Preface to Special Issue on Robot Perception and Control

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Since 2011 once every two years Journal of Automation, Mobile Robotics and Intelligent Systems has published a regular issue devoted to a particular aspect of robotics research conducted in Poland. The papers composing each such issue have been selected by the Program Committee of the National Conference on Robotics organized by the Department of Fundamental Cybernetics and Robotics, Electronics Faculty of Wrocław University of Technology. The selection has been based on the excellence of the papers published in the conference proceedings in Polish, and necessarily presented and discussed during these conferences. These papers contain most insightful achievements that had been attained during the last two years preceding every such a conference. It should be stressed that the papers put together in those issues of Journal of Automation, Mobile Robotics and Intelligent Systems have been by no means a simple translation into English of the conference papers. The results reported have been updated, described more comprehensively and in a wider context. The new papers have been subjected to the regular Journal of Automation, Mobile Robotics and Intelligent Systems review procedure. Gratitude should be expressed to all of the reviewers who provided in depth comments enabling many clarifications and overall improvements of the papers. The papers published in this issue of Journal of Automation, Mobile Robotics and Intelligent Systems are the results of research presented at the 15-th National Conference on Robotics held in Polanica Zdrój from 5th till 9th of September 2018. As the title of this editorial suggests, the recent robotics research in Poland has mainly concentrated on robot perception and control.

Perception is understood in robotics as the process of acquiring, processing, and interpreting data obtained from sensors in order to understand the situation existing in the environment, for the purpose of making decisions. Those decisions pertain both to the control of the robot, treated as a device, and to the task that it has to execute. Herein a broad view of robotics is taken, hence it encompasses all kind of robots, including telemanipulation systems as well as prosthesis. The fifth issue of Journal of Automation, Mobile Robotics and Intelligent Systems stemming from the National Conference on Robotics is thus devoted to diverse aspects of robot perception and control. The following overview briefly characterizes the selected papers.

The first three papers of this selection are devoted to the organization of the perception process.

The paper "On the efficiency of population-based optimization in finding best parameters for RGB-D visual odometry", authored by A. Kostusiak and P. Skrzypczyński, focuses on mobile robot odometry based on the visual stream obtained from RGB-D cameras. The presented approach avoids the computationally intensive stage of data processing as a result of which the map of the environment is produced. Instead, it is based on the direct extraction of geometric transformations from the data stream to reproduce the camera motion trajectory. The paper describes the particle swarm and evolutionary algorithm optimization process leading to the evaluation of the visual odometry parameters.

The article "Overhead vision system for testing swarms and groups of wheeled robots", written by Z. Hendzel and J. Wiech, deals with the localization of mobile robots forming a swarm. For that purpose each of the robots is equipped with a binary marker that is detected by a global camera overhanging the environment in which the robots act. The paper describes the calibration of the system and the marker detection algorithm resulting in the position and orientation of each robot, whose accuracy depends on the resolution of the camera.

A. Kobierska, P. Rakowski and L. Podsędkowski wrote the paper entitled "Estimation of orientation and position of the manipulator using the extended Kalman filter based on measurements from the accelerometers", which concentrates on proprioception in medical mini-manipulators used for measuring lengths of femoral bones subjected to surgery. Cumbersome and relatively expensive encoders or resolvers used in large manipulators were substituted by light-weight and cheap accelerometers able to produce the solutions to the direct kinematics problem for the mini-manipulator. As the signals from the accelerometers contain significant noise they had to be further processed by an extended Kalman filter.

The next three papers concentrate on the interaction between an operator and a robotic system or a prosthesis. All of them highlight perception and the use of its results for the purpose of control of the device.

The work "Evaluation of simple microphone-based mechanomyography (MMG) probe sets for hand stiffness classification", authored by I. Zubrycki and G. Granosik, is devoted to the design of mechanomyographic sensors based on electret microphones, for use by operators controlling the stiffness of telemanipulator grippers. The data

collected from several subjects was processed by three alternative machine learning algorithms classifying grasp stiffness that the device operator will be able to produce remotely.

The paper "Determination of the relationship between EMG signals and hand grips using a commercial myo armband", delivered by M. Błędowski and A. Wołczowski, describes the study of the relationship between signals produced by skeletal muscles and grasping movements of the palm. Electromyography is the technique of recording those signals. The studied relationship can be used in the process of control of bioprosthesis or a telemanipulator equipped with a gripper. The readings obtained from myosensors located in an arm-band were extended by measurements received from bend and pressure sensors located in a sensory glove. As a result of processing the thus acquired data the state of the operator's hand can be classified.

"Manipulator control system for remote USG examination" reports on the work conducted by A. Kurnicki and B. Stańczyk. It presents a telemanipulation system used for remote acquisition of ultrasonographic data about the state of internal organs of a patient. The system is composed of a haptic interface generating the motion of the USG head and reflecting the forces exerted by the head onto the patient. The remote robot is equipped with a camera stereopair enabling the doctor to locate the sensoric head in the required place. The paper focuses on the control aspects of this master-slave system.

The last two papers solve two different control problems. The first deals with position-force control of a manipulator and the second provides insight into the design of software enabling mission coordination and planning for heterogeneous robots executing separate tasks.

The authors A. Mazur, M. Kaczmarek, J. Ratajczak and W. Domski of the article "Modified position-force control for a manipulator geometrically constrained by round obstacles", looks at the problem of manipulator position-force control when round obstacles exist in the environment. The method of obtaining joint-space orthogonalisation between force and motion vectors is presented. A mathematical proof that the resulting control algorithm causes the tracking errors to converge to zero is presented.

The paper "Using LabVIEW and ROS for planning and coordination of robot mission, the example of ERL Emergency Robots and University Rover Challenge competitions", authored by A. Węgierska, K. Andrzejczak, M. Kujawiński and G. Granosik, delves into the problem of creating mission coordination and planning software for robots taking part in robotic challenges. The software enables heterogeneous groups of robots to be teleoperated or to act partially autonomously. It also monitors the mission execution thus providing data for future analysis. The paper also describes the experience gained in using the created software during robotics challenges.

All of the subjects of the papers composing this issue of Journal of Automation, Mobile Robotics and Intelligent Systems, briefly characterized above, are the topics of current deliberations of the robotics community conducting research concerned with robot perception and control. Each of the papers gives a thorough insight into a particular problem, providing its formulation, background, and deriving its solution. We hope that this selection of papers will be found useful both by researchers and practitioners involved in diverse aspects of robotics.

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