Industrial Robot

Introduction

The term industrial robot is defined, by ISO, as an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes [1]. It is the technology that currently motorizes the automation system of manufacturing process. The worldwide demand for industrial robot has increased in the last decade, as labor cost increases while industrial robot price decreases. The purpose of this paper is to review the latest trend in industrial robot application and to briefly introduce the technology behind it.

Commercial Application

In manufacturing, six axes articulated industrial robots are largely incorporated for applications such as welding, assembly, handling, packaging, machining, packaging, cutting, measurements, etc. This type of robot has six degrees of freedoms. Therefore it has relatively flexible movement, and is suitable for almost all types of application. The majority of installations of industrial robot are in the motor vehicle sector. As of 2008, this sector has a density of 2 robots per 10 workers [2], nearly doubles the density in 2007. Several other sectors that significantly use industrial robots are chemical, rubber, and plastic industry, electrical and electronic machinery, and metal products.

An example of a six axis articulated industrial robot is the KR 30 series by KUKA Robotics. This robot is primarily designed for handling and assembly purposes. However, due to its capability to perform complex movement, BMW recently incorporated this robot to sew leather covers for seat squabs and seat backs for their new 7 Series car [3].

Technology

Kinematically, six axes articulated industrial robot can be broken down into two main parts: the arm and the wrist. The arm needs at least 3 degrees of freedom to allow positioning of the end effectors anywhere in 3D space within its reachable workspace [4]. In addition, the wrist needs three axes (each joint axis is orthogonal to the others) to allow the end effectors to point towards any direction within the reachable workspace [4].
Assuming the joint angles are known, the position and orientation of the end effectors are evaluated using the forward kinematics formulation. From there, given the final position and orientation of the end effectors, the possible final joint angles can be calculated using inverse kinematics. It is also important to map the velocity of the joint angles to the velocity of the end effectors. This task can be done using the manipulator Jacobian [5].

In order to control the manipulator to move smoothly, each joint is moved as specified by a smooth function of time. Normally each joint starts and ends at the same time, so that the motion appears coordinated. This motion function is calculated using the trajectory generation algorithm. This technique uses intermediate points in between the initial and final positions. More intermediate points result in smoother movement [5].

**Implementation**

Implementation of an industrial robot system needs the robot itself and a robot controller. The robot controller is needed to do the positioning, motion control, and programming the robot [5]. It receives signals from the robot sensors, figures out its current state, plans the next movement, and sends signals back to the robot actuator. Most robot controllers available in the market are compatible with Windows based PC. They can be pre-programmed to do certain job multiple times (offline control), or they can be controlled in real time (online control).


