CHAPTER 4
THE MICROCOMPUTERS: HARDWARE AND SOFTWARE

4.1 Introduction
The implementation of a more complex digital controller is normally made with the assistance of a development system or a real-time operating system. Typically, an interactive dialog program is responsible for the establishment of controller parameters and structures, and it is necessary in order to test different controllers and to evaluate their performance and behaviour. The digital controller itself is programmed in the form of a real-time program. Algebraic and logic operations necessary for the control algorithm, as well as measurement of plant signals and the computation of control signals are the principal task of the real-time program. This program is usually scheduled at constant time intervals (the sampling time) and has high priority. The dialog program, which has low priority, is executed only at times, when the real time program does not use the CPU. These two programs share some variables, that make the dialog effective.

The realization of this scheme is often done with a single CPU under the control of a real-time operating system, that administers the usage of the CPU and its peripherals. The 16-bit microcomputer system available for the purpose of this investigation is based on a standard PC, which is not well suited for operation in an industrial control environment. Furthermore, the use of a general purpose real-time operating system for the control of the DC-motor has two significant disadvantages:

- The small sampling time in comparison with the computation time, that is necessary for the proposed control schemes, does not allow the CPU to be involved with operating system tasks.
The interval timer, the interrupt controller, the parallel interface and the other peripherals necessary for the motor control have, normally under a general purpose operating system, already established tasks.

Therefore, the first step towards the realization of the controllers proposed here was to add a single-board-computer (SBC) computational system (Fig. 4.1). The first 8086/8087 SBC used in this project was based on the MULTIBUS I and was a product of the firm Matrox furnished with Intel components (Matrox, 1984). Also in the following prototypes the hardware was based on similar components but a simpler and cheaper bus system technology was used, which will be described in the next section together with the development system.

4.2 The Development System and the Single Board Computer

4.2.1 The Basic Concept

As stated in the introduction of this chapter, the use of a standard PC-based real-time system was not taken into consideration for the semi-industrial implementation of adaptive control for thyristor-fed DC-motors. Instead, a solution based on a standalone microprocessor system specialized for this control task was chosen. This meant also that in the beginning of the project no software was available to support the implementation. A development system was necessary to do the actual programming, including editing, compiling and linking of the control software. Existing development systems were found to be expensive or not appropriate for the programming in a mix of high and low level languages. The approach actually carried out in this project was the development of software with standard tools of the MSDOS/PCDOS operating system. These tools comprise the standard assembler, compiler and linker programs available for this system.

The complete system for development and application of adaptive control is depicted graphically in Fig. 4.1. A logic analyser can be connected to a maintenance port of the controller to monitor the status of the hardware and software. This is of importance for measuring the computation time of several tasks without interfering with the internal operation of the microcomputer, which would be the case if this would be done exclusively by SBC operating system software. A PC is connected by a serial communication line, which allows interactive supervision and operation of the control software by an intelligent terminal. The additional parallel connection can be used for fast download and upload of data in the development of control programs, or for the task of data recording and