou S.E., Karagiannis G.G., Iturburu M., Arampatzis S., Zieliński C., Prunet V., Psomopoulos F.E., Symeonidis A.L., Mitkas P.A.: Towards an integrated robotics architecture for social inclusion–the rapp paradigm, *Cognitive Systems Research*, **43**: 157–173, 2016, doi: 10.1016/j.cogsys.2016.08.004.

[102] Vaughan R.T., Gerkey B.P.: Reusable robot software and the Player/Stage project, [w:] D. Brugali (red.), *Software Engineering for Experimental Robotics, Springer Tracts in Advanced Robotics*, tom 30, str. 267–289, Springer, 2007.

[103] Winiarski T., Banachowicz K., Seredyński D.: Multi-sensory feedback control in door approaching and opening, [w:] D. Filev, J. Jabłkowski, J. Kacprzyk, M. Krawczak, I. Popchev, L. Rutkowski, V. Sgurev, E. Sotirova, P. Szynkarczyk, S. Zadrozny (red.), *Intelligent Systems'2014, Advances in Intelligent Systems and Computing*, tom 323, str. 57–70, Springer, 2015, doi: 10.1007/978-3-319-11310-4_6.

[104] Yim M., Shen W.M., Salemi B., Rus D., Moll M., Lipson H., Klavins E., Chirikjian G.S.: Modular self-reconfigurable robot systems [grand challenges of robotics], *IEEE Robotics & Automation Magazine*, **14**(1): 43–52, 2007.

[105] Zielińska T., Kasprzak W., Szynkiewicz W., Zieliński C.: Path planning for robotized mobile supports, *Journal of Mechanism and Machine Theory*, **78**: 51–64, 2014, doi: 10.1016/j.mechmachtheory.

[106] Zieliński C.: TORBOL: An object level robot programming language, *Mechatronics*, **1**(4): 469–485, 1991.

[107] Zieliński C.: The MRROC++ system, [w:] *Proceedings of the First Workshop on Robot Motion and Control, RoMoCo'99*, str. 147–152, 1999.

[108] Zieliński C.: A quasi-formal approach to structuring multi-robot system controllers, [w:] *Second International Workshop on Robot Motion and Control, RoMoCo'01*, str. 121–128, 2001.

[109] Zieliński C.: By how much should a general purpose programming language be extended to become a multi-robot system programming language?, *Advanced Robotics*, **15**(1): 71–96, 2001.
[110] Zieliński C.: Formal approach to the design of robot programming frameworks: the behavioural control case, *Bulletin of the Polish Academy of Sciences – Technical Sciences*, **53**(1): 57–67, 2005.
[111] Zieliński C.: Systematic approach to the design of robot programming frameworks, [w:] *Proceedings of the 11th IEEE International Conference on Methods and Models in Automation and Robotics* (on CD), str. 639–646, Politechnika Szczecińska, Szczecin 2005.
[112] Zieliński C.: Transition-function based approach to structuring robot control software, [w:] K. Kozłowski (red.) *Robot Motion and Control, Lecture Notes in Control and Information Sciences*, tom 335, str. 265–286, Springer-Verlag, 2006.
[113] Zieliński C.: Formalne podejście do programowania robotów – struktura układu sterującego, [w:] *Inteligencja wokół nas. Współdziałanie agentów softwareowych, robotów, inteligentnych urządzeń*, tom 15, str. 267–300, Akademicka Oficyna Wydawnicza EXIT, 2010.
[114] Zieliński C., Figat M.: Robot system design procedure based on a formal specification, [w:] *Recent Advances in Automation, Robotics and Measuring Techniques, Advances in Intelligent Systems and Computing (AISC)*, tom 440, str. 511–522, Springer, 2016, doi: 10.1007/978-3-319-29357-8_45
[115] Zieliński C., Figat M., Hexel R.: Robotic systems implementation based on fsms, [w:] R. Szewczyk, C. Zieliński, M. Kaliczyńska (red.), *Automation 2018: Advances in Automation, Robotics and Measurement Techniques*, str. 441–452, Springer, 2018, doi: 10.1007/978-3-319-77179-3_41.
[116] Zieliński C., Figat M., Hexel R.: Communication within multi-fsm based robotic systems, *Journal of Intelligent & Robotic Systems*, **93**(3): 787–805, 2019, doi: 10.1007/s10846-018-0869-6.
[117] Zieliński C., Kasprzak W., Kornuta T., Szynkiewicz W., Trojanek P., Walęcki M., Winiarski T., Zielińska T.: Control and programming of a multi-robot-based reconfigurable fixture, *Industrial Robot: An International Journal*, **40**(4): 329–336, 2013, doi: 10.1108/01439911311320831.
[118] Zieliński C., Kasprzak W., Szynkiewicz W., Winiarski T., Kornuta T., Stefańczyk M., Walęcki M., Banachowicz K., Pokorski, T., Figat M., Seredyński D.: Interfejs operatorski robota prototypowego na bazie komputera PC z klawiaturą i monitorem umożliwiający ruchy ręczne w przestrzeni konfiguracyjnej i operacyjnej, a także uruchamianie zadania w trybie automatycznym, *Tech. Rep. 2014-12*, Instytut Automatyki i Informatyki Stosowanej Politechniki Warszawskiej, Warszawa 2014.
[119] Zieliński C., Kornuta T.: Diagnostic requirements in multi-robot systems, [w:] J. Korbicz, M. Kowal (red.), *Intelligent Systems in Technical and Medical Diagnostics, Advances in Intelligent Systems and Computing*, tom 230, str. 345–356, Springer, 2014, doi: 10.1007/978-3-642-39881-0_29.
[120] Zieliński C., Kornuta T.: *An object-based robot ontology*, str. 3–14, Springer, 2015. doi: 10.1007/978-3-319-11310-4_1
[121] Zieliński C., Kornuta T.: Programowe struktury ramowe do tworzenia sterowników robotów, *Pomiary Automatyka Robotyka PAR*, **19**(1): 5–14, 2015. doi: 10.14313/PAR_215/5
[122] Zieliński C., Kornuta T., Stefańczyk M., Szynkiewicz W., Trojanek P., Walęcki M.: Języki programowania robotów przemysłowych, *Pomiary Automatyka Robotyka*, **16**(11): 10–19, 2012.
[123] Zieliński C., Kornuta T., Trojanek P., Winiarski T.: Metoda projektowania układów sterowania autonomicznych robotów mobilnych. Część 2. Przykład zastosowania, *Pomiary Automatyka Robotyka*, **10**: 84–91, 2011.
[124] Zieliński C., Kornuta T., Trojanek P., Winiarski T., Walęcki M.: Specification of a multi-agent robot-based reconfigurable fixture control system, *Robot Motion & Control 2011 (Lecture Notes in Control & Information Sciences)*, **422**: 171–182, 2012, doi: 10.1007/978-1-4471-2343-9_14.
[125] Zieliński C., Kornuta T., Winiarski T.: A systematic method of designing control systems for service and field robots, [w:] *19-th IEEE International Conference on Methods and Models in Automation and Robotics, MMAR*, str. 1–14, IEEE, 2014, doi: 10.1109/MMAR.2014.6957317
[126] Zieliński C., Stefańczyk, M., Kornuta T., Figat M., Dudek W., Szynkiewicz W., Kasprzak W., Figat J., Szlenk M., Winiarski T., Banachowicz K., Zielińska T., Tsardoulias E.G., Symeonidis A.L.,

Psomopoulos F.E., Kintsakis A.M., Mitkas P.A., Thallas A., Reppou S.E., Karagiannis G.T., Panayiotou K., Prunet V., Serrano M., Merlet J.P., Arampatzis S., Giokas A., Penteridis L., Trochidis I., Daney D., Iturburu M.: Variable structure robot control systems: The RAPP approach, *Robotics and Autonomous Systems*, **94**: 226–244, 2017, doi: 10.1016/j.robot.2017.05.002.

[127] Zieliński C., Szynkiewicz W., Mianowski K., Nazarczuk K.: Mechatronic design of open-structure multi-robot controllers, *Mechatronics*, **11**(8): 987–1000, 2001.

[128] Zieliński C., Szynkiewicz W., Winiarski T.: Applications of MRROC++ robot programming framework. [w:] K. Kozłowski (red.) *Proceedings of the 5th International Workshop on Robot Motion and Control, RoMoCo'05*, Dymaczewo, Polska, str. 251–257, 2005.

[129] Zieliński C., Trojanek P.: Stigmergic cooperation of autonomous robots, *Journal of Mechanism and Machine Theory*, **44**: 656–670, 2009.

[130] Zieliński C., Trojanek P.: Współpraca robotów, [w:] S. Ambroszkiewicz, A. Borkowski, K. Cetnarowicz, C. Zieliński (red.), *Inteligencja wokół nas. Współdziałanie agentów softwareowych, robotów, inteligentnych urządzeń*, tom 15, str. 301–315, Seria Monografie Komitetu Automatyki i Robotyki PAN, Akademicka Oficyna Wydawnicza EXIT, 2010.

[131] Zieliński C., Winiarski T.: General specification of multi-robot control system structures, *Bulletin of the Polish Academy of Sciences – Technical Sciences*, **58**(1): 15–28, 2010, doi: 10.2478/v10175-010-0002-x.

[132] Zieliński C., Winiarski T.: Motion generation in the MRROC++ robot programming framework, *International Journal of Robotics Research*, **29**(4): 386–413, 2010, doi: 10.1177/0278364909348761.