Part III
Intelligent Robotics

Part III Overview

Traditionally, industrial robots have been developed to perform repetitive tasks in a structured environment, which means that the task is clearly and precisely known by the robots, no variables exist so that it is fully predictable and the consequences of the robot action are predictable too. However, the development and emergence of Industry 4.0 technologies, such as Internet of Things, Big Data, Cloud Computing and Artificial Intelligence, is enabling the emergence of a new generation of robotics. Intelligent and autonomous robots will achieve a significant breakthrough in future manufacturing. Smart factories will cause a wide range of changes to industrial production and productivity. The interconnectivity of intelligent machines and facility components leads to a flexible, reconfigurable and fully automatic production line. The incoming orders are processed by a machine, which defines the production process, orders the materials, which are handled by robots, as well the final product and the shipping. In such an interconnected environment, robots monitor their own health so that predictive and self maintenance is possible, reducing the downtime and increasing efficiency and productivity. The role of humans will be to supervise the correct operation.

Although there is huge opportunity, it is still challenging to achieve due to the implementation issues of Industry 4.0 technologies. Indeed, even though the level of the I4.0 enabling technologies is already quite high, their adoption is hindered by the complexity of the concept and the lack of detailed roadmaps, strategic guidance and implementation advice, together with the large investment which can be required.

In this context the final three chapters of this book present some insight into the potentiality of Industry 4.0 in robotics, providing basic and advanced knowledge on robotic systems and their applications in digital manufacturing. Chapter 7 considers robots generally, describing the different types of robots which currently exist, introducing common robot terminology, discussing robot applications and introducing innovative concepts on collaborative robots, human-robot collaboration and mobile robots. The subsequent chapters then consider the different elements which comprise a robot and discuss their development in the context of digital manufacturing. Chapter 8 considers one of the key elements of intelligent robotics, the hardware element, which has been developed in the past few decades and

provides solid foundations for the smart factory. Basic and advanced principles of sensing and actuation in robots are discussed as the link between physical and cyber world. The chapter then discusses microrobotics, which introduces a core element of Industry 4.0: Cyber Physical Systems. Chapter 9 then considers the software, or cyber, elements which are essential to enabling the new generation of intelligent robots. It explains what a Cyber Physical System is and how it applies in the production environment, stressing the benefit and challenges of collaborative systems. This chapter also explains the different ways of programming a robot and the principals of robot control. Following this, Artificial Intelligence – an essential element to enabling intelligent robots – is discussed. The chapter, and this book, conclude with a brief overview on the ethical issues related to intelligence implemented in machines.

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