PDA: An Empowering Tool for Engineering Learning with Applications in Structural Dynamics

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Abstract *--- This paper documents the power of Pervasive Computing through Personal Digital Ass istants (PDA) as an empowering tool for Engineering Learning. There have been attempts to move towards the concept of paperless classroom. PDA's can be employed for word processing, spreadsheet use, accessing web, e -mailing, personal information organizati on, data storage and mobile computing. Currently symbolic mathematical calculations using programs ported to Linux based PDAs are possible with the added capability beyond a simple calculator. This paper includes an example of solution of structural dynami c problem using symbolic mathematics on a PDA. These act as motivational tools in engineering education*

Index Terms *--- m-learning, Personal Digital Assistants, Pervasive Computing, Symbolic Mathematics*

Introduction --- The cost of computing and the networking infrastructure has been rapidly decreasing for the past decades. Also, the size of the computing devices is shrinking with the increase in data processing capability due to the advances in microelectronics manufacturing techniques. This creates an ideal environment for developing innovative applications that can be used in a pervasive mode for these devices. These applications will find their use in Enterprise information processing, mobile learning and many day-to-day consumer applications.

The merger of computing and computer networking has spanned a whole new area of distributed network computing and information processing. There are major projects undertaken by the large corporations such as IBM and HP to support activities in the area of pervasive computing.

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 desktop personal computers in the near future. In computing capabilities these devices are as powerful as the personal computer's 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 pervasive computing 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.

Capability of PDAs --- Originally called Electronic Organizers, PDAs have come a long way since its inception [1,2,3]. The PDAs are now becoming as powerful as mini-computers. One of the examples is Sharp Zaurus series [4,5,6]. The SL-C750 [4] features 64mb RAM and 64mb flash RAM. The SL-C860 [6] and SL-C760 [5] feature 64mb system RAM, 128mb flash RAM, and an upgraded battery. 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 but has one new feature capability to be recognized as a hard drive under Windows. This new feature is capable of easier data transfer. The Zaurus SL-Series has an innovative swiveling screen that transforms its shape from PDA-style to laptop-style (Figure 1). Once in laptop-style, you can utilize the QWERTY keyboard. The Sharp VGA (640x480) screen 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 has compact flash and SD card slots, as well as an IrDA port. The user accessible RAM has 32mb, with approximately 18mb used by the Operating System. The battery provides around 4 hours of use per charge. There is a stereo-out for MP3 playback. The Linux Operating System, which is open source based Operating System, called the Linux OpenPDA on the SL-C860 and its siblings make it unique from other PDA's on the market. This is pretty much the same Linux that is used to run desktop and laptop

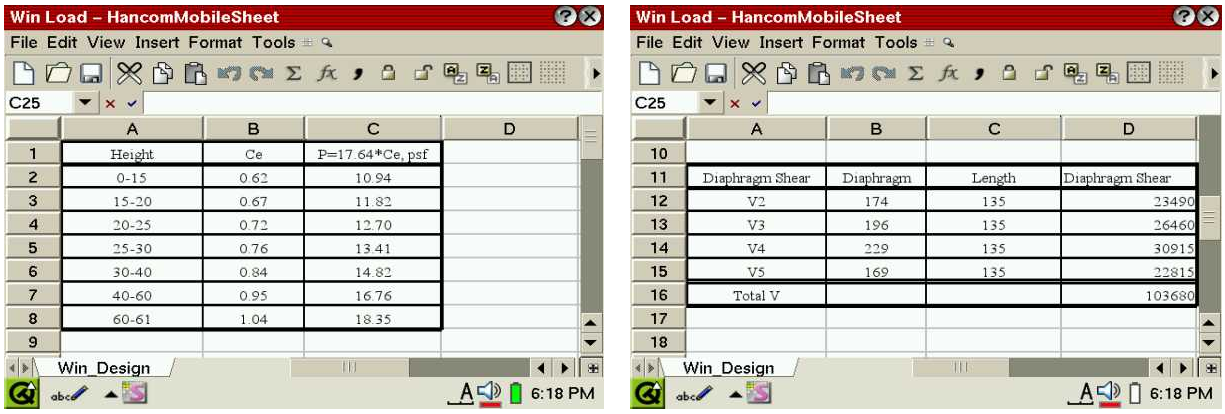
computers with some modifications that allow for the smaller display and memory sizes.

Linux commands are accessible on the C760 by running the Terminal application. Linux commands are input at command line prompt. This allows modification or installation of new custom ROM's, or other applications like Telneting into another computer, and write software code and compile it on the C760. The Zaurus has become an attractive platform for the Linux development community through use of Linux. One of the largest third party Zaurus software developers, theKompany.com has already released most of their applications in compatible with C700 series.

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

Web-enabled mobile devices [7,8,9] and the Web-server based computing infrastructure provide users access to an information-rich environment, anytime, anyplace at a modest cost. It creates an ideal platform for developing innovating e-learning applications that can be used to improve the teaching and learning process. The application of m-learning in the form of "Paperless Classrooms" has been tested in High Schools using personal digital assistants (PDAs) [10, 11].

Software Capabilities in Zaurus PDAs--- The included software is organized into several groupings using tabs. The software applications include 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, a spreadsheet equivalent to MS Excel (Figure 2), presentation software equivalent to MS PowerPoint and an ImagePad equivalent to Photo Viewer which enhance the m-learning capability of students. It also has the capability of Email, and web browser (NetFront), Music and Video Player.



	A	B	C	D
1	Height	Ce	P=17.64*Ce, psf	
2	0-15	0.62	10.94	
3	15-20	0.67	11.82	
4	20-25	0.72	12.70	
5	25-30	0.76	13.41	
6	30-40	0.84	14.82	
7	40-60	0.95	16.76	
8	60-61	1.04	18.35	
9				

	A	B	C	D
10				
11	Diaphragm Shear	Diaphragm	Length	Diaphragm Shear
12	V2	174	135	23490
13	V3	196	135	26460
14	V4	229	135	30915
15	V5	169	135	22815
16	Total V			103680
17				
18				

Figure 2: Zaurus C760 Spread Sheet Program Calculation Example

Also by installing symbolic mathematics based "Maxima" [12] program it is possible to perform mathematical functions such as differentiation, and integration on the PDAs. This will make the PDAs a powerful tool in engineering education.

Structural Dynamic Problem Solution with Symbolic Mathematics--- Example in Figure 3 is to determine the fundamental natural vibration frequency ω_1 of first mode of a tapered beam with 1 Degree of freedom system, with length l , and base width $2b$. The vibration is in axial direction.

Theoretical calculations and Maxima solutions (Figure 4) from Sharp Zaurus are shown below. See attached hand calculations for theoretical solutions.

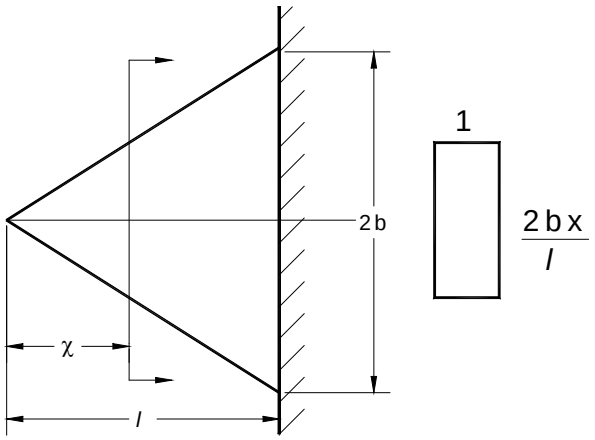


Figure 3: Vibration of a Tapered beam

The mode shape $\phi(x)$ is given by

$$\phi(x)=a_1\psi_1$$

where a_1 is an unknown constant and ψ_1 is a known assumed function.

Assuming a quadratic function for ψ_1

$$\psi_1=(1-x/l)^2$$

In order to find ω_1, we need to solve the dynamic equation for a single degree of freedom system.

$$\mathbf{K_{11} - \omega_1 M_{11} a_1 = 0}$$

Where

$$K_{11} := \int_0^1 E\left(\frac{2}{3}\cdot\frac{b^3}{l^3}\cdot x^3\right)\cdot\left(\frac{2}{l^2}\right)^2 dx = \frac{2}{3}\cdot\frac{Eb^3}{l^3}$$

and the hand calculated solution is

$$M_{11} := \int_0^l \rho\cdot\frac{2\cdot b\cdot x}{l}\cdot\left(1-\frac{x}{l}\right)^4 dx = \frac{bl\rho}{15}$$

$$\omega_1 := 5.477 \cdot \frac{b}{l^2} \cdot \sqrt{\frac{E}{3\rho}}$$

Using symbolic mathematic calculations on PDA with Maxima program we obtain the same results as shown in Figure 4.

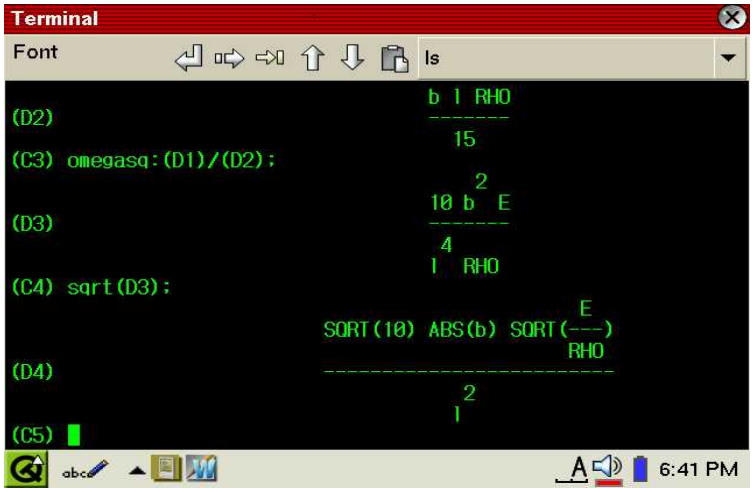


Figure 4: PDA solution of final step with Maxima program

Conclusions--- The paper describes the capabilities of PDAs as an empowering tool for potential Engineering Education. The students can have a powerful computer a PDA in their pocket anywhere anytime for mobile learning, networking, and complicated mathematic calculations. The capability of symbolic mathematics on a PDA is demonstrated with an example from Structural Dynamics.

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