robotics

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Editorial

Advances in Mechanical Systems Dynamics

Giulio Rosati [1,*], Giovanni Boschetti [2] and Giuseppe Carbone [3]

1 Department of Industrial Engineering, University of Padova, 35131 Padova, Italy
2 Department of Management and Engineering, University of Padova, 36100 Vicenza, Italy; giovanni.boschetti@unipd.it
3 DIMEG, University of Calabria, 87036 Cosenza, Italy; giuseppe.carbone@unical.it
* Correspondence: giulio.rosati@unipd.it; Tel.: +39-049-827-6809

Received: 4 March 2020; Accepted: 5 March 2020; Published: 9 March 2020

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1. Introduction

Nowadays, robotics is developing at a much faster pace than ever in the past, both inside and outside industrial environments. Service robotics [1], surgical and rehabilitation robotics [2–4], assistive robotics, and other novel application fields are becoming more and more significant, not only from technological and economical viewpoints, but also in terms of their daily life and social implications. Even the implementation and role of robots in production lines and other traditional frames is being widely revised, towards novel flexible [5,6] and agile [7] manufacturing systems. Moreover, novel architectures such as cable robots [8], devices for handling of horticulture products [9] and other service robotics tasks are also being widely investigated. In this context, research on machine and robot mechanics, modelling, design, and control is going to play an increasingly central role, as outlined for example in [10].

This Special Issue aims at disseminating the latest research achievements, findings, and ideas in the robotics field, with particular attention to the Italian scenario. This Issue includes revised and substantially extended versions of selected papers that have been presented at IFIT2018, the 2nd International Conference of the italian branch of the International Federation for the Promotion of Mechanism and Machine Science (IFToMM ITALY). However, we have also strongly encouraged the submission of additional contributions from researchers working in this field who did not participate to the IFIT 2018 Conference, in order to further widen the field coverage.

2. Advances in Italian Robotics

This journal special issue includes papers belonging to a broad range of disciplines, such as robotic manipulation, variable stiffness actuation, mobile system, social robotics, optimization of robotic tasks, compliance property of robot, biomedical device, collaborative robotics, trajectory planning and wearable robotics.

In the first paper, the authors outline the influence of electric power quality on the performance of a robotic device. Namely, voltage dip effects are addressed from an experimental viewpoint by focusing on robotic grasping applications [11]. A specific case study is reported, by means of a three-fingered robotic hand. The main goal of paper [12] is to introduce an original two-DoFs planar variable-stiffness mechanism, characterized by an orthogonal arrangement of the actuation units to favor the isotropy. Such a device combines the concepts of a one-DoF agonist-antagonist variable-stiffness mechanism and the rigid planar parallel and orthogonal kinematics leading to an innovative solution. The authors of paper [13] present the modeling and the validation of a novel family of climbing robots that are capable of adhering to vertical surfaces by means of permanent magnetic elements. The robotic system is composed of two modules, the master and the follower carts, which are arranged in a sandwich configuration. Accordingly, the surface to be climbed is interposed between the master and follower modules. Palli and Pirozzi in [14] present a robotized cabling of switchgears with main focus at a gripper with tactile sensors for the wire manipulation. In particular, the developed gripper is experimentally tested to assess its success rate during wire manipulation.

A key challenge in the Human-Robot Interaction (HRI) field is to provide robots with cognitive and affective capabilities, by developing architectures that let them establish empathetic relationships with users. Nocentini et al. in [15] propose a survey of multiple models that have been proposed in the literature as referring to three key aspects. Namely, the development of adaptive behavioral models, the design of cognitive architectures, and the ability to establish empathy with the user. Another emerging technology for assistive robotics is reported in [16]. In particular, this paper addresses a low-cost mechanical design solution exploiting compliant actuation at the shoulder joint to increase safety in human-robot cooperation of an Industrial Exoskeleton for Advanced Human Empowering in Heavy Parts Manipulation Tasks. Authors of paper [17] address a specific industrial application on assembly kitting lines studying the subsystems that compose a hybrid flexible assembly workcell. In particular, the authors investigated the possibility and performance of replacing a conventional weighting device with a vision on inspection system. The paper [18] focuses at robot compliance modeling for achieving a compensation of small position and orientation errors of the end-effector as well as reducing chatter vibrations. In this paper, joint compliances of a serial six-joint industrial robot are identified with a novel modal method making use of specific modes of vibration dominated by the compliance of only one joint. Then, in order to represent the effect of the identified compliances on robot performance in an intuitive and geometric way, a novel kinematic method based on the concept of "Mozzi axis" of the end-effector is presented and discussed.

Menga and Chirardi propose a control of the sit-to-stand transfer of a biped robotic device [19]. The control has been synthesized analyzing the basic laws of dynamics by considering a two-phase dynamic setting, with an external force disturbance affecting the center of pressure under the feet. The paper objectives are threefold: identifying the major dynamical determinants of the exercise; sythesizing an automatic control for an autonomous device; proposing an innovative approach for the rehabilitation process with an exoskeleton. A similar approach is later developed as referring to a device for postural rehabilitation [20]. In paper [21], Martelli et al. propose an analysis of ankle mechanical properties for the design of an exoskeleton to be suitable for both adults and children. Experimental tests have carried out on 16 young adults and 10 children for the evaluation of ankle mechanical impedance and kinematic performance. Ankle impedance was measured by imposing stochastic torque perturbations in dorsi-plantarflexion and inversion-eversion directions. Kinematic performance was assessed by asking participants to perform a goal-directed task. Magnitude and anisotropy of impedance were computed using a multiple-input multiple-output system. These findings are considered for a proper development of robotic devices.

Over the last decade, the market has seen the introduction of a new category of robots—collaborative robots (or "cobots")—designed to physically interact with humans in a shared environment, without the typical barriers or protective cages used in traditional robotics systems. The paper [22] provides an overview of collaborative robotics towards manufacturing applications. In paper [23] Bottin and Rosati address the challenging problem of trajectory planning and optimization by considering a redundant serial robot and a set of Cartesian via points. The proposed method is based on a search of suboptimal paths as based on graph theory and the Dijkstra algorithm, allowing performing a reasonably wide search of the suboptimal path within a reasonable computation time. Malvezzi et al., in [24] address the topic of augmenting the human hand with robotic extra fingers for a compensatory and rehabilitation purposes on patients with upper limb impairments. The paper [25] outlines several solutions with one or two extra fingers. Underactuation and compliance are considered as design choices that can reduce the device complexity and weight, maintaining the adaptability to different grasped objects.

This Special Issue follows other two special issues that were published in the International Journal of Mechanics and Control, whose content is available at www.jomac.it. In particular, Marco Ceccarelli et al. have contributed a paper on a novel parallel mechanism for a biped robot leg application [25]. Paolo Gallina et al. introduced the concept of Anti-Hedonistic Machine (AHM), which is designed to "prevent people from doing something" [26]. Giulio Reina et al. reported a novel architecture of robotic hand designed for prosthesis purposes with under-actuation features [27]. A kinematic and quasi-static analysis of a class of Quick-Release hooks was presented by Luca Bruzzone et al. in [28]. Paolo Boscariol et al. introduce a novel design of an electromechanical clamp for portable ultrafiltration device [29]. Giovanni Boschetti et al. reported a novel failure recovery strategy for direct driven cable robots [30]. Francesco Biral et al. propose an analytical model for tractors having suspended front axle with a combination of a four-bar linkage mechanism and a hydraulic system [31]. Ilaria Palomba et al. report a technique for the reduction of nonlinear models of flexible-link multibody systems through an equivalent rigid-link system method [32]. A novel design of a human powered press for straw bale construction is proposed by Giuseppe Quaglia et al. as optimized for underserved communities [33]. Francesco Timpone et al. proposed a method for on-line estimation of tyre/road friction forces by considering various road conditions [34]. Sforza et al. presented a literature overview on electric vehicles with independent drivetrains [35]. Giannoccaro et al. presented control aspects for an active suspension system [36] while paper [37] deals with the modelling and simulation of vehicle lateral dynamic behavior. Aspragkathos et al. presented a control strategy for robots with flexible beams [38], while paper [39] provides insight on the energy efficiency of a parallel manipulator when considering compliant elements. Finally, paper [40] addresses the application of robots for surgical craniotomy operations.

3. Final Remarks

This Special Issue contains valuable research works focused at advances in robotics, covering a wide area of application areas. This collection shows the high research interest in these topics with high impact and potential for future developments.

Author Contributions: Conceptualization, G.R., G.B., G.C.; writing—original draft preparation, G.R., G.B., G.C.; writing—review and editing, G.R., G.B., G.C.; supervision, G.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

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

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