Introduction

Human-robot interaction and advanced robot control

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 Chair of Cybernetics and Robotics, Faculty of Electronics, Fotonics and Microsystems of Wrocław University of Science and Technology. As due to the COVID pandemy the 2020 conference was postponed by two years, the associated issue of JAMRIS is also delayed by two years. The selection of papers for all of the mentioned issues, including this one, has been based on the significance of the research results conveyed in 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 years preceding every of those conferences. It should be stressed that the papers gathered in those issues of JAMRIS 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 JAMRIS 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 JAMRIS are the results of research presented at the 16-th National Conference on Robotics held in Trzebieszowice from the 31st of August till the 2nd of September 2022. As the title of this editorial suggests, the recent robotics research in Poland has mainly concentrated on human-robot interaction and robot control.

Human-Robot Interaction

The papers devoted to human-robot interaction concentrate on the anticipation of the actions of humans, so that robots can take that information into account while executing their tasks or during the process of their programming. All of the papers in that group start with visual perception of the human and employ neural networks to categorize the actions performed by the observed humans. This is the basis for robot decision making.

The paper “Skeleton-Based Human Action/Interaction Classification in Sparse Image Sequences”, by Włodzimierz Kasprzak and Paweł Piwowarski, reports on the classification of human activities based on the data obtained in video images. The presented algorithm estimates the location of human skeletons from the video frames. Single person actions and interaction between two persons are considered. The estimation is done by a neural network. The paper focuses on tracking skeleton motion. The tracking ability is significantly improved by processing selected features rather than using raw data. As not all video frames are used in the classification process the resulting algorithm can be run on devices that do not provide high computational power.

The article “Improved Competitive Neural Network for Classification of Human Postures Based on Data from RGB-D Sensors”, authored by Vibekananda Dutta, Jakub Cydejko and Teresa Zielińska, delves into the problem of recognising human postures. This research is motivated by the requirements of robots collaborating with humans. The robot has to anticipate human behaviour thus the information about human posture is necessary. Usually such information is obtained by using cameras tracking markers. However here the authors use marker-less motion capture systems and investigate whether they provide sufficient data to recognize human postures in a side view. To reduce the cost later they substitute the motion capture system by RGB-D cameras. Posture classification is based on neural network processing of images.

Another problem involving human-robot interaction is considered in “Multimodal Robot Programming Interface Based on RGB-D Perception and Neural Scene Understanding Modules” , written by Bartłomiej Kulecki. Here RGB-D cameras and neural networks are employed to program manipulation tasks. The system detects objects and the operator’s hand inferring the intensions of the human. Voice commands supplement gesture recognition in programming the task at hand. This research falls into the category of programming by demonstration, which is the most sought for form of programming robots, alas the most difficult to accomplish.

Robot Control

The batch of papers devoted to robot control concentrates on the solution of problems encountered while controlling manipulators in certain specific situations. Thus, avoidance of kinematic singularities, approach to a preset path and following it, as well as manipulator model parameter identification are discussed.

The paper "Singularity-Robust Inverse Kinematics for Serial Manipulators", authored by Ignacy Dulęba, deals with solving the inverse kinematics problem (IKP) near a singularity. It is shown that singularity avoidance can be performed in two different ways: either via properly modified manipulability matrix or by prohibiting the decrease of the minimal singular value below a certain threshold. Solution of IKP is generally difficult especially for serial manipulators, but dealing with a singularity is extremely difficult. The presented discussion is theoretical, however it has a fundamental impact on the implementation of controllers, as the specification of trajectories in operational space is preferred to the expression of those trajectories in configuration space, for practical reasons. Thus the solution of IKP is a necessity, but then avoidance of singularities is a prerequisite.

The article "Comparison of Curvilinear Parametrization Methods and Avoidance of Orthogonal Singularities in the Path Following Task", presented by Filip Dyba and Alicja Mazur, investigates Serret–Frenet and Bishop curvilinear parametrizations of paths to be followed by a manipulator. In the path following task both the orthogonal parameterisation of the path and the dynamics of the manipulator are taken into account. Both a fully known and partially known dynamics model are considered. Theoretical considerations are validated by simulation experiments conducted using a holonomic stationary manipulator. In some cases the singularity of the orthogonal projection of the manipulator end-effector on the given path is located directly on the path. The paper proposes a solution of this problem.

The paper "Adaptive and Robust Following of 3D Paths by a Holonomic Manipulator", by Alicja Mazur and Mirela Kaczmarek, tackles the problem of following 3D paths by a holonomic serial manipulator with parametric or structural uncertainty in the dynamics model. The path to be followed is parameterized orthogonally to the Serret-Frenet frame which moves along the prescribed 3D curve. The theoretical considerations assume that the distance between the desired path and the one realised by the manipulator end-effector is non zero. The theory has been validated by simulation.

The paper "Parameter Identification of Space Manipulator's Flexible Joint", written by Mateusz Wojtunik, Fatina Liliana Basmadji, Grzegorz Granosik and Karol Seweryn, focuses on debris removal from Earth orbits by a manipulator attached to a satellite. Taking into account the number of satellites that have been launched, some of which have disintegrated, this research is of great practical value. To this end modelling and identification of satellite and manipulator dynamics is of utmost importance. As in the case of space manipulators their weight is crucial, so flexible designs are preferred. In the considered case flexible joint manipulator is analyzed. Both numerical simulations and those conducted in a microgravity experiments were used to validate the identification procedure.

All of the subjects of the papers composing this issue of JAMRIS, 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 derivation of its solution. We hope that this selection of papers will be useful both to researchers and practitioners involved in diverse aspects of robotics.

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