8

Design and Implementation of Mechatronic System

After reading this chapter the reader will:

1. master the design and real time implementation of mechatronic systems
2. be able to perform the different phases of the design of mechatronic system
3. be able to solve the control problem and establish the control law that we have to implement in real time
4. be able to write programs in C language using the interrupt concept for real time implementation

8.1 Introduction

In the last chapters we developed theoretical concepts and it is now time to pass to action and show how these concepts apply for real systems and how we can implement them in real time. This chapter deals with the design and the real-time implementation of algorithms for mechatronic systems. The design process consists
of creating the physical mechatronic system and once this system is designed the next step consists of implementing the intelligence we want to give the system. The two phases are not independent and care should be paid during the execution of these two phases. In either the design or the implementation, specifications must be stated first and the request task is done in order to satisfy these restrictions.

The design consists in some sense of creating the mechatronic system with all its components, mechanical part, sensors, actuators, electronic circuit, etc. The mechanical part can either be manufactured in house or assembled from existing parts in the marketplace, meanwhile the other components, actuators, sensors, electronic parts are selected with precaution and assembled in an electronic circuit that will be the brain of the mechatronic system once the control algorithm is implemented.

The implementation consists of building a real-time control system which requires itself two stages that are the controller design and its digital implementation. At controller design stage, some specifications are firstly formulated and a controller that can satisfy these performances is designed. The controller can be designed using one of the methods developed earlier. At the implementation phase, the recurrent equation of the controller is implemented in real-time. Care should be paid during the implementation to minimize computation errors and delays that may cause instability of the whole system. The implementation is mainly based on interrupts and uses information from the used sensors to generate the actions that the microcontroller should send to the different actuators.

In the rest of this chapter we will cover these concepts and give an idea to the reader on how these concepts work in practice. In Section 2, the design phase is developed and some design techniques are presented. Section 3 covers the electronic design. In Section 4, the software design and real-time implementation are tackled. Section 5 treats the design and implementation based on the transfer function while the Section 6 covers the one based on state space representation. Numerical examples are used in all the chapter to give an idea to the reader.

### 8.2 Design Phase

As we said earlier the design is the philosophy by which the mechatronic system is created. This phase starts in general from a vague idea that can be improved to produce the desired system. The design can start by a desire to build a system that can perform a task. In general, the design phase is done by a group of persons that own some experience in the field. The success of the project requires that the group of persons follows a certain number of steps to attain the goal. Most of the steps that are mostly used are:

- define the project and its planning
- identify customers and their needs