Work in Progress - Breaking Free of the Laboratory Using PDAs

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Abstract - **Laboratory experiences are often contrived and limited in scope by resources. Additionally, students often fail to transfer the knowledge gained in the laboratory to "real world" systems. At many institutions, lecture courses are linked to laboratories that may or may not be taken within the same semester, making it a challenge to insure concepts learned in lecture are mastered by practice in lab. A novel approach is needed to widen the breadth and flexibility experimental problems to increase students' proficiency and knowledge transfer. Moreover, this approach should facilitate exposing students to laboratory experiences temporally closer to the time in the lecture sequence when they are learning the pertinent concepts. To this end, PDA-enabled laboratory experiences have been piloted at the University of Texas at San Antonio (UTSA) and are being implemented at the University of Texas-Pan American (UTPA) using the National Instruments' LabVIEW PDA Module and off-the-self sensors.**

Index Terms – PDA-enabled experiments, inquiry-based, in-lecture laboratory experiences.

INTRODUCTION

At UTSA, the PDA Module was used to develop a set of virtual instruments including one for measuring vibrations and another for measuring light intensity. During the pilot, students were given open-ended problems and were tasked with submitting a report detailing their findings. In one example, students were asked to identify a system in their everyday life that exhibits vibration and were tasked with using the PDA-enabled module to measure and characterize the vibration. They were asked to determine time- and frequency-domain characteristics of the signals they measured. Some example experiments they devised include a comparison of shock induced in bicycles with and without suspensions, a measurement of vibrations experienced within the wrists of professional gamers as they deal cards, and a measurement of lateral acceleration generated in a vehicle when conducting a U-turn at slow to moderate speeds.

Anecdotal evidence which will be presented suggests that the pilot proved to be successful in number of ways including reinforcing lecture content, increasing student participation and interest, and furthering knowledge transfer to a much wider base of engineering problems than could have been achieved in the laboratory. Plans are currently underway to implement a greater variety of PDA-enabled modules including ones to measure thermocouples and strain gauges. These modules will be employed within laboratory courses to expand the base of problems that can be investigated, and will also be used within lecture courses to provide students short laboratory experiences or demonstrations related to concepts and theories they are learning in class. The in-class experiences can be implemented immediately before or after they learn the concepts.

The use of PDA-enabled modules provides both opportunities and challenges for student laboratory experiences. As such, the authors will thoroughly study the impact on student concept mastery through a variety of instruments. This project will develop a series of modules, devise appropriate assessment instruments, and develop guidelines for implementing PDA-enabled laboratory experiences.

PREVIOUS PROJECTS USING PDAS

The mobility and increasing functionality of PDAs has enabled innovative applications in many undergraduate educational settings. Dr. Connolly conducted an extensive review of publications, conference proceedings, and NSF-funded grants and found that these applications fall into the following broad categories:

- Using PDAs to access and view course materials and to exchange ideas [1]. Some of these initiatives employed a "wiki" model [2] .
- *Using PDAs in a working-group environment to enhance real-time interactions among students*, instructors, and student groups. These efforts typically involved PDA-based applications that facilitated class discussions or brainstorming sessions [3]. At MIT, researchers used PDAs as an integral part of "participatory simulations" of complex interactive systems that depended on human judgment and decision-making [4].
- *Using PDAs as intelligent tutoring devices*, which adapted to a student's responses to questions and also used progress-based factors such as location, available time to study, and the time of day to adapt to a particular student's learning style and behavioral patterns [5].
- *Using PDA-based software to guide a student through a procedure*, such as plotting and interpreting pre-

recorded or simulated experimental data [6], [7]. Such projects often featured Web-based content to enhance their flexibility and scope [8].

- *Using PDAs in an observational setting*, in which students used a PDA to (a) manually enter experimental data and qualitative observations in the classroom or out in the field [9], (b) receive experimental data over the Internet [10], or (c) remotely control an experiment located in a campus laboratory [11], [12].

The projects in the first four categories differ from the PDA modules being discussed herein in that they are used to display and retrieve content, or to enable a student when performing investigative tasks. The last category more closely resembles the PDA-modules herein. The PDAs are used to monitor and/or control an experiment and to record experimental data.

While the modules discussed herein indeed use a PDA in some of these capacities, it goes beyond manual data entry and monitoring/control of an experiment by incorporating on-board high speed data acquisition hardware, local sensors, and signal conditioning circuitry. This creates a mobile, self-contained, and flexible experimental data collection and analysis tool that is applicable to a broader range of experimental activities.

THE PDA MODULES

As depicted in Figure 1, the PDA Modules use a National Instruments Compact Flash data acquisition card. Virtual Instruments are programmed in LabVIEW and uploaded to the PDA using the LabVIEW Mobile module from National Instruments. At present, a module has been developed for accelerometer readings and is being modified to use more economic, off-the-self, hobbyist accelerometers. Additionally, modules are being developed for strain gauge and thermocouple readings. The modules will see use in lecture courses such as System Dynamics, Heat Transfer, Solid Mechanics, and Dynamics.

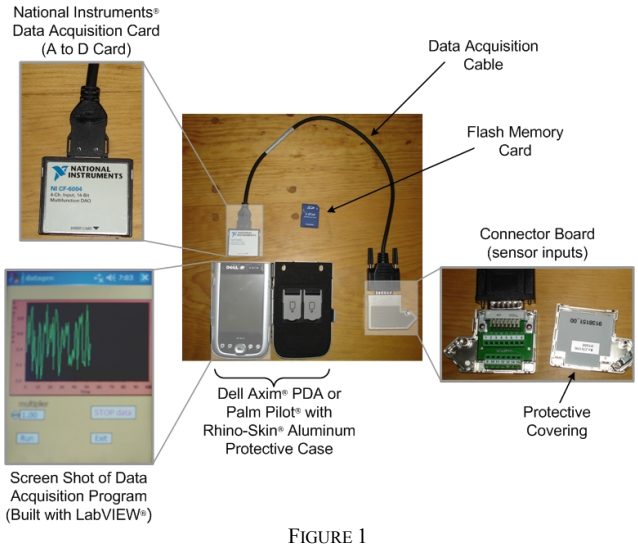

FIGURE 1
PDA-BASED DATA ACQUISITION HARDWARE

CONCLUSIONS

In addition to developing hardware for each module, the authors are creating exercises and assessment instruments to measure the impact of using such modules in lecture and for homework. Future publications will detail findings and practices developed for effective use of such modules in a variety of lecture courses.

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