A Senior Level Laboratory Course in Computer Engineering Technology Program

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Abstract

The richness of Engineering Technology program depends on the hands-on experience provided to the students through rich laboratory exercises. These exercises are critically developed to reflect the common practices in the industry. Thus the list of laboratory works needs critical analysis and frequent updates to keep up with the changes in the industry. As in the sophomore or freshman level traditional laboratory courses, e.g., AC, DC, Electronics, Digital Logic Circuits, a well written laboratory manual is seldom available to meet the need of technical courses usually offered in the junior and senior levels of the program. This paper describes three laboratory exercises of a senior level course, Software Applications of Microprocessors Laboratory. These specific exercises, usually given towards the end of the semester are on serial communication. The first one focuses on the study of the parameters of serial communication using a commercial NULL modem and a commercial program. In the second exercise, the students fabricate NULL modem in the laboratory and write driver program in assembly language. In the third laboratory, the students write assembly language programs to interface a PC with an LED display unit. These two laboratory exercises give the students an opportunity to add their creativity in developing practical projects on serial communications and build confidence on their academic development as well.

Introduction

In the first half of the semester, the students work on extracting system information, memory processing, message encryption, and graphics programming including object animation. Towards the end of the semesters, they devote their time in writing utility programs to reflect the industrial practices. This paper discusses three exercises related to serial communication given during the second half of the semester.

In the first of the three laboratory exercises, students work on a commercial software with a commercial NULL modem to study the basic steps of serial data communication. The parameters under study are: baud rates, 7 or 8-bit data sizes, parity and stop bits and COMPort selection. The software has the flexibility to change all the parameters during runtime of the program. In the second lab, the students fabricate their NULL modem in the laboratory and write their own programs to establish communication between two

PCS. The completion of this lab has a driving force for the students to improve their work closer to the commercial ones. In the third lab, the students study the control characters of a message display unit (MDU) and write program to upload messages to the unit.

The Second Lab – NULL Modem and Program for Serial Communication

Figure 1 shows a simple model for serial communication between to two PCs (Data Terminal Equipment – DTE).

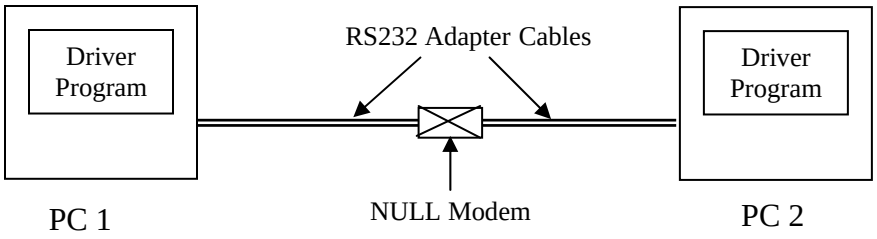


Figure 1. A model for serial communication between two PCs

A NULL modem can be fabricated by connecting some specific pins of two DB 25 adapters of RS232 Standards. Many less important pins can be set aside from communication. Figure 2 shows a moderate version of connectivity between two PCs including the Pin names and numbers.

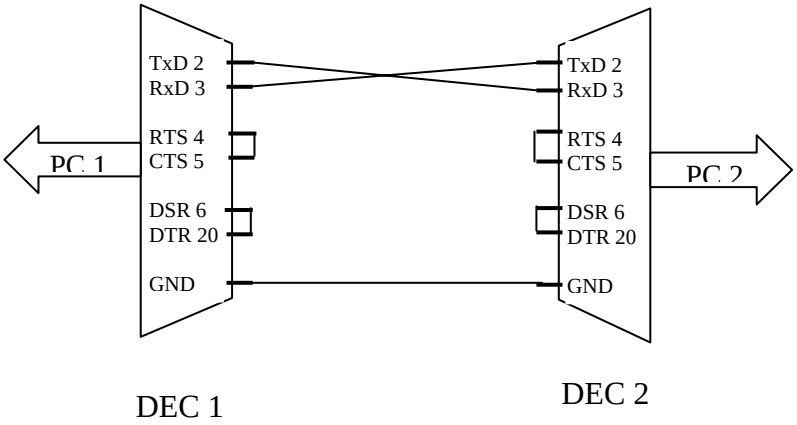
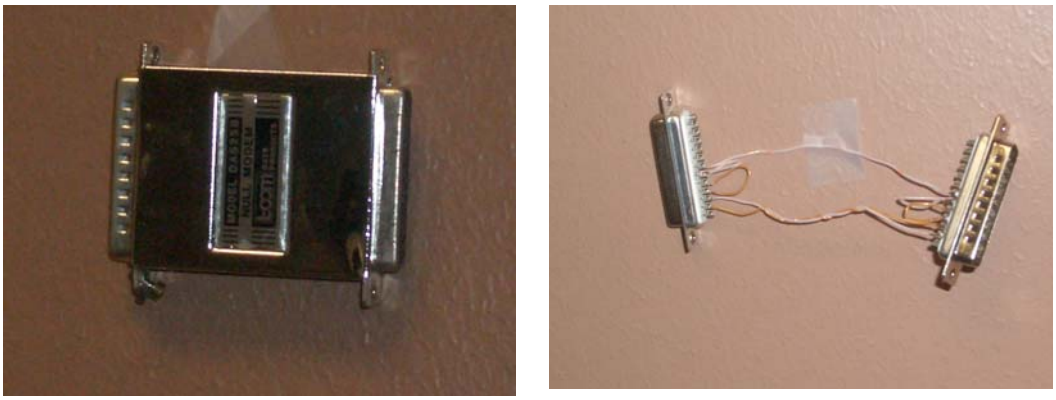


Figure 2. Pin connections to fabricate a NULL modem

In communication, a PC is often referred to as a Data Terminal Equipment (DTE) and a modem is referred to as a Data Communicating Equipment (DCE). In Figure 2, DB25 adapters are used where Pin 2 transmits bits while Pin 3 receives bits. Therefore, these

two pins are connected between two DCEs. Some pins, e.g. Pin 4 and 5, are shorted for handshaking purposed between the adapters. Once a communication is established after the handshake, the DTEs start transmission via Pin 2 and reception via Pin 3.

The open DB25 adapters are available in the market. A NULL modem can be made by following the Figure 2 with some copper wires soldered to the appropriate pins. Figure 3 shows one commercial NULL modem and one fabricated in the laboratory.



A commercial NULL modem A fabricated NULL modem

Figure 3. NULL modems

Communication Program

The executable program in each of the DTEs continuously searches for any incoming characters in the designated COMPort and then looks for if the user has pressed any character in the keyboard. If the pressed character is meant to quit, the program terminates; else it writes the character to the COMPort for immediate delivery to the other DTE. If a character has arrived, the program picks up the character and displays on its monitor. This cycle continues until a special character is pressed to quit the program.

At start, the program initializes the following parameters:

- COMPort (1, 2, 3, or 4)
- Communication speed (baud)
- Data size (7 or 8 bits)
- Parity bit (even, odd or no parity)
- Stop bit (1 or 2)

The construct of the program written by the students is shown in the flowchart of Figure 4. The commercial software allows runtime changing of parameters. However, in the

student version, the parameters are hard-coded. Additional lab exercises may be given to incorporate parameter changes during runtime.

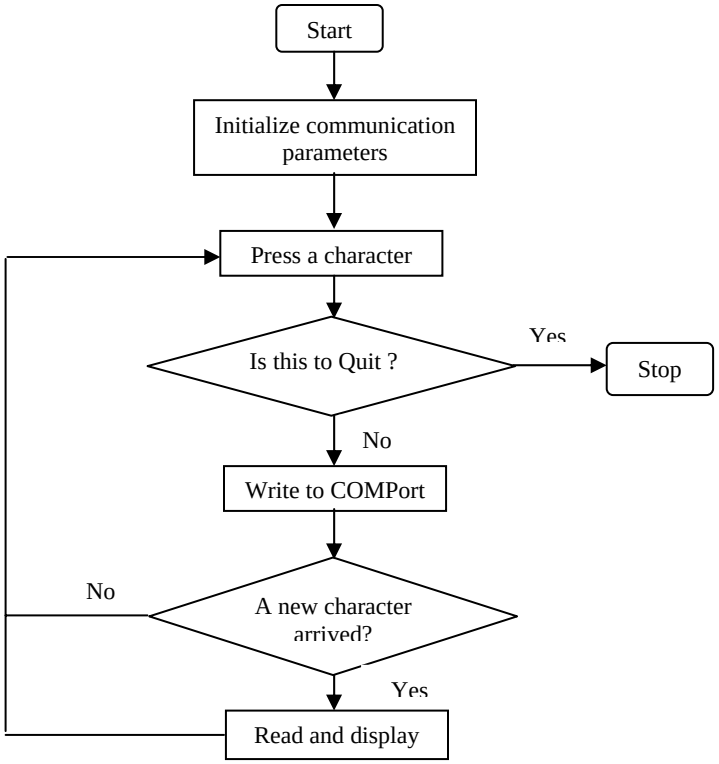


Figure 4. Flowchart for developing a program for serial communication

In Figure 5, two students are seen to communicate each other using a commercial NULL modem and software. In Figure 6, students are using their own products.

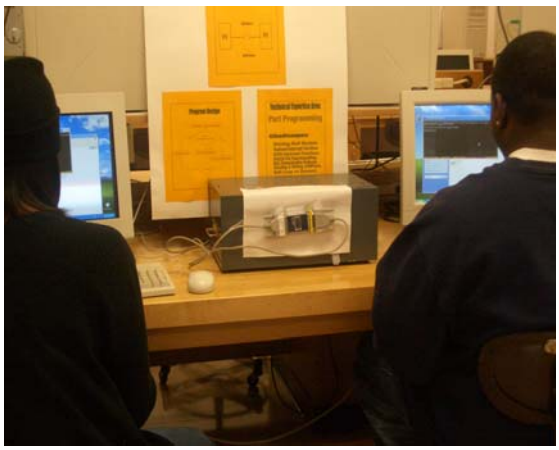


Figure 5. Students are communicating using commercial modem and software

Figure 6 Students are seen using their own products. The NULL modem is seen hanging from an object with white background. The commercial modem is seen sitting on the desk beside the mouse.

Third Lab – Uploading Message to a Message Display Unit (MDU)

A message can be displayed in a variety of ways. Certain control characters are embedded into the messages while uploading it to the MDU for an intended way of message display, e.g. scrolling horizontally, colors, display at a certain time of the day, priority display, etc. Figure 7 shows simple model for uploading a message.

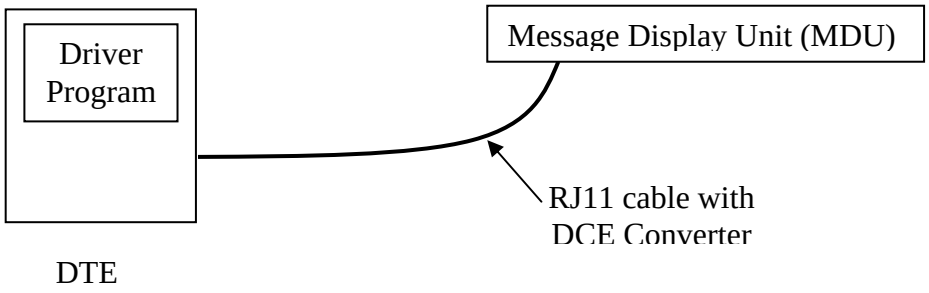


Figure 7. A simple for message uploading to a display unit

Program to Upload Message

Just in the case of second lab as described above, this program also required initialization of communication parameters. Each MDU has its own control character set to diversify the display patterns. The program needs these control characters embedded into the message to be uploaded. Each message, at its minimum, needs enveloped by one start and one message end characters and a set of 4-digit display identity numbers. The message priority number, text colors, display timings all need to be embedded inside the message.

Figure 8 shows the flowchart develop one driver program to upload message.

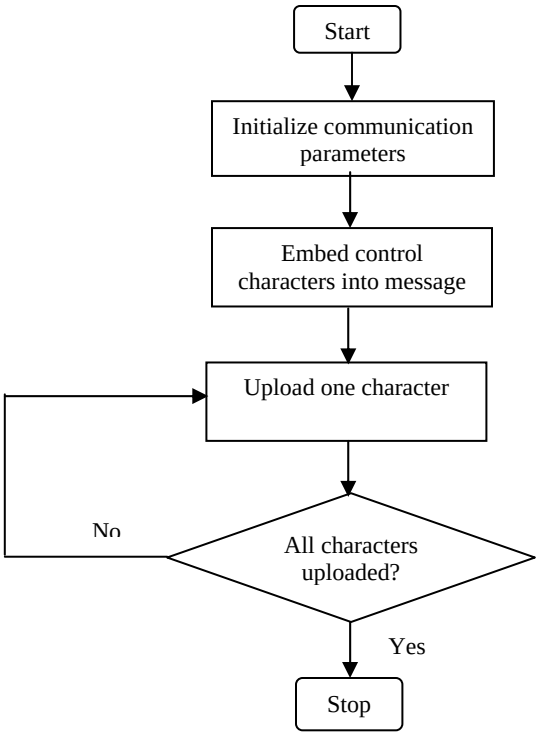


Figure 8. Flowchart to develop a utility program to upload message to MDU

To create a message during runtime, fractions of message may be read from the standard input device and added together form a single message. Control characters are to be inserted into the message as well. A message can have its priority, text color combinations, time of the day to be displayed, frequency of display, etc. The MDU can store 99 messages. Figure 9 shows two students working on a program to upload messages.

Figure 9. Students working a on a program to upload message

Conclusion

The commercial software and modem used in the first lab proved to be very useful in understanding the basics of serial communication. The software has the flexibility to set parameters during runtime. It also allows file transfer between PCs. A file or any message being transferred can be captured as well. After this lab, the students develop enough skills and confidence to build their own NULL modem and write programs to drive the modem for serial communication. In the third lab, students study the control characters for the MDU and develop their own programs to upload messages to be displayed for public viewing.

These three labs together provide the students with high level of confidence as they see their immediate use in the industry. With the third, the students see the practical use of what they learn in the lab. As an immediate result, they come up with new ideas to develop the program further. In fact, students get ready to develop programs closer to the commercial utility programs.

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