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Smart Button- A Wearable System for Assessing Mobility

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Prior RCEU involvement: I have not participated in the RCEU program thus far, but I have supported a number of undergraduate researchers on my grants.

Project Summary: Smart Button – A Wearable System for Assessing Mobility

Recent technology advances in sensors, embedded computer systems, wireless networks, mobile and cloud computing enable the development of wearable systems for continuous human health monitoring. These systems can be used as a part of diagnostic procedures, for optimal maintenance of chronic conditions, for monitoring of adherence to treatment guidelines, and for supervised recovery. In this project we plan to develop the next-generation wearable system called Smart Button. Smart Button is designed to assess mobility in elderly and in patients with mobility impairments.

Smart Button is an intelligent battery-powered computer platform in the form factor of a button. One or more Smart Buttons are typically mounted on a subject – e.g., on subject's chest, hip, knee, or ankle. Each Smart Button includes an array of inertial sensors and environmental sensors, an embedded computer for processing signals from sensors in real-time, a wireless communication interface for sending information to personal computers or smartphones, and a battery with charger. Software running on a Smart Button derives a number of parameters that quantify physical activity or physiological state. These, in turn, can be used in standardized medical tests for quantitative assessment of subject's mobility (e.g., time to complete a test, time to transition from seating to standing, the number of steps made, balance and stability, and others). The parameters are sent to smartphones and the cloud platforms for further analysis and storing.

Smart Button will initially support several tests used in clinical settings for assessing mobility, including the Timed-Up-and-Go, 30-Second Chair Stand, 4-Stage Balance, and Berg Balance tests. These tests are routinely used to assess mobility, balance, strength of the lower extremities, and fall risk of elderly and people with Parkinson's disease. Smart Button offers an affordable solution for quantifying mobility of patients, requires minimum setup, provides an instantaneous feedback to the user in a form of a report on a smartphone, and supports automatic logging on servers, if desired. The tests can be conducted anytime by professionals or individual users. With long term storage and analysis of the tests on the medical servers, patients, informal caregivers, and health care professionals can gain insights into overall

wellness of the subjects, evolution of disease, or evaluate the impact of therapeutic interventions.

Student responsibilities will be related to analyzing inertial and physiological signals from sensors, developing new algorithms for quantifying tests of interest, and developing and testing software components for (a) interfacing sensors, (b) processing sensor signals to extract desired parameters of selected tests, and (c) communicating to smartphone/cloud applications.

Student Prerequisites

This project is open to juniors with background in Electrical and Computer Engineering or Computer Science. A student is expected to be proficient in C/C++ programming language (CPE 211, CPE 212 or equivalent courses), Arduino software development, and has working experience in embedded computer systems (CPE 323, CPE 325 or equivalent courses). Working knowledge of Linux and Android smartphone programming is a plus, but not mandatory.

Student Duties

The student will work with wearable embedded computer systems designed by UAH researchers affiliated with the mHealth Laboratory (http://portal.mhealth.uah.edu). The student will learn principles of wearable system design and principles of software development and testing of such systems. Main responsibilities will include the development of software modules for interfacing sensors, on-board signal processing in real-time, and wireless communication and synchronization with smartphones and other platforms. In addition, the student will learn the state-of-the-art in the Internet-of-Things system design and testing. The mHealth Laboratory includes a number of experimental computer systems, from low-end wearable systems to high-end cloud computing platforms. The student will learn new approaches to algorithm development, performance optimization and tuning, and energy profiling and optimization of battery-powered devices using our custom development experimental setups.

The expected deliverables include a working prototype – the next generation Smart Button, running tested and documented software components for quantifying a selected set of clinical tests for mobility assessment.

Mentor Supervision and Interaction

The student will directly be supervised by Dr. Aleksandar Milenkovic who will define monthly and weekly goals. Every week a 1-hour one-to-one meeting is planned during the summer program. In addition, the student will be working closely with graduate students affiliated with the mHealth Laboratory. Software development will be carried out using a modified agile process – the student will file brief reports about daily activities and software changes. Periodic code reviews will be conducted. The student will be exposed to research in the area of embedded computer systems through reading papers and writing technical reports.