

Editorial

# Advances in Robotics and Mechatronics

Yukio Takeda <sup>1,\*</sup> , Giuseppe Carbone <sup>2</sup>  and Shaoping Bai <sup>3</sup> 

<sup>1</sup> Department of Mechanical Engineering, School of Engineering, Tokyo Institute of Technology, 2-12-1, Ookayama, Meguro-ku, Tokyo 152-8552, Japan

<sup>2</sup> Department of Mechanical, Energy and Management Engineering, University of Calabria, 87036 Rende, Italy; giuseppe.carbone@unical.it

<sup>3</sup> Department of Materials and Production, Aalborg University, Fib. 16, 9220 Aalborg, Denmark; shb@mp.aau.dk

\* Correspondence: takeda.y.aa@m.titech.ac.jp

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## 1. Introduction

Robotics and Mechatronics technologies have become essential for developing devices/machines to support human life and society. Examples include assistive devices for elderly and handicapped persons and cooperative robots for workers in factories and automation in unstructured environments, such as construction fields and farms. Several leading international researchers and engineers are addressing these trending topics also within several books and conference series such as reported in the recent publications [1–8]. Additionally, several journal special issues have been made recently available such as those reported in [9–16] with valuable insight on recent topics and achievements in this trendy and wide research field.

The International Federation for the Promotion of Mechanism and Machine Science (IFTToMM) has been very active in the field since its early beginning. IFTToMM was founded in 1969 with the aim to establish a scientific community in the wide field of Machines and Mechanisms. IFTToMM sponsored several activities including the IFTToMM World Congress, which is celebrated every four years with a broad coverage of all topics and disciplines on Mechanism and Machine Science. Within IFTToMM a specific Technical Committee (TC) has been established on Robotics and Mechatronics. Currently, prof. Giuseppe Carbone is the Chair of the IFTToMM TC on Robotics and Mechatronics and Prof. Shaoping Bai is the actual deputy Chair and Prof. Yukio Takeda the past TC chair for the term 2017–2019.

This Special Issue contains a selection of the best papers that were presented at the 15th IFTToMM (International Federation for the Promotion of Mechanism and Machine Science) World Congress, 30 June–4 July 2019, Krakow, Poland, on recent advances in Robotics and Mechatronics. It will present novel results and solutions. This journal Special Issue includes papers belonging to a broad range of topics such as kinematic analysis and synthesis, mechanism design, sensors and actuators, modelling and simulation, control issues, navigation and motion planning, applications of robots and mechatronics systems.

Handling and maneuvering tools across a robot workspace is a challenging task that often requires the implementation of constrained motion planning. In the case of wired or tethered tools, their maneuvering becomes considerably harder due to the tool cable. If the cable presence is not considered, the robot motions may make the cable become entangled with the robot arms or elements of its workspace, causing accidents or unnecessary strain on the robot and the tool. The first paper in this Special Issue introduces a constrained manipulation planner for dual-armed tethered tool manipulation involving tool re-grasping. The planner predicts the cable states during manipulation and restricts the robot motions in order to avoid cable entanglements and collisions while performing

tool re-posing tasks. Simulations and real-world experiments validated the presented method as reported in paper [17].

Paper [18] proposes a novel UGV (unmanned ground vehicle) for precision agriculture. In particular, the integration of a seven DOFs (degrees of freedom) manipulator and a mobile frame results in a reconfigurable workspace, which is open to samples collection and inspection in non-structured environments. Moreover, the proposed device mounts an orientable landing platform for drones which is made of solar panels, enabling multi-robot strategies and solar power storage, with a view to sustainable energy. In fact, the device will assume a central role in a more complex automated system for agriculture, that includes the use of UAV (unmanned aerial vehicle) and UGV for coordinated field monitoring and servicing. This paper collects all these elements and shows the advances of the previous works, describing the design process of the mechatronic system and showing the realization phase, whose outcome is the physical prototype.

The paper [19] deals with a collaborative robot, coupled with a new prismatic compliant joint (PCJ) at its end-effector. The proposed collaborative solution is intended for Doppler sonography to prevent musculoskeletal disorders issues. On one hand, the Doppler sonographer's postures are investigated based on motion capture use during the arteries examination. This study highlighted that configurations adopted by angiologists lead to the musculoskeletal disorder. On the other hand, the proposed PCJ with variable stiffness gives an intrinsic compliance to the cobot handling the probe. This feature allows preserving the human safety when both human and cobot share a common workspace. The effectiveness of the proposed solution is experimentally validated through a seven-DoF Franka Emika robot virtually coupled with the PCJ, during the execution of a trajectory performed during a Doppler ultrasound exam. The impact force criterion is considered as a safety performance index.

In paper [20], an investigation is presented that demonstrates the application of a new approach for enabling the reduction of liquid slosh by implementing optimized motion profiles over a continuous range of operating speeds. Liquid slosh occurs in the packaging process of beverages. Starting by creating a dynamic process model, optimal control theory is applied for calculating optimal motion profiles that minimize residual vibration. Subsequently, the difficulty of operating speed dependency of the herewith synthesized motion profiles is examined. An approach in which the optimal motion profiles are consolidated into a characteristic map of motion specifications, which can be executed by a programmable logic controller in real time, is discussed. Eventually, the success of this novel approach is demonstrated by the comparison with state-of-the-art motion profiles and conventional motion implementation.

The paper [21] proposes a classification of all non-isomorphic anatomies of an orthogonal metamorphic manipulator according to the topology of workspace considering cusps and nodes. Using symbolic algebra, a general kinematics polynomial equation is formulated, and the closed-form parametric solution of the inverse kinematics is obtained for the coming anatomies. The metamorphic design space was disjointed into eight distinct subspaces with the same number of cusps and nodes plotting the bifurcating and strict surfaces in a Cartesian coordinate system. In addition, several non-singular, smooth and continuous trajectories are simulated to show the importance of this classification.

Locomotion over different terrain types, whether flat or uneven, is very important for a wide range of service operations in robotics. Potential applications range from surveillance, rescue, or hospital assistance. Wheeled-legged hexapod robots have been designed to solve these locomotion tasks. Given the wide range of feasible operations, one of the key operation planning issues is related to the robot balancing during motion tasks. Usually this problem is related with the pose of the robot's center of mass, which can be addressed using different mathematical techniques. The paper [22] proposes a new practical technique for balancing wheeled-legged hexapod robots, where a Biodex Balance System model SD (for static and dynamic) is used to obtain the effective position of the center of mass,

thus it can be recalculated to its optimal position. Experimental tests are carried out to evaluate the effectiveness of this technique and modify and improve the position of hexapod robots' center of mass.

## 2. Final Remarks

This Special Issue contains valuable research works focused on advances in robotics, covering a wide area of applications. This collection shows the significant research interest in these topics with a high impact and potential for future developments. In addition to the topic coverage, this Special Issue included contributions from several countries including France, Germany, Greece, Italy, Japan, Mexico.

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