GUEST EDITORIAL PREFACE

Special Issue on Architectural Design of Advanced Swarm Robotics Systems, Part 2

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Robotics systems and corresponding design and development have played an increasingly important role in robotics research in general multiple disciplinary both academic and industry. Numerous emerging novel and challenge research areas present the cutting edge studies and integrated methods, including artificial intelligence, formal methods, software engineering, data mining, cyber security that range from hardware design, firmware development, to the human robot interaction, human behavior, psychology, and so on. Yet, no systematic design of individual and swarm robotics architectures has been performed; establishing a comprehensive list of design criteria targeted at robotics applications is desirable that can subsequently be used to compare their strengths and weaknesses. Moreover, there are no practical architectures of the usability and application of a large scale complex robotics systems that provide precise and accurate selection for researchers most suited to their needs, nor uniform middleware supports for researchers for future development.

This issue addresses the above concerns under a broad phenomenon that connects the hardware design, firmware realization, system reliability and other main challenge issues of autonomous robotics systems by selecting nine cutting edge research work in various areas. The selected works sees the growth of robotics architecture design by considering a combination of trusted system in using formal methods and computational science approach so that readers are exposed to two dimensions with a collaborative point of view of robotics design from software to hardware.

One of the most important issues of autonomous robotics system architecture is reliability, which resulted from correctness and robustness. As the nonfunctionalities are hard to address in the complex robotics systems, this issue presented a diverse overview of novel research efforts of this area.

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The first article provides valuable input from an educational point of view using a game based approach with project based learning method for multiple discipline curriculum design. The platform presented has been used in the past three years at Politecnico di Torino and experimented in challenging students with a complex goal that can be achieved only by combining multidisciplinary know-how and teamwork that takes inspiration from similar experiences. This approach is implemented on a robot platform Freescale Cup, which is a worldwide competition to develop autonomously race vehicle able to run on an unknown track. This study stresses the necessity of developing processes between private and public sectors, claims that both private and public organizations can enjoy from procurement of progressive and economical public services. Thus, it offers valuable results and suggestions for directing the current professional efforts toward optimization of information trends and avoiding redundancy in the interaction between the market and government.

The second article, referring to the runtime verification of robotics systems, an area of firmware verification that rarely touched by runtime verification, presented a strategic framework of trusted and high confidence software intensive systems that applied formal method based runtime verification on robotics systems. Runtime verification is a technique for generating monitors from formal specification of expected behaviors for the underlying system. It can be applied to automatically evaluate system execution, either on-line or off-line, analyzing extracted execution traces; or it can be used online during operation, potentially steering the application back to a safety region if a property is violated. The framework proposed has included the logic based monitor generation, waive the monitors script to the firmware, and execute the runtime checker on the device. From the literature review, there is few discussion that covers this topic. The study was validated in a nontrivial case study of the LEGO mindstorm platform. In this regard, this work article maybe the first work that devoted to provision of a trusted strategic framework using runtime verification on the robotics systems.

The third article, considering the reconfiguration of robotics systems, presented a high level architecture model based on the PrT nets and component development approach. Autonomous robotics systems (ARSs) consist of multiple heterogeneous objects and intelligent inferences that are expected to take appropriate actions even in unforeseen circumstances. Dynamic reconfiguration of ARSs is a key enabling technology and plays a major role in the future cyber-enabled battle field. This research work, focused on the development of a formal approach to the specification and verification of reconfigurability of ARSs. Two typical problems w.r.t. the dynamic adaptation and reconfiguration of ARSs were identified and studied. The first problem is how to formally represent the ARSs and describe the reconfigurable behavior precisely so that the ARSs can adapt to the new changes. The second problem focuses on how to analyze and verify the formal model of the reconfiguration and ensure the correctness of the system during reconfiguration. Considering behavior preserving in the reconfiguration model, a net reconfigurations based on the natural transformation is introduced.

The last article discussed a video based tracking approach to the robotics systems. In this article, the authors describe a video localization system for swarm robotics using video and depth information provided by a Microsoft Kinect camera. To enable simple robot tracking, the robots are assumed to be circular shaped or are composed of circular shapes so that circle detection algorithms may be used such as those relying on the Hough transform. When viewed from above, many modern swarm robots are circular or composed of circles, such as helicopters, quadcopters, hexacopters, etc. and the iRobot Create. To exploit these circular shapes for use with circle detection, the camera is ceiling mounted and orthogonally facing the ground.

Little-to-no calibration is required for the system, unlike calibration required with multi-camera motion capture systems, and the system is orders of magnitude less expensive than such multi-camera systems. Localization results for the Parrot AR Drone quadcopter are presented.stresses the necessity of strategic approaches for providing infrastructures and structural requirements appropriate for the future world.

CONCLUSION

In sum, we believe that the increase in capability of robotic architecture design and applications will soon require extensive and strategic process and infrastructure support, with expanding development of support for formal methods and autonomic computing in the future. The trusted and high confidence properties of such systems will be highly desirable and expected. Tools and techniques will be needed based on the presented approach, esp formal methods, that will be used not only for the development and debugging of robotic architectures, but also for the execution and maintenance of robotic architectures as part of application deployment. The development choice of robotics systems will be based on more than just the design strategies and approaches that support offered, but increasingly on the features it provides for the long-term operation of robotic applications. Furthermore, and perhaps more significantly, the integration of system infrastructure with the development of intelligent robotic architectures will lead to robots that display ever greater levels of autonomy.

Such discussions with great diversity and a broad scope have caused an international dialogue that merges the boundaries of academic and industry, government and civil in an interdisciplinary and multidisciplinary arena. A broad and expansive set of knowledge, skills, techniques, and approaches for workforce will be highly needed. In this sense, educational design and curriculum development can be an alternative view of robotics system study.

Achieving the above goal of robotics design in both individual and groups requires much more efforts in the technology of computer science and engineering as well as educational strategies. More collaborative studies and beyond will be desired due to the complex of swarm and individual robots and human behavior and intelligence simulation. It is one of the grand challenge of the era in the information technology and today's social life due to high benefits of swarm robots.

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