Abstract

This paper describes the educational experience gained by the introduction of wireless computer technology that is used as a learning tool in the Digital System Design and Microprocessor System Design courses in the Electrical and Computer Engineering Department at the University of Minnesota Duluth. The wireless capability is used to access class material and lab tools, and makes the learning process more dynamic and interactive. It also makes difficult topics more accessible and easier to understand to the students. The paper concludes with a description of the assessment for the course and a discussion of future uses of this technology.

1.0 Introduction

The University of Minnesota Duluth (UMD), College of Science and Engineering requires engineering and computer science majors to have a personal computer equipped with wireless access for use in some of their classes, the students can choose to use a normal laptop computer, or a smaller iPAQ pocket PC, but the use of the later one is preferred due to its small size. The purpose of the wireless PC requirement is both to enhance the technological environment of the engineering and computer science classroom, and to better prepare UMD students to be competitive in the work world. In particular, UMD students use the wireless equipped computer and Internet connection as a tool in class and lab, for learning and working and to interact with the professor. The wireless capability is cutting edge technology, and it has very recently and very rapidly become an important tool of practicing professionals in engineering, industry, business, and information technology.

The main motivation to use the handheld PC computer and to implement the wireless access at UMD was to provide computing and network access to the faculty and student body at any place inside campus, and to make the learning experience for the students more interactive. The main academic interest for the use of the wireless network as a teaching and research tool involves but is not limited to the following applications:
a) Increase interaction between instructor and students in large classes
b) Enhance communication outside class
c) Support students software development for mobile computers
d) Enhance active learning and instruction
e) In laboratory data collection and document viewing
f) In class assessment and evaluation of students, by means of electronic quizzes and polls.
g) The wireless connectivity facilitates collaborative and interactive learning, and promotes in class participation for the students.

With the integration of this technology in our classes we have made the learning experience more interesting and dynamic, and made difficult topics more accessible and easier to understand to the students. The wireless computer provides each student with immediate access to course material such as lecture slides, examples and quizzes. In addition, the use of the wireless PC as an interactive media makes students more willing to participate in class discussions.

Most of the programs developed take advantage of the laptop and iPAQ\(^1\) handheld computers capabilities together with the wireless connection, such that students have access to databases, simple design tools, spreadsheet use, and display of images. In addition, students are able to generate or acquire data files during laboratory or lecture sessions, return to a desktop environment, and continue to work. Software demonstrations and interactive exercises could be downloaded and run in the lab and then carried home for future reference. As they progress, students will be able to write software on their desktops that can be downloaded and run from the handheld. Infrared file transfer from one device to another can be very useful for students in team projects and between faculty and students.

The wireless environment made possible with this device provides efficient and accurate interaction with course material and data free from transcribing errors. The pocket PC also has the capability of loading scientific calculator software that saves students the expense of purchasing a separate scientific calculator. Students are able to use the handheld PC as a personal productivity tool. They also are able to take advantage of the UMD’s expanding wireless network, to access the Internet and their email throughout the day, without having to go into a computer lab. Many class-related documents (lecture notes, assignments, syllabi, and software) are available through the wireless network.

2.0 iPAQ Main Characteristics.

To ensure standard quality and configuration, the hand-held personal computer must have the following characteristics:

- Compaq iPAQ H3950 (Color Display, 64MB RAM, Protective Slipcover Pack, Li-ion Polymer Battery, AC Adapter)
- Compaq WL100 11 Mbps Wireless LAN PC Card
- Compaq PCMCIA Jacket, Y adapter cable, USB Sync Cradle, ActiveSync Software CD

\(^1\) Although the programs were developed with the iPAQ in mind they also can run in a laptop computer running the Windows operating system
3.0 Software Package.

In this section we describe the software applications that we developed to be used in the iPAQ handheld computer. In order to use and develop the applications for this package, we tried to make use of all the software tools already available in the iPAQ’s Microsoft® Windows for Pocket PC operating system [2]. These tools include: iPAQ image viewer, Pocket Word, Pocket Excel, Internet Explorer, Presentation Player, Sound recorder, etc.

In Figure 1, we show the File Explorer’s main menu, that displays all the applications and directories available for the students in the Digital Design class, as can be seen, the hand held PC is a great place to store class information and reference documents.

Figures 2-4 show some application programs that are used to show basic information about gates, TTL devices, Truth table implementation, etc. Pocket Word can be used to make notes and annotations for the lectures, or can also be used to display text files given in class such as assignments and lab descriptions. One interesting characteristic of this program is that students can make notes using the handwriting and character recognition capabilities of this tool.

Microsoft Explorer can be used together with the wireless capability to connect to the Internet and be used to access the class web pages, to transfer files, and to answer class quizzes and polls. The web pages are formatted so that they fit the small display of the handheld computer. Best of all, it can be used at any time and anywhere to improve student access. The handheld PC provides true mobile computing and is a valuable resource with or without access to the Internet. While on campus the iPAQ allows students to instantly access the Internet from a variety of locations. These include class and laboratory rooms, the UMD library, the cafeteria and various rooms in the engineering building. The iPAQ also supports wireless email using the...
iMAP protocol. Also, students can use the sound recording capability of the iPAQ for recording limited segments of lecture material, or to reproduce sound and music files.

The set of programs were developed during two summers, using mainly the pocket PC toolbox available from Microsoft, and Visual Basic and Java languages. Among the programs developed using these languages are a K-Map solver (Figure 5), a Quine-McCluskey minimization program (Figure 6), and interactive programs to simulate logic gates and digital devices operation (Figures 7, 8).

"Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition
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Finally, in Figures 9-12 we show some of the utilities and programs developed for the Microprocessor System Design class. They include basic system information such as memory maps; CPU’s register set, CPU’s instruction and interrupts sets, etc.
4.0 Student Survey

The iPAQ is also the repository for interactive quizzes and a host of material that will help students study for upcoming exams. It is a very good exam study aid. Since we integrated the use of the handheld computer in the Introductory Digital System Design course in the fall of 2001, we have made a survey among students to find their opinion about the use of the iPAQ in class, an example question and result of the survey are displayed in Figures 13 and 14.
5.0 Conclusions.

Based on the survey responses from students, and our own experience, we found the response of the students to the use of the wireless computers in class and laboratories, to be generally acceptable. With the use of the wireless computers we have noticed an increment in class participation for part of the students and a faster dynamic in the class environment. In particular for the iPAQ, the main complaints we get from students is about its cost, and limited memory available to store information. The small display and low resolution of the iPAQ seems not to be a problem for the students because they are used to the small screens of their wireless phone. Although the software package was initially developed to be used on the iPAQ, all of software can be run with no problem in any laptop or desktop computer with the help of a free PDA simulator [3] available from Microsoft.

Another problem we detected involves the access of the students to email, chat/IM, and web browsing software, etc. during class and laboratory. Up to now we have been working based on an honor code only, and to discourage student abuse and distractions during class, they need to login to the Internet with their student ID, so that with the knowledge that their accounts could be monitored is a good restraint for their misuse during class.

Since the cost of the handheld computer, with all its added components for wireless communication, is getting closer to the price of the lower end laptop (around the thousand dollar mark), then it makes the option to buy the laptop more appealing rather than the handheld. However, the main attraction of using the iPAQ is the real portability characteristic of the handheld over the laptop, since carrying a laptop all day is not that appealing to them.

As more technological advances are developed, the handheld computer will add more capabilities that will make its use more attractive and universal, such as cell phone and GPS connection capabilities. Another advantage is that with the Bluetooth technology already available, it is possible to use the handheld computer as a universal remote control, and also allow the communications to hundreds of peripherals such as wireless keyboard, mouse, printer, etc. As these technologies become more popular the price of the handheld will tend to decrease too, so that the handheld PC will be more attractive and universal tool to use in general, which will give our students an advantage in the long run.

References

[1] Hewlett-Packard Company, Handheld Devices, Palo Alto, CA; URL:


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