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Editorial

Cognitive Robotics and Control

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1. Introduction

Robotics and control are both research and application domains that have been frequently engineered with the use of interdisciplinary approaches like cybernetics [1]. Cognition is a particular concept of this approach, abstracted from the context of living organisms to that of artificial devices, about knowledge acquisition and understanding through thought, experience, and the senses [2]. Cognitive robotics and control refer to knowledge processing as much as knowledge generation from problem understanding, leading to special forms of architectures enabling systems to behave in an autonomous way [3–5].

The main aim of this special issue is to highlight emerging applications and address recent breakthroughs in the domain of cognitive robotics and control and related areas. Procedures, algorithms, architectures and implementations for reasoning, problem solving or decision making in the domain of robotics and control are elements under consideration.

2. The Present Issue

This special issue consists of eight papers covering important topics in the field of cognitive robotics and control, including robotic platforms in interactive scenarios such as operating rooms, trajectories learning and optimisation from nature-inspired and computational cognition approaches, and hardware developments for motor control. The contents of these papers are introduced here.

Robotic platforms are taking their place in the operating room, providing stability and accuracy during surgery. Most of these platforms are tele-operated, as in Reference [6], where the learning from demonstration (LfD) approach is extended for object tele-manipulation. The method is experimentally verified in a tele-operated task using a lightweight robot remotely controlled with a haptic device. In the same domain, research is also being carried out to design collaborative platforms, reducing surgeon workload. The automation of auxiliary tasks would benefit both surgeons and patients by facilitating the surgery and reducing the operation time. A novel autonomous camera guidance approach for laparoscopic surgery is proposed in Reference [7], using LfD as well as being validated using an experimental surgical robotic platform. Moving forward, an important step towards a more natural and user-friendly manner of physical human-robot interaction in scenarios where humans and robots collaborate in the accomplishment of a task is presented in Reference [8]. A robotic system is introduced that is able to identify different humans' intentions and to adapt its behaviour consequently, only employing force data.

Nature-inspired solutions, like particle swarm optimisation (PSO) and artificial bee colony (ABC), are employed in Reference [9] as meta-heuristic optimisation techniques to tune a proportional-integral-derivative (PID) controller for an upper limb rehabilitation robotic arm exoskeleton RAX-1. In a different way, computational solutions are based on ontologies and knowledge representation. Aiming to represent the knowledge in robot task planning, the Robot Task Planning Ontology (RTPO) is first designed and implemented in Reference [10], so that robots can understand and know how to carry out task planning to reach the goal state. Experimental results demonstrate good performance in scalability and responsiveness. In Reference [11], the authors focus on the challenging problem of trajectory optimisation for an automatic spraying robot. Using the Bézier surface approach, an automatic solution is provided in the form of an initial trajectory, establishing the appropriate spraying model, planing the appropriate space path, and finally planing the trajectory optimisation along the specified painting path.

Field-Programmable Gate Arrays (FPGA) are considered in Reference [12] as a balanced approach to develop computing in technological low-cost applications empowered with the flexibility of software and the high-speed operation of hardware. A robotics application to control an inverted pendulum robot is designed, built, and programmed using open FPGA tools. In Reference [13], the rate of change in acceleration value is used to develop an S-curve velocity profile for motion control, which presents smoother movements to avoid high stress in the motor than in the trapezoidal velocity profile. The new methodology is developed applying an open source architecture in a hybrid electronic platform compounded by a system on a chip (SoC) Raspberry Pi 3 and a FPGA.

3. Future Research

Socio-technical system (STSs) are those considering requirements spanning hardware, software, personal, and community aspects [14–16]. Some examples were shown in our special issue, from operating rooms and exoskeletons to industrial robots for automatic spraying and motion control using edge computing. In this kind of environment, assistance to skilled users (workers, health professionals, impaired people) becomes crucial. Beyond ergonomic or safety issues, new qualification and technical competences with regard to users are needed. Hence, a hot topic of research activity to look at in the near future for robotics and control is to consider the cognitive or social dimension, by the development of computational agents, robots or electronic devices in the edge designed for increasing efficiency and effectiveness in the environment and global organisation [17].

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