Robotics and Automation Technologies in Construction

Special robots and automation technology have the potential to increase productivity by performing tasks efficiently and improving working conditions through applications that limit the exposure of humans to safety hazards. Construction is a diverse industry characterised by almost unique circumstances for each project and a dynamic unstructured environment, with safety hazards, temporary activities and changing weather conditions, which all together hold back greater automation. This explains why there are few industrial robots to be found in the construction sector. However, recent years have seen an increase in the development of special robot and automated machines that carry out complex sequences of operations in the construction sector with certain impact. Examples of these special robots include wall (façade) climbing robots for inspection and maintenance, concrete power floating machines, concrete floor surface finishing robots, construction steel frame welding robots, wall panels’ bricklaying robots, robotic excavators and automated cranes for the assembly of modular construction elements.

Other advances in the automation in construction have been reported on the software side where IT applications have been developed, to increase the safety standards of the construction site, to assist in better planning and execution of projects, to automate the buildings’ design process, to visualize the community projects using immersive 3D VR techniques and to monitor and control the parts and materials flow (through tags and RFID) of the entire construction process.

Research activities in the field of robotics and automation in the construction industry are divided according to applications into two large groups: civil infrastructure and house building. Typical civil infrastructure applications are the automation of road, tunnel, and bridge construction; earthwork; etc. In the field of house construction, main applications include building skeleton erection and assembly, concrete compaction, interior finishing process, etc. Classification according to applications is consistent with other possible classifications, which divide R&D activities according to the development of new equipment and processes (robots, automatic systems, IT application, etc.) or the adaptation of existing machinery to transform them into robotic systems.

The intention of the guest editors is to include a variety of papers to cover different aspects of the above mentioned classification. This special issue includes 10 papers in 3 groups. Overall, the papers cover the development of complete robotic solutions to construction problems, planning of the assembly of modular construction elements, external cleaning robots, painting robot solutions and IT solutions.

The first and largest group covers the development of robotic solutions. The paper entitled “Development of a Multi-Arm Mobile Robot for Nuclear Decommissioning Tasks” by M. Bakari et al describes a civil engineering solution consisting in a two-arm mobile delivery platform for application in the nuclear decommissioning tasks. The development and integration of the proposed dexterous system is described in the paper. The second paper: “Set up of an automated multi-colour system for interior wall painting” by B. Naticchia et al. describes the development of a robotic multicolour interior painting system which has been tested successfully. The following paper by Young S. Kim et al presents a conceptual design and feasibility analyses of a robotic system for automated exterior wall painting, which is applicable to high rise apartment buildings. In their design concept they present the high ladder truck as the best alternative for automation of the exterior wall painting. The paper entitled “Development of a Wearable Robot for Assisting Carpentry Workers” by Junpei Naito et al. describes the development of an assisting wearable apparatus to help the carpentry worker in lifting heavy objects in order to reduce the muscular fatigue and provide a suitable assistive force. The next paper of this group entitled “Mechanical Design and Dynamics of an Autonomous Climbing Robot for Elliptic Half shell Cleaning” by H. Zhang et al. is dedicated to the description of the development of an external cleaning robot to be used in particular building. The last paper of this group by Wahyudi presents a control strategy for a gantry crane, which can be applied to larger contraction cranes.

The second set of papers deals with research related to planning and coordination. The first paper entitled “AUTMOD3: The Integration of Design and Planning Tools for Automatic Modular Construction” by R. Diez et al presents a software environment tool for the planning of the assembly of modular building elements by automatic or semi automatic constructions cranes. The tool is part of a larger package, which seamlessly integrates architectural design, planning and simulation tools in a well-known CAD program commonly used by designers. The following paper by N. M. Kwok et al proposes the use of the particle swarm optimization (PSO) algorithm in deriving drive commands, speed and turning, for construction vehicles such that they are steered into and maintained in desirable formations according to an assigned task.
The third group includes 2 papers of IT applications. The first entitled “An Augmented Framework for Practical Development of Construction Robots” by K. Zied proposes a framework for the development of construction robots and apply the to the Starlifter robotic system which is mainly designed to carry heavy tools for construction tasks. The proposed framework consists of a feasibility analysis model and a development process model. The last paper of this special issue is dedicated to the use of the Augmented Reality to plan the virtual construction worksite. The author X. Wang discusses the related AR work and issues in construction and describes the concept and prototype of an AR-based construction planning tool.

Finally, the guest editor would like to thank the editors, the authors and the reviewers and appreciate their effort for making this issue possible.

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