AN EXAMPLE OF MOBILE LEARNING IN ENGINEERING THROUGH THE USE OF PERSONAL DIGITAL ASSISTANTS

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This paper describes the power of Pervasive Computing through the use of Personal Digital Assistants (PDA) as an empowering tool that will enable the mobile learning in Engineering, also creating a possibility of future paperless classrooms. The current crop of PDAs are capable of performing functions of word processing, spreadsheet application, sending e-mails, accessing the web, personal information organization and data storage through wired and wireless connectivity. The symbolic mathematical calculations using programs ported to Linux based PDAs are possible adding the functionality that is not available in average calculators. This paper presents how to use a one PDA model, Zaurus, in an engineering classroom that also serves the purpose of motivational tool to the students.

Introduction

The merger of computing and computer networking has spanned a whole new area of distributed network computing and information processing. The cost of computing and the networking infrastructure has been rapidly decreasing for the past decades in accordance with the famous Moore's law. Also, the size of the computing devices is shrinking with the increase in data processing capability due to the advances in microelectronics manufacturing techniques. There are major projects undertaken by the large corporations such as IBM and HP to support activities in the area of pervasive computing. It primarily deals with the computing devices of small form factor or mobile devices that exchange data between each other through wireless networks. The devices that fall in this category are personal digital assistants, smart-phones and thin and lightweight laptops.

This year alone 500 million small factor computing devices will be sold worldwide and it is expected that there will be 2 billion such devices in use by the year 2007. The adoption of smart phones in Europe and South East Asia has been phenomenal. It is expected that the use of such devices will surpass the use of desktop personal computers in the near future. In computing capabilities, these devices are as powerful as the personal computers of five years ago. The laptops already have the same capability as the desktop computers and their sale volume has exceeded the sale volume of desktop PC's.

The web-enabled mobile devices[1,2, and3] and the Web-server based computing infrastructure provide users access to an information-rich environment, anytime, anyplace at a modest cost. The application of mobile learning in the form of "Paperless Classrooms" has been tested in High Schools using personal digital assistants (PDAs)[4, 5]. Some other application that use mobile devices for mobile learning are described in ref.[6,7].

This creates an ideal environment for developing innovative applications for these devices that can be used in a pervasive mode. These applications will find their use in Enterprise information processing, mobile learning and many day-to-day consumer activities. This development also opens up exciting possibilities for innovation in the teaching and learning process by creating new applications and processes that use these devices. It provides an ideal platform for developing innovating e-learning applications that support mobile learning environments and can be used to improve the teaching and learning process in engineering education.

Hardware/Operating System Capabilities of PDAs

Originally known as Electronic Organizers, PDAs have come a long way since inception[2,3,and 8] and are now becoming as powerful as desk top computers of few years ago. This section describes the hardware capabilities of the available PDAs from Sharp Electronics in its Zaurus series SL-C7XX.[9] The PDA SL-C750 features include 64MB RAM and 64MB flash RAM. The SL-C860 [10] and SL-C760[11] include 64MB system RAM, 128MB flash RAM, and an upgraded battery that last longer between charges. All models use the latest Intel XScale PXA255 400MHz processor that has twice the speed of the original SL-C700.

The latest version, the SL-C860, has the same hardware as the SL-C760 with additional features that include the capability to be recognized as a virtual hard drive when connected to a Windows XP based desktop PC, enabling easier data transfer between a PC and a PDA. The Zaurus SL-Series has an innovative swiveling screen that transforms its shape from PDA-style to laptop-style (Figure 1). Once it is set in laptop mode the QWERTY keyboard can be utilized for data entry. The VGA screen with a pixel resolution of (640x480) is bright and sharp. The Zaurus SL-C750 series weighs 225g and measures 120 x 83 x 18.6mm. The SL-C860 and SL-C760 is 5mm thicker and 25g heavier. It also has slots for compact flash and SD cards, as well as an IrDA port. The user accessible RAM size is 32MB and approximately 18MB of the available RAM is used by the Operating System for performing system related functions. The battery provides approximately four hours of uninterrupted usage time per single charge. The stereo-output is available to play and for listening to sound and music files in mp3 format.

The use of Linux OpenPDA, an open source Operating System in the SL-C860 and its sibling make them unique when compared from other PDA's that are based upon the proprietary operating systems such as Windows CE and Palm OS. It is the same Linux operating system that is used in desktop and laptop computers with some modifications to support the smaller display and memory sizes in the PDA. All the familiar UNIX commands are available on the C760 in a console window while using the Terminal application. This allows modification or installation of new custom ROM's. Other TCP/IP based applications such as Telnet, FTP allow network access into other computers.

Figure 1: Zaurus SL-C760 in Laptop (Landscape) Mode and PDA (Portrait Mode).

It is also possible to write computer programs and compile them to develop new software applications on the C7XX PDAs. The Zaurus PDAs have become an attractive software development platform for the Linux development community. The software distributer - theKompany.com - has already released most of the software applications developed by the third party developers that are compatible with C7XX series PDAs. In addition to that, most of the existing freely available open source software that is being developed for Linux operating system can easily be ported to the Linux based PDAs with minimal efforts. This openness in the software development environment creates many opportunities for creating new student projects that focus on mobile applications for student learning.

Software Capabilities/Applications For Zaurus PDAs

The standard application software that is distributed with the PDA is organized into several groups. It includes a Clock, Calculator, Calendar, Contacts, and ToDo List, which is very useful for students to organize their work. It also include a Text Editor for word processing (Figure 2), a spreadsheet equivalent to MS Excel (Figure 3), presentation software equivalent to MS PowerPoint (Figure 4) and an ImagePad equivalent to Photo Viewer that enables mobile learning for the students. It also has the capability of sending e-mails and allows web browsing through NetFront browser (Figure 5) while connected to the Internet through wired or wireless networking. It also comes with a Music and Video Player. These are ideal features in PDAs to allow engineering students to use a multimedia capable internet connected device in pervasive computing mode. These features facilitate mobile learning where student can perform class related work from any location and they can access course material anytime at their own convenience.

Zaurus's HancomMobile Word program, an equivalent of MS Word, can be used for word processing in engineering course work. An example of a word processed file is shown in Figure 2. The document files created by using PDA are fully compatible with the MS Word file format. However, it does lack a spell checker. It is also supplied with a version of the HancomMobile Sheet that is similar to the MS Excel spreadsheet in its functionality. The figure 3 shows an example of its use for a wind load calculations performed on a building.

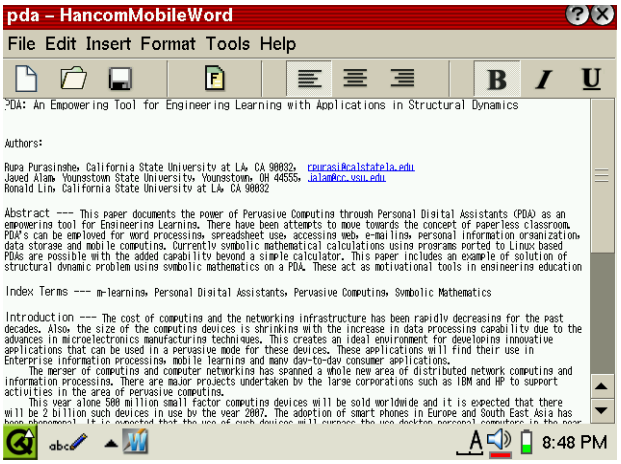

Figure 2: HancomMobile Word: PDA's word processor.

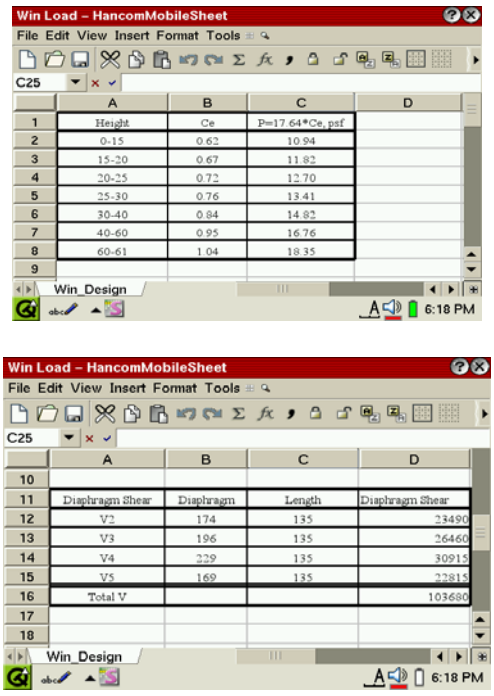

Figure 3: Zaurus C760 Spread Sheet Program Calculation Example.

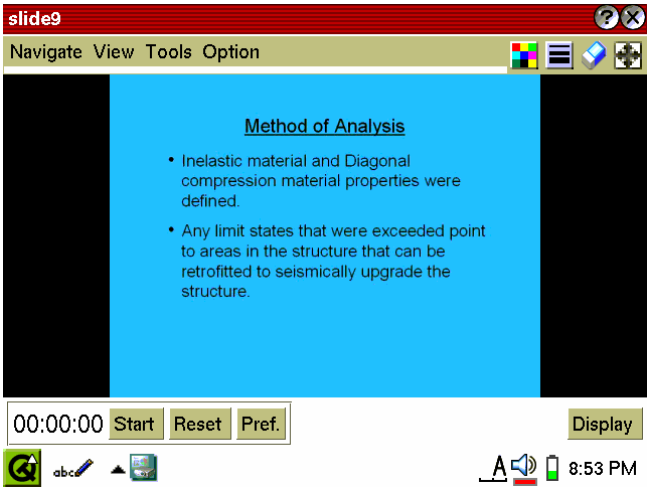

Figure 4: Zaurus C760 Presentation Program Slide Example.

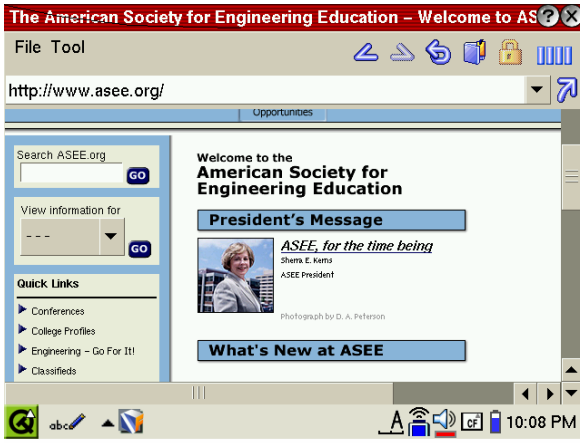

Figure 5: Zaurus C760 Web (Net Front) access example.

As part of the application package, the PDA comes with the presentation software similar to MS PowerPoint. However, the software on the PDA is not capable of creating or modifying presentations. The PowerPoint presentations can be viewed on the PDA and with a properly connected projection system the PDA can act as a computer that controls the presentation. Also, 24/7 based accessibility is an added benefit that allows students to review their project or course related presentations from anywhere anytime. Figure 4 is an example page of a presentation created using PowerPoint and ported and viewed on the PDA.

The PDA is also equipped with a web browser known as "NetFront". This web browser is capable of displaying multiple windows, bookmarks and JavaScript. It appears to be superior to many browsers in handhelds, but lacks desk top quality. Figure 5 shows a screen capture of PDA's web browser for the web site of the "American Society of Engineering Education" (ASEE).

A significant amount of work in Engineering and Engineering education involves numerical and symbolic mathematical calculations. Ordinary calculators used by the students have limited functionality to perform these types of calculations. The MAXIMA[12] package that has its origin in the original program Macysma, that was developed at MIT, is now available as an open source program under GNU/GPL license as a free download from http://maxima.sourceforge.net. To add more useful functions to the PDA the MAXIMA was successfully implemented[13] on Sharp Zaurus PDAs by using CLISP , a very portable Lisp programming language interpreter. Now, it is possible to perform symbolic mathematical functions such as differentiation, integration and solution of ordinary differential equations on the PDAs. Figure 6 shows an example of the symbolic mathematical computations performed for obtaining frequencies of a tapered beam for a problem related to the area of structural dynamics. This enhancement in the capability of the Zaurus PDAs that allows performing numerical and symbolic mathematical calculations makes the PDA a powerful tool for mobile learning with a wider set of potential applications in engineering education.

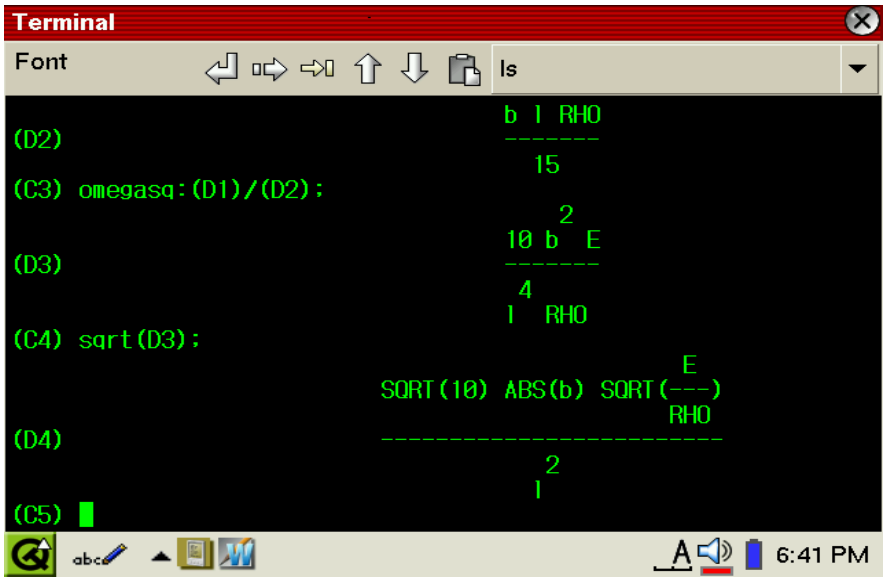

Figure 6: Zaurus symbolic mathematic calculation example.

Shortcommings of PDAs as an Engineering Education Tools

The small form factor that is an advantage of the PDAs because they can be carried in the pocket as a portable device also acts as a basic shortcoming of PDAs. It is often hard to read the character displayed in small fonts on the screen. Also the size of the keyboard is small and some skill is required to use it. There is a need to develop more responsive user interface for the current PDAs. These drawbacks notwithstanding, the PDAs or the handhelds in a form factor that is in between a PDA and a Laptop, will find widespread use in mobile learning environments with significant implications for engineering education.

Discussion and Summary

We have discussed and demonstated the use of a PDA as an empowering tool for mobile learning environments with applications in engineering education. It has most of the functionality of the laptops and desktop computers, with word processing, spreadsheet, presentation, web browsing capability as well as added feature of performing symbolic mathematical computations which are very useful for students in engineering. It will allow them to carry out their learning activity from any location any time in a connected environment using a device that they can carry in their pockets. It does have the draw back of having small form factor making it difficult to view web pages with full width due to limited size of the screen. The small keyboard also presents a challenge to use. We anticipitate that the future improvements in the user interface for PDAs will make it an empowering tool for mobile learning that could be effectively used to deliver accessible engineering education to traditional and non-traditional students in blended or online mode.

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