IT and Mechatronics in Industrial Robotic Workcell Design and Operation

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INTRODUCTION

An industrial robot is defined as "an automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes which may be either fixed in place or mobile in use in industrial automation applications" (Robotic Industries Association, 1998). The Robotic Industries Association (RIA) definition stresses the automatic control and reprogramming capabilities of industrial robots that exclude the special-purpose "hard automation" devices and equipment as well as the manually guided remote manipulators found in constructions and dangerous environments. In addition, the mobility is stressed to include the Autonomously Guided Vehicles (AGVs) used for material handling and transportation in production lines, which are not considered in this article.

The aim of industrial automation is to replace or assist workers in tasks that are difficult, dull, dangerous or, unhealthy and simultaneously to reduce the labor cost, improve the product quality and reduce the material waste. Robots are the main components of the contemporary industrial automation and are considered as the most representative mechatronic devices. Robots can be programmed, controlled and used locally in an independent manufacturing cell, or integrated in (controlled by a coordinating computer).

However, their advanced capabilities could be mostly exploited in flexible and agile manufacturing environment, since the integration is high, operating under commands by higher levels of control, and the intervention of humans is minimized. Recent developments in modular and metamorphic robots enhance the Reconfigurable Manufacturing System (RMS) paradigm that aims at achieving cost-effective and rapid system changes adapting to the production requirements and low lifecycle of products. (Chen, 2001; Aspragathos, 2005; ElMaraghy, 2006).

This article is organized as follows. It continues with the industrial robotics technology overview presenting the robot components as well as their control systems. The software for planning, control and robot programming, as well as the design process of robotic workcells are presented. Concluding remarks are finalizing this article.

ROBOTS TECHNOLOGY OVERVIEW

In this section, the industrial robot technology is presented with particular attention to the software and control. The industrial robots are highly integrated and highly-sophisticated mechatronic machines so their development and operation involve the synergetic integration of mechanical, electronics, control and software science and technology. In Figure 2 three cycles and their mutual sections representing the areas of synergy between the experts of the corresponding disciplines is shown, so the robot design and application requires a mechatronics approach, (Hewit, 1996). The collaboration of experts from all the disciplines is stronger in the development of low-level control however the development of robots requires a close collaboration from the beginning of the design process.

In the following, the main hardware and software components of industrial robots are presented along with the relative science and technology for the development of them. In addition, the levels of the hierarchical control systems enabling the industrial robot flexibility and agility are discussed.

DOI: 10.4018/978-1-4666-5888-2.ch652

Figure 1. A flexible manufacturing system for food packaging

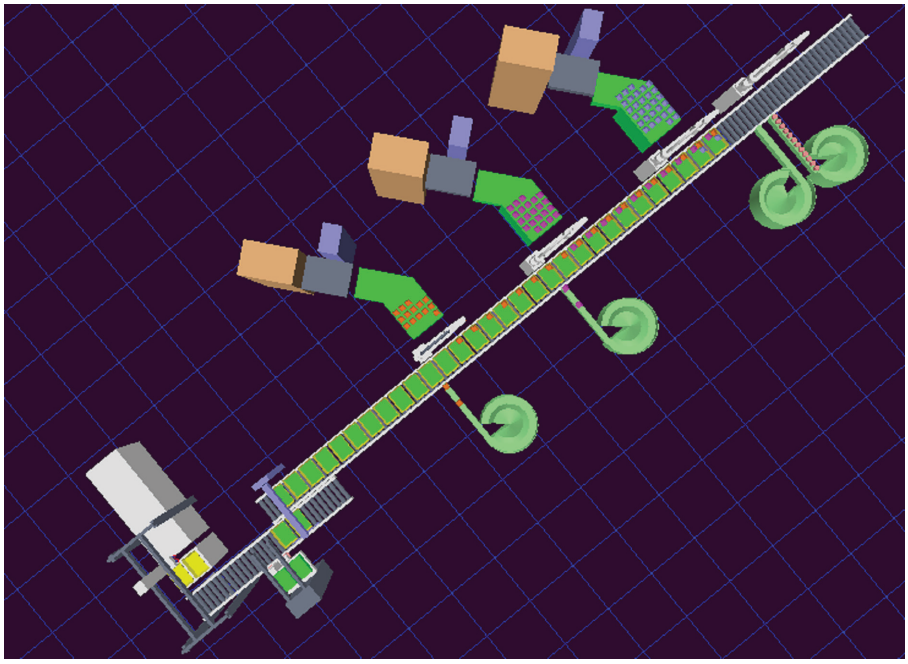

Figure 2. Synergy of robot subsystems