EN 580.471 Fall 2008
Principles of Design of Biomedical Instrumentation

Challenge Project: Smart Cane for Blind

It is time to take on the challenge of a project that incorporates many of the circuits you have designed in the laboratory sessions and that requires you to think beyond what you have done so far.

The project will be mainly completed in about 4 weeks from October 20 to November 20, 2008. The lab will be accessible throughout this period and the keys will be provided upon request. You will be required to work in **groups of two** on any one of the projects listed in this handout. You should choose your partner and project (rank your preferences), and email **gracee@jhu.edu** by **5 pm** on **October 21, 2008**. Since we should have equal number of people for each project, it will be a "*first come, first serve*" method! Please send one email per group. All groups will be required to participate in the competition, which will be held in **Clark Hall** on **November 21, 2008**.

You are responsible for obtaining any parts that are not normally stocked in the laboratory room. After completion of your preliminary design and parts list, email these items to the TAs for recommendations and for approval. Each group will be given a **maximum of $25 per person in a group** for funding non-stock items. Any additional funds needed for completion of the project will be your responsibility (unless your request to exceed this amount is approved by Prof. Thakor). A receipt is necessary for reimbursement up to the stated limit (Note: sales tax will NOT be reimbursed).

The project will be judged according to the following criteria: originality/creativity/innovation, design/workmanship, whether it works or not, performance in the competition and report. As you can see, how well you plan and how you do in lab are all important, so do not leave it to the last minute.

The exact details of the problem, competition and scoring are subject to change and will be finalized in a week. Feedback (difficulty, ideas, bugs, scoring…) is welcome.

This project is designed to challenge and to stimulate. The TAs and lab manager will be available to assist you. Work hard and have fun!

Project 1: Smart Cane for Indoor-use

The objective of this project is to develop a device that provides sufficient feedback for a blind person to navigate through an obstacle course. The device can be manifested in any form that you choose (i.e. an actual "cane" is not necessarily needed). The device must include at least an optical sensor of some kind. Additional sensors of other types are permitted. The feedback can also be in any form that you choose. Examples of feedback mechanisms include vibration (on the hand, arm, leg, etc.) and sound (buzzing, beeping, speech, etc.). You are not limited to these mechanisms; however, you must use at least one type of "smart" feedback mechanism (feedback is considered "smart" if it goes beyond that of the normal long cane, i.e. incorporates some type of electronics).

The challenge is to design a smart cane that is capable of detecting moving people, low and mid-height objects (i.e. below the shoulders), ascending and/or descending stairs, and walls/doorways, in order that you are able to walk (blindfolded) through a custom obstacle course within Clark Hall. An example of the obstacle course might be: walk out of Clark Hall from room 221 via the main stairway and the main entrance. In this example, there may be opened or closed doors, chairs, people, etc. that impede your path. You must be able to detect these objects and navigate around them.

On the challenge day, one member from each team will be blindfolded and required to use their device in an obstacle course. The competition will be judged based on the time it takes for the person to traverse the course. Time penalties will be added on if an obstacle is not successfully avoided. The other team member is allowed to accompany the blind team member and give them 3 warnings/instructions, which can be - "stop", "turn left/right/around". If a team member assists the contestant more than 3 times during the competition, there will be further time penalties. Two trials will be performed per team. The team that completes the course with the lowest time (the lower of the two trials, including time penalties) will be the winner.

Project 2: Smart Cane for Outdoor-use

The objective of this project is to develop a device that provides sufficient feedback for a blind person to navigate through an obstacle course. The device can be manifested in any form that you choose (i.e. an actual "cane" is not necessarily needed). The device must include at least an optical sensor of some kind. Additional sensors of other types are permitted. The feedback can also be in any form that you choose. Examples of feedback mechanisms include vibration (on the hand, arm, leg, etc.) and sound (buzzing, beeping, speech, etc.). You are not limited to these mechanisms; however, you must use at least one type of "smart" feedback mechanism (feedback is considered "smart" if it goes beyond that of the normal long cane, i.e. incorporates some type of electronics).

The challenge is to design a smart cane that is capable of detecting moving objects (such as passersby, bicycles and cars) as well as stationary objects (such as poles, curbs, a parked car, rocks etc). Your design should have an appropriate range and warn you, with sufficient time to respond, of any moving object coming towards/by you. The final competition will not have cars coming towards you, but you should be able to tell a stationary person from a person walking towards you and both from a person running towards you. In each case, a different signal (actuator) should indicate to the blind person whether the object in front is stationary, slow or fast. Your design should also be able to detect stationary objects such as some low objects on the ground, some long curb-like low objects, as well as slender objects like poles, and high objects like over-hanging tree branches.

On the challenge day, one member from each team will be blindfolded and required to use their device in an obstacle course. The competition will be judged based on the time it takes for the person to traverse the course. Time penalties will be added on if an obstacle is not successfully avoided. The other team member is allowed to accompany the blind team member and give them 3 warnings/instructions, which can be - "stop", "turn left/right/around". If a team member assists the contestant more than 3 times during the competition, there will be further time penalties. Two trials will be performed per team. The team that completes the course with the lowest time (the lower of the two trials, including time penalties) will be the winner.

Project 3: Computer Interface

This project will demonstrate how quadriplegics may communicate with the world. The objective of this project is to develop a computer-interface, utilizing signals from your body. The bio-signals can be of any form. Examples of bio-signals include puffing/sipping, eye motion, or any other relevant signal.

The challenge is to use commands from the body to type out a message on a computer. The bio-signal should interface wirelessly to the computer. The likely design will include (1) sensors mounted on the body for signal acquisition and transmission, (2) the interface circuitry to the sensor and to the computer, (3) and typing out the message on the screen. You will compete with other teams to develop a strategy for the fastest communication of an unknown message (e.g. Give me an A+ grade). You will race against a clock to see who reaches the destination the fastest.

On the challenge day, one member from each time will be required to operate their device. The competition will be judged based on how fast you can type a particular message, with a penalty for each wrong character you type or other failures. We will then ask one of the TAs or an "unbiased" guest (same for all competitors) to operate your device and do the same. The objective is to demonstrate how quickly a naive individual learns and masters the gaming control (for this the mistakes won't be penalized, but time will be important). Your final metric for the competition will be a weighted average of the two scores.

Time-Table

It is important that you use your time wisely! The next four weeks will come and go quickly, so you need to set up a time-table and divide the labor accordingly. It is suggested that during the first laboratory period, you should have a preliminary design (show it to a TA) and begin testing the sensors that you plan to use. It is a good idea to test these sensors using the PIC to ensure their compatibility (Note: it is not necessary to use the PIC in this device). During the second and third laboratory periods, you should be working to make sure that your circuit design is implemented on a breadboard. The last laboratory period should be available for testing and for debugging your device; and also for making the enclosures, etc. It is recommended that you work throughout the week between the laboratory periods in order to ensure that you maintain this schedule. Do not wait until the last week to begin coming to the lab! You will not complete in time if you do not start early.

Division of Labor

You should divide the responsibilities up such that each member of the group is performing an equal amount of work. Be sure to take advantage of each member's strengths. If you make your circuit design modular, testing of these modules can be performed separately and in parallel with each other. As the testing of these modules is completed, implementation can be performed with ease. Remember, an actual device, not just a circuit, must be produced by the end of three weeks. Be sure to leave sufficient time to build the mechanical aspect of your device (you may need help in the workshop or from Chris).

Design Document

Each team will be required to submit a preliminary conceptual design document consisting of a brief description of the system, block diagrams, circuit schematics, algorithms/flowcharts and a list of parts that you think will be used in the project. This document will be due before the lab session on **October 24, 2008**. This will ensure that your respective TAs can go through the design with you during the lab session, and give their comments.

Report

Each team will be required to submit a report that describes your idea, the design, and any other details pertaining to the project (i.e. the results of your trials, the advantages/weaknesses of your device, etc.). The report will be due on **November 24, 2008** by **5 pm**.

Some Important Dates

- Email choice of partner and project (rank your preferences) by **5 pm** on **October 21, 2008**
- Preliminary conceptual design document due before the lab session on **October 24, 2008**
- Challenge project competition in **Clark Hall** on **November 21, 2008**
- Report due on **November 24, 2008** by **5 pm**