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*Editorial*

# Automation, Operation and Maintenance of Control and Communication Systems

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**Abstract:** The special issue is devoted to selected papers, which results of the research were presented during the XVIII Conference on Automation, Operation and Maintenance of Control and Communication Systems ASMOR 2022. The conference was conducted from the 12th to the 14th of October 2022 in Władysławowo, Poland. The scope of the conference is quite wide, focusing mainly on automation and exploitation aspects of the control and communications systems. Due to the specified scope of the Electronics, only the papers selected by the ASMOR Scientific Committee and the Electronics Editors were published after an extensive reviewing and revising process.

**Keywords:** automation of control systems; operation and maintenance of control systems; automation of communication systems; operation and maintenance of communication systems

## 1. Introduction

Autonomous control systems for air, land, surface and underwater objects have become increasingly popular. The articles presented in this special issue, titled "Automation, Operation and Maintenance of Control and Communication Systems", focus on the current developments in mechanics, energy supply, automation and control problems, especially for robotics and autonomous vehicles. The topics include the latest techniques, solutions, and their applications in various civilian and military fields. The issue presents four theoretical and experimental papers on automation and robotics, autonomous vehicles, mechatronic systems, and renewable energy, as well as the modelling and simulation of dynamic objects.

This Special Issue is dedicated to control and communication systems research, which results were presented during the XVIII Conference on Automation and Exploitation of Control and Communication Systems ASMOR 2022 (Figure 1). With their provision of safety and autonomy, they have become critical in various civilian and military operations. Recently, with this given role, they have generated substantial research investigation. This has resulted in significant progress in their automation and operation of sophisticated tasks using advanced algorithms, methods and state-of-the-art devices. The Special Issue is devoted to displaying noteworthy studies concerned with recent advancements in control and communication system technological aspects.

This Special Issue includes 13 original research papers that address advancements in automation, operation, and maintenance of control and communication systems and 1 review concerning a significant topic from the underwater robotics domain, i.e., obstacle detection and avoidance.

The papers report research and real applications covering topics including, but not limited to:

- Autonomous systems;
- Mechatronic systems;
- Telecommunication systems;
- Diagnostic and measurement systems;

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- Modeling and simulation of dynamic objects

The details of the papers are presented in the next section of the work.

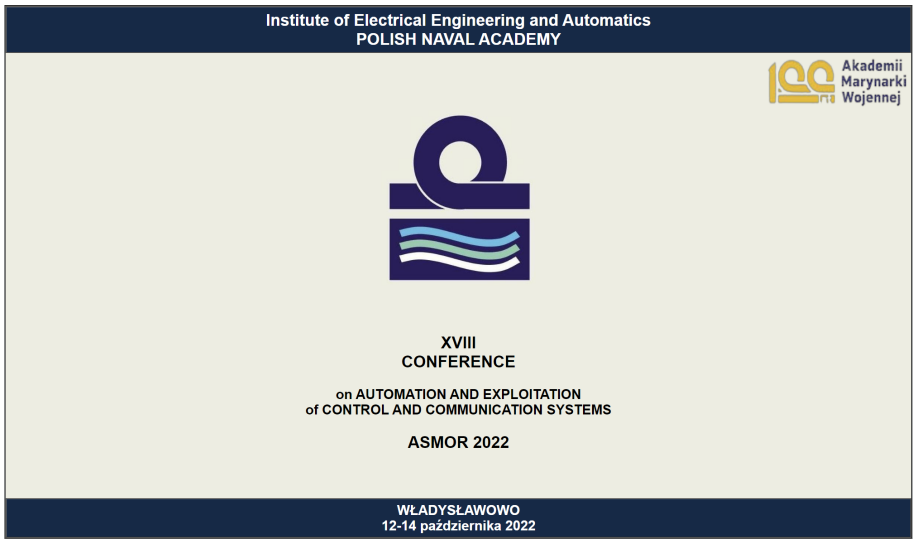


**Figure 1.** The details about the Automation and Exploitation of Control and Communication Systems 2022 conference (accessed on 10 July 2023): https://asmor.amw.gdynia.pl/.

## 2. Overview of Contributions

The first paper [1] entitled "Review of Collision Avoidance and Path Planning Algorithms Used in Autonomous Underwater Vehicles", considers the newest results of verifying collision-avoidance and path-planning algorithms in real applications together with a comparison of the difficulties encountered during simulations and their practical implementation. Analysing the last 20 years of AUV development, it can be seen that classical methods dominate experiments in a real environment. In the case of simulation studies, artificial intelligence (AI) methods are used as often as classical methods. In simulation studies, the APF approach is most often used among classical methods, whereas reinforcement learning and fuzzy logic methods are used among AI algorithms. The most used approach for real applications is reactive behaviours, and AI algorithms are rarely used in real implementations. This article provides a general summary, future works, and a discussion of the limitations that inhibit further development in this field.

The second paper [2] undertakes the problem of analyzing surfaces of non-stable, rapidly changing materials such as waxes or adhesive materials. NIR spectroscopy using a Digital Light Projection (DLP) spectrometer was used to obtain their characteristic spectra. Based on earlier experiences and the current state of the art, Artificial Neural Networks (ANNs) were used to process spectral sequences to proceed with an enormous value of spectra gathered during measurements.

The third paper [3] presents the novel concept of creating a 3D map based on the adaptive Monte-Carlo location (AMCL) and the extended Kalman filter (EKF). This approach is intended for inspection or rescue operations in a closed or isolated area with a risk to humans. The proposed solution uses particle filters and data from onboard sensors to estimate the local position of the robot. Its global position is determined through the Rao–Blackwellized technique. The developed system was implemented on a wheeled mobile robot equipped with a sensing system consisting of a laser scanner (LIDAR) and an inertial measurement unit (IMU) and was tested in the real conditions of an underground mine. One of the contributions of this work is to propose a low-complexity and low-cost solution to real-time 3D map creation.

The following paper [4] introduces a proposal for an Autonomous Navigation System for Unmanned Surface Vessels. A special emphasis is carried out on collision avoidance and manoeuvre auto-negotiation. For the purpose of manoeuvre auto-negotiation, the

concept of multi-agent systems has been applied. The algorithm developed for the task of collision avoidance is briefly described and the results of the simulation tests, confirming the effectiveness of the applied method, are also given. Presented outcomes include solutions of test scenarios from the perspectives of different ships taking part in the considered situations, confirming the applicability of the collision avoidance algorithm in the process of manoeuvre auto-negotiation.

The next paper [5] presents a neuro-evolutionary algorithm called Hill Climb Assembler Encoding (HCAE), which is a light variant of Hill Climb Modular Assembler Encoding (HCMAE). While HCMAE, as the name implies, is dedicated to modular neural networks, the target application of HCAE is to evolve small/mid-scale monolithic neural networks, which, despite the great success of deep architectures, are still in use, for example, in robotic systems. The paper analyses the influence of different mechanisms incorporated into HCAE on the effectiveness of evolved neural networks and compares it with several rival algorithms. The paper entitled "A Concept of Autonomous Multi-Agent Navigation System for Unmanned Surface Vessels" introduces a proposal for an Autonomous Navigation System for Unmanned Surface Vessels. The system architecture is presented with a special emphasis on collision avoidance and manoeuvre auto-negotiation. For manoeuvre auto-negotiation, the concept of multi-agent systems has been applied. Presented outcomes include solutions of test scenarios from the perspectives of different ships taking part in the considered situations, confirming the applicability of the collision avoidance algorithm in the process of manoeuvre auto-negotiation.

The paper devoted "LTE and NB-IoT Performance Estimation Based on Indicators Measured by the Radio Module" presents research results leading to the development of a decision algorithm, called Multilink—ML, dedicated to the presented device [6]. This algorithm enables the selection between LTE and NB-IoT interfaces for packet transmission without burdening the communication system with additional transmissions.

The paper [7] entitled "Selection of Robotic Machining Parameters with Pneumatic Feed Force Progression" concerns the robotic deburring of the V2500 diffuser's sharp edges. The paper's authors propose a procedure for carrying out work allowing for the selection of suboptimal process parameters. In the analyzed case, these parameters are the speed of movement of the characteristic point of the tool (TCP) and the tool/workpiece contact force. The proposed procedure for determining the parameters of the force and speed of movement allowed for indicating a set of parameters ensuring the product's performance by the requirements defined in the documentation.

The paper [8] presents an innovative approach to measuring, comparing the results with a pattern, sending the deviations to a neural decision-making system, selecting the forces and send the results to a robot controller for adaptive machining. The presented proprietary solution includes a data acquisition system, a neural decision-making system and a robot that carries out the machining process via force control. The proposed solution was verified on aviation components. During the process parameter optimization stage for the diffuser and ADT gearbox, the points describing the change in width of the chamfer being performed and the blade thickness in the control sections were approximated.

The next paper [9] is devoted to "Development of a Dedicated Application for Robots to Communicate with a Laser Tracker". It presents the concept of operation and methods of using laser trackers in robotics. The developed solution is based on the software development kit (SDK) provided by Leica and the Python language. The structure and functioning of the developed software were described in detail. The software meets the goals set at the beginning of the design process regarding online communication with the tracker and using the universal, popular TCP/IP standard. The functioning of the developed software was shown in the paper in a few examples related to manipulating robots and mobile robots. The capabilities of the developed software were described, as well as the planned work on its development.

In the paper "TCP Parameters Monitoring of Robotic Stations", one representative process is selected, namely machining performed with various tools by ABB robots [10].

For the robotic process to be controlled, it is necessary to compare the defined path with the speed profile. Then, the speed parameters can be controlled and corrected. The proposed approach allows for improving the quality of implemented robotic processes. It presents the available IT tools for station monitoring and how to use them. The proposed solutions' advantages and limitations are shown in the examples of the implementation of robotic stations in the industry.

The paper entitled "Quaternion Attitude Control System of Highly Maneuverable Aircraft" presents an extension to research on spacecraft attitude control [11]. The article extends existing concepts and applies them to the control problem of aircraft operating in Earth's atmosphere. The controller synthesis is described using quaternion algebra. The quaternion-based attitude controller is then compared with a classical Euler-based attitude controller. The methodology for comparison and performance evaluation of both controllers is described.

In the paper "Analysis of Impulse Responses Measured in Motion in a Towing Tank", the authors present the results of the measurements realized in a towing tank where the transmitter could move with a precisely set velocity and show that the analyzed channel was non-stationary, even during the time of the transmission of a single chirp signal [12]. The article presents an evaluation method of channel stationarity at the time of the chirp transmission, which should be treated as a novelty. There is also an analysis of the impulse responses measured in motion in a towing tank.

The paper [13] is focused on "Selection of the Depth Controller for the Biomimetic Underwater Vehicle". Its main aim is to select a depth controller for innovative biomimetic underwater vehicle drives. In optimizing depth controller settings, two classical controllers were used, i.e., the proportional–integral–derivative (PID) and the sliding mode controllers (SM). The parameters of the regulators' settings were obtained as a result of optimization by three methods of the selected quality indicators in terms of the properties of the control signal. The starting point for the analysis was simulations conducted in the MATLAB environment for the three optimization methods on three types of indicators for three different desired depth values. The article describes the methods and quality indicators in detail. The paper presents the results of the fitness function obtained during the optimization. Moreover, the time courses of the vehicle position relative to the desired depth, the side fin deflection angles, the calculated parameters of the control signals, and the observations and conclusions formulated in the research were presented.

This issue ends with the paper entitled "Dynamics of Separation of Unmanned Aerial Vehicles from the Magnetic Launcher Cart during Takeoff" [14] describing the process of modelling and analyzing the dynamical properties of a launch cart of an innovative prototype launcher, which employs a passive magnetic suspension with high-temperature superconductors, developed under the GABRIEL project. The developed mathematical model of the magnetic catapult cart was employed to conduct numerical studies of the longitudinal and lateral movement of the cart, as well as the configuration of the UAV–cart system during UAV takeoff under variable atmospheric conditions. An essential aspect of the research involved experimentally determining the magnetic levitation force generated by the superconductors as a function of the gap. The results obtained demonstrate that the analyzed catapult design enables safe UAV takeoff. External factors and potential vibrations resulting from uneven mass distribution in the UAV–cart system are effectively balanced by the magnetic forces arising from the Meissner effect and the flux pinning phenomenon. Compared to commercial catapults, the primary advantage of the magnetic levitation catapult lies in its ability to provide a reduced and consistent acceleration throughout the entire takeoff process.

## 3. Conclusions

The editors hope all readers of the papers published in this special issue will find that the authors' detailed and careful presentation of ideas, methods and results broadens their knowledge. We want to thank all the authors of the submitted papers and the reviewers who provided constructive comments and suggestions.

**Conflicts of Interest:** The authors declare no conflict of interest.

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