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Service Design Projects Sponsored by the Kansas State University Student Chapter of the IEEE EMBS

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Abstract—**Service projects offer volunteer student organizations a means to generate interest and focus activity outside of the context of the classroom. This paper addresses efforts by the Kansas State University (KSU) Student Chapter of the IEEE Engineering in Medicine and Biology Society (EMBS) to initiate and guide service projects in two primary areas: (1) research to aid persons with disabilities (RAPD) and (2) hands-on efforts to interest young women in the quantitative fields of science and engineering. Three RAPD projects are presented: a computer mouse design that helps to alleviate productivity problems associated with Parkinson's tremors, a battery removal tool for arthritic individuals with limited dexterity, and a wireless door control and communication system to assist mobility-limited individuals. Service projects to garner science and engineering interest in young women are co-sponsored by the KSU Women in Engineering and Science Program (WESP). The most recent activity, entitled "Vital Signs Shirts," is presented in this paper, along with a summary of pending interactive laboratories designed to interest participants in engineering as applied to the human body. These service projects encourage IEEE EMBS student chapter members to explore their biomedical engineering interests and make a positive impact in the community.**

Keywords—**Assistive technology, design projects, recruitment, student chapter activities, women in engineering**

I. Introduction

Service-driven research and design efforts are an effective means to focus the activities of undergraduate engineering students. The satisfaction derived from making a positive impact on a community of individuals is substantial and can be a powerful motivator both inside and outside of a structured classroom environment [1–3]. Within the overarching structure of the IEEE EMBS, service projects led by student chapters have been an effective means to retain membership levels and nurture the biomedical engineering expertise of the student members [4].

In recognition of the importance that these types of efforts can play in the health of a student chapter, the KSU Student Chapter of the IEEE EMBS [5] chose to focus its early efforts on design projects that can improve the quality of life for persons with disabilities [6]. Service projects were then defined to address the needs of individuals with Parkinson's disease and arthritis, where these special needs follow themes of tremor control, balance assistance, gripping, and mobility. Additionally, the gender diversity embodied in the new KSU student chapter prompted its members to consider the idea that the student chapter could play a large role in the recruitment and retention of female students to quantitative science and engineering disciplines supporting by the various colleges within KSU. The student chapter therefore initiated an ongoing collaboration with the KSU Women in Engineering and Science Program (WESP) to generate learning experiences for junior high and high school girls that would pique their interest in biomedical engineering and increase the opportunity to recruit these individuals into collegiate science and engineering programs. This approach and its perceived benefits are consistent with other outreach efforts focused on promoting biomedical engineering interests in young students [7–8].

This paper highlights three design projects mentored by members of the KSU Student Chapter of the IEEE EMBS. It then describes efforts to create learning experiences that encourage young female students to consider the pursuit of biomedical engineering coursework within the context of the science and engineering degrees offered at KSU.

II. Design Projects: Research to Aid Persons with Disabilities

The projects described here were modeled after the National Science Foundation's Research to Aid Persons with Disabilities (RAPD) program [9]. The program seeks to support new technology development for the disabled and encourages undergraduate research through grant-funded projects that emphasize custom solutions for individuals. Under this model, an assistive device is designed for a person with a specific need, and upon project completion, the individual receives a copy of the prototype design. Annual summaries of these funded projects are collated and widely distributed [10]. While the KSU student chapter has not yet submitted a proposal to the NSF RAPD program, the design projects undertaken are based upon the same principles. This section highlights three of these projects: a computer mouse design that helps to alleviate productivity problems associated with Parkinson's tremors, a battery removal tool for arthritic individuals with limited dexterity, and a wireless door control and communication system to assist mobility-limited individuals.

A. Computer Mouse for Individuals with Parkinson's Tremors

In early discussions with members of a local Parkinson's disease support group, several individuals reported difficulty using a computer mouse due to tremors associated with the disease. The size, shape, and light weight of typical computer mice make these devices unwieldy for fine pointer movements when the user experiences tremors.

Early team design efforts focused on the mechanical design of the computer mouse. After brainstorming several solutions, the team opted for a relatively simple design that featured a wide base and an inclined surface. The large, wide base effectively locks the wrist in a stable position, allowing the user to interact with the computer using broader, upper-arm muscle movements as opposed to fine wrist movements that are highly susceptible to tremors. The inclined surface was intended to slightly supinate the hand, yielding a more stable orientation of the user's forearm bones.

The design offered two primary challenges: the creation of a working tracking system and new mouse button functionality. After several failed attempts, the team designed the hardware as a shell around a commercial mouse, thereby eliminating the need to redesign the optical tracking and push-button elements. Pro/ENGINEER Wildfire 2.0 was used to create computer models of the mouse shell (see Fig 1). Given these three-dimensional computer-aided-design models, a Stratasys Dimension BST (Breakaway Support Technology) rapid prototyping machine was used to create proof-of-concept hardware (see Fig. 2). Note that software filters to remove shaking from the mouse coordinates sent to the operating system were also considered. These may be addressed in future efforts.

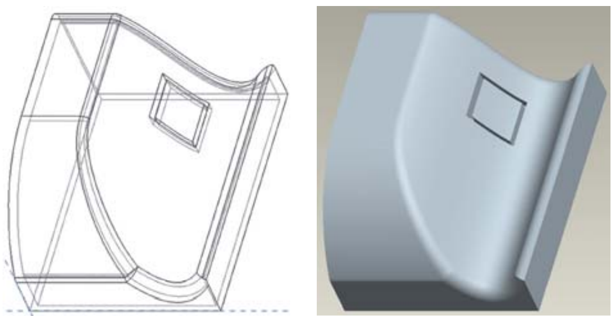

Fig. 1. Pro/ENGINEER Wildfire depiction of the prototype mouse shell.

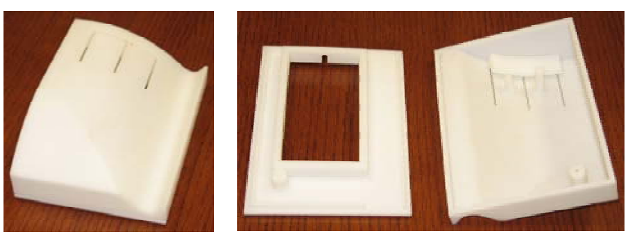

Fig. 2. Proof-of-concept mouse shell hardware. Left: Top view; Right: Interior view of the two sandwiched components.

B. Battery Removal Tool

After meeting with the arthritis support group, it was clear that battery removal, whether from a TV remote control or a CD player, was difficult for these individuals. One team set out to design a simple tool for this purpose. The group first decided which traits the removal tool should exhibit. Most importantly, the removal tool should be dependable and effective at removing batteries from a variety of spaces. The tool should also accommodate a large range of commercial battery sizes. The design group decided the handle must be ergonomically designed to ensure that an arthritic patient had maximal control. Finally, the handle and removal tip should be cushioned or rounded for safety reasons.

With these traits in mind, the group considered several ideas. One initial design would stretch an elastic band lengthwise across a battery, and then exerted force would pop the battery from its resting place. A second design, similar to an adjustable wrench, would wrap around the battery and allow it to be removed with an upward vertical force. The final design, which was implemented, employed a slightly forked and bent tip with a long slender body. This tool could be placed somewhere along the length of the battery, then a small downward force on the end of the round, cushioned handle would remove the battery. Due to the torque created, minimal force would be required, and the handle at the end would allow for good control. Additionally, the tool would easily fit into various spaces and would be easier to use than the other designs, which entail wrapping a tool around a battery. The other two designs would also require more force in an upward direction, which might be difficult to create (since the device would have to be held down during the process) or unbalance a person when the battery was released. Fig. 3 contains a computer-generated design of the final battery removal tool. Note the slightly curved tip, which is subtle enough to hug any size battery from AAA to D. Also, the texture and shape of handle fits the curves of the human palm well to aid in control and movement.

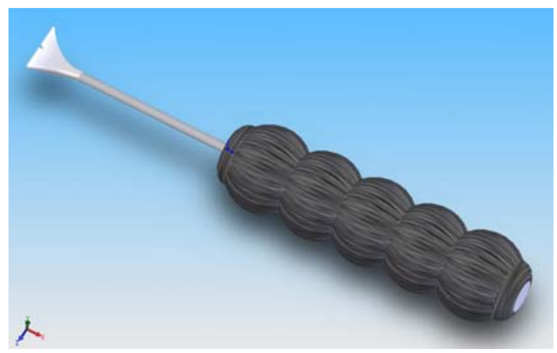

Fig. 3. Computer depiction of the battery removal tool.

C. Wireless Door Control and Communication System

Other members of the Parkinson's support group mentioned that it can be difficult to make it to the front door of their home in time to greet guests. Often they expend the effort to get to their door, only to arrive after their guest has already left. In response, one design group proposed to build a wireless door control and communication system, consisting of a small unit worn by the individual that would control a wireless audio link to the door and a remote locking mechanism.

A CC1010DK-868/915 MHz wireless transceiver evaluation kit from Texas Instruments was chosen as the development platform. The kit is built around Chipcon's CC1010 chip, a wireless transceiver with an integrated 8051-compatible microcontroller. The CC1010 was chosen for two reasons: its high level of system integration and resulting low part count make it ideal for portable design, and adequate documentation exists describing its use for applications such as this remote entry tool. The Small Devices C Compiler (SDCC), an open source compiler that can target the 8051, was used to program the chips. It was necessary to integrate the SDCC into a graphical development environment so that it could used efficiently. The freely-available Eclipse IDE was chosen for this purpose. Primary software efforts involved porting the code libraries and header files shipped with the development kit (which are written for the commercial Keil compiler) over to an SDCC-compatible format that yields equivalent machine code. This issue is common for academic users of the CC1010 platform. Fig. 4 contains a picture of the wireless door control and communication system. The inset in the upper left of Fig. 4 shows the development kit and the wireless transmitter that would be worn by the person. The inset in the lower left shows the receiver module and the circuit used to control the solenoid on the automatic door.

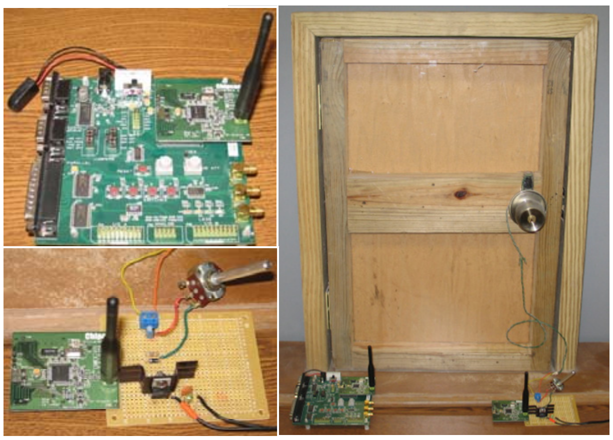

Fig. 4. Wireless door control and communication system.

III. Engagement Efforts: Women in Science & Engineering

As with the RAPD projects, the arrangement with the KSU WESP program encourages student chapter members to explore their personal biomedical interests. From a service standpoint, the additional incentive is that these college students also become involved in efforts to recruit young women into quantitative science and engineering degree programs. This section of the paper summarizes efforts to engage young women in interactive learning sessions that address topics germane to biomedical engineering.

A. Vital Signs Shirts

In the “Vital Signs Shirts” session, participants in the Fall 2007 WESP Helping Hands event [11] were introduced to the idea that unobtrusive mobile health monitoring technologies which accompany patients as they engage in their daily routine can contribute to the quality of life of those individuals in a significant, positive way. Session organizers first discussed how the heart works and introduced participants to the origin and makeup of an electrocardiogram. Each team of girls was then given a T shirt and a set of electrodes. Their task was to embed the electrodes into the shirt with whatever means necessary to make the electrodes inconspicuous (see Fig. 5).

Once the electrodes were in place, they were snapped to a CB Sciences C-ISO-255 electrocardiograph, a unit which incorporates signal amplification, filtering, and electrical isolation. Electrocardiographic data from these units were sent to an iWorx ETH-255 bioamplifier, which passed the signals on to a National Instruments connector block, where they proceded through a ribbon cable to a 12-bit data acquisition card. The data were viewed on a personal computer using the National Instruments BioBench virtual instrument. A typical data set is illustrated in Fig. 6. Fig. 7 shows a small group of participants with their student chapter mentors.

Fig. 5. Vital signs shirt construction and data visualization.

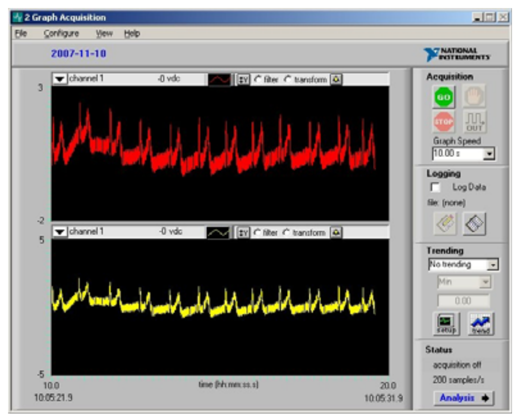

Fig. 6. Typical data set received from the acquisition equipment.

Fig. 7. A group of participants and EMBS mentors.

B. Pending Interactive Laboratories

The "Vital Signs Shirt" experience was so positive that the student chapter officers decided to expand the collaboration with the KSU WESP office to include additional interactive learning modules. These pending modules will convey the interdisciplinary nature of biomedical engineering and support member interests. Each of these labs will highlight concepts from a separate discipline, namely chemical, mechanical, and electrical engineering. One laboratory under development will teach membrane and mass transport concepts, which are fundamental to understanding human physiology and cellular-level ion transport. A second laboratory will explain friction and viscosity by way of a competition, where teams attempt to minimize the force required to slide a brick across an uneven surface. These concepts will then be related to the structure and function of hip joints by viewing radiographs and skeletal computer animations. A third laboratory will address robotic prostheses, where participants will assemble electromyogram hardware (designed by EMBS student chapter members) then use their own physiologic signals to actuate a robotic device.

VI. Conclusion

Service projects offer students a means to collectively focus on societal benevolence outside of the context of a scripted educational setting. This paper highlighted several service projects sponsored by the KSU Student Chapter of the IEEE EMBS during the first two years of the chapter's existence. These highly positive experiences affirm the decision of the chapter to focus on these service efforts. KSU faculty and the local community have responded well to requests for ideas and support, and donations of time and in-kind resources have been forthcoming by both academic and industry supporters.

Acknowledgements

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