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A new approach for teaching microcontroller courses to undergraduate students

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Abstract

The microprocessors and microcontrollers are playing an extremely important role in a wide range of engineering applications. Nearly all intelligent electronic devices nowadays use one or more microprocessor or microcontroller chips. Microprocessor courses are currently taught by electrical engineering departments of all universities in the world. The classical method of teaching such courses is largely based on theory and little practical sessions. In this paper, a new approach is proposed for the teaching of microprocessor and microcontroller courses. This new approach enables students to learn the practical use of microprocessors and microcontrollers from a practical point of view.

Keywords: Microprocessors, microcontrollers, teaching microcontrollers, undergraduate engineering teaching;

1. Introduction

Microprocessors have been around for several decades. Many control and monitoring problems were previously solved using microprocessors. A microprocessor is the brain of a computer, consisting of the Control Unit (CU) and the Arithmetic and Logic Unit (ALU). A microprocessor on its own is not useful and several support chips are needed to build a working computer. As a result, many large chips were put together and considerably large power supply was required to power the resulting computer. The cost of the overall system was considerably high and maintenance was a big problem because of the large number of interconnections and the requirement for a large Printed Circuit Board (PCB) area.

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The increased use and the importance of microprocessors have led to the appearance of microcontroller chips. A microcontroller is also known as a single-chip computer and it is manufactured by combining the basic microprocessor and the peripheral modules inside a single chip. Today, a complete computer can be built using only a handful of chips, such as a microcontroller, and some interface chips, such as keyboard, display, switches, etc.

Because of the complexity and the high cost of microprocessor systems, most universities and technical colleges have removed microprocessor teaching from their curriculum, and have replaced them with more powerful and much lower cost microcontrollers.

Traditionally, microprocessor and microcontroller courses have been taught by concentrating mainly on the architecture and programming of these devices, with very little exposure to their practical applications, Mayer *et al* (1995). For example, in a typical 3 month, one semester microprocessor course, the first month is spent teaching the hardware architecture and the peripherals of the target device, about 6 weeks is spent on teaching the assembly language programming of the target microprocessor, and only a few weeks is spent teaching the practical aspects of these very important devices, Hanson (1981).

Microprocessor and microcontroller teaching is a one semester compulsory course for undergraduate engineering students at the Near East University. Both electrical and electronic engineering students and computer engineering students take this course in their third years. The course have traditionally been taught using the classical methods where much of the emphasis has been given to the theory with little practical sessions.

In this paper, a new teaching method is proposed for teaching microcontroller courses to engineering students where the emphasis has been placed on problem solving rather than the theory. The paper describes the features of the proposed method. The results of a survey carried out at the department of computer engineering at the Near East University.

2. The proposed approach

The traditional method of teaching the microcontroller courses has many problems associated with it. In such a teaching environment, much of the teaching is based on the architecture and teaching the assembly language of the target device, Schultz (1991). Students memorise the assembly language mnemonics and learn their use in very simple applications, such as carrying out simple arithmetic operations, or bit manipulation operations. Towards the end of the semester they may have the opportunity to either write simple programs using the software simulators, or using the target microcontroller hardware. Most applications will be very simple, such as flashing some LEDs connected to the output ports of the microcontroller, or responding to some push-button switches.

Microcontroller development boards (or kits) are used in most engineering teaching laboratories. Some institutions design and build their own development boards, while many others choose to purchase ready built development boards with integrated device programmers, LEDs, LCDs, GLCDs, switches, buzzers, and so on. Using a ready build development board has the advantage that the board has been tested by the manufacturer and the students are required only to develop the software to control the various devices on the board or attached to the board externally.

In this paper, the proposed approach is based on using the microcontroller as a design tool, emphasizing its use in solving practical engineering problems, Hamrita & McLendon (1997). Thus, the course is organized around the application rather than the pure theory. More specifically, the focus is placed on using the microcontroller as a tool to solve an engineering problem rather than on the details of the microcontroller architecture and assembly language instructions.

There are hundreds of microcontroller devices in the market place, manufactured by many different companies. The architecture and assembly language instructions of these microcontrollers are usually all different. Students who learn the details of one microcontroller architecture may find it difficult to use another microcontroller when encountered in industry. Thus, it will be useful to teach the very basic architecture of as many microcontrollers as possible to make students familiar with such different architectures. Little time should however be spent in this exercise.

The proposed approach in this paper involves the following points: