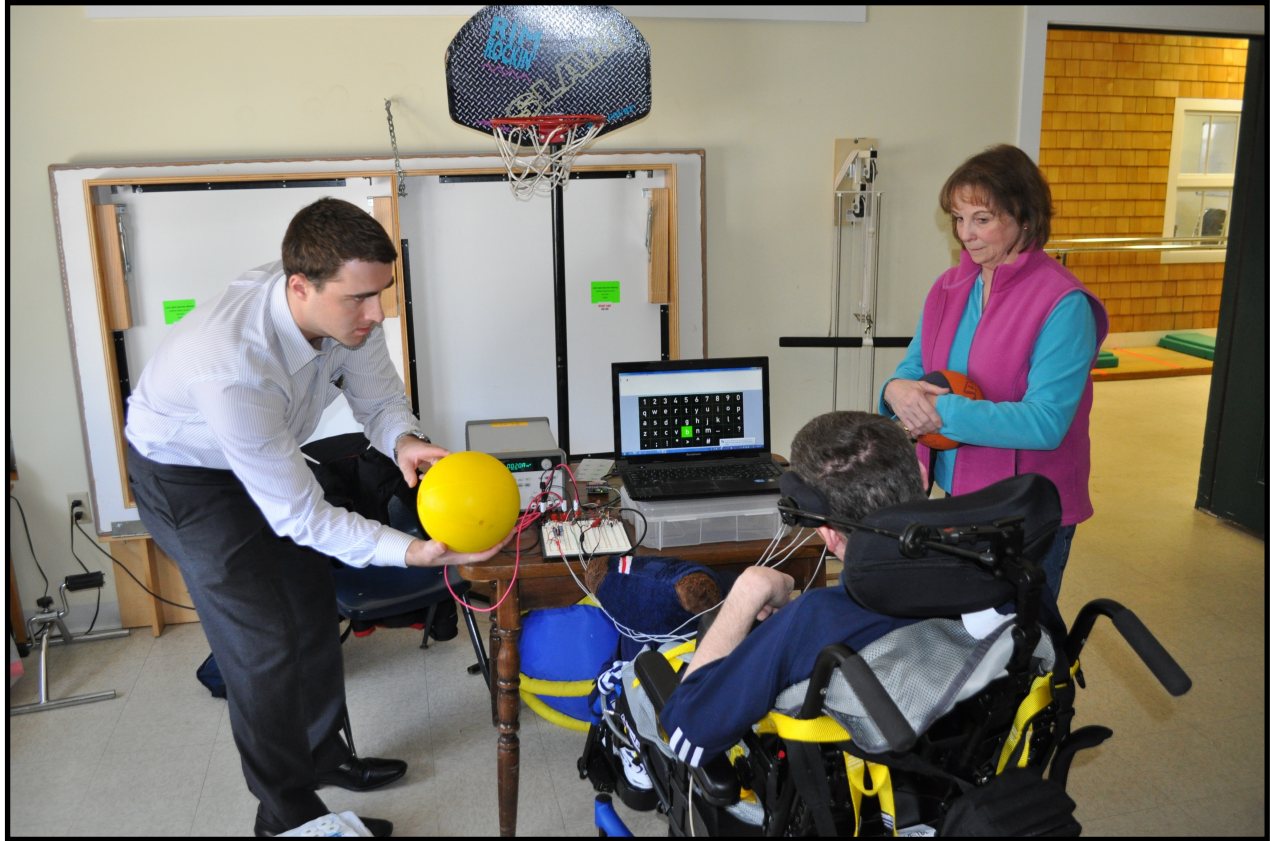# Northeastern University

Enabling Engineering Student Group Annual Report, 2014

Applying engineering to enable and empower individuals with disabilities

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Enabling Engineering
Northeastern University
http://www.neu.edu/enable

Welcome to Enabling Engineering's 2014 annual report!

Who we are: Enabling Engineering is a Northeastern University student group that applies engineering technologies to build low-cost devices that improve the lives of the elderly and individuals with physical or cognitive disabilities.

What we do: We help family members and nursing care professionals care for people with special needs. Our goal is to empower affected individuals by giving them greater independence, reducing medical errors, and increasing social connectedness, at minimal cost.

We encourage you to read about our group's mission, recent group and project milestones, and our projects. There are many ways to get involved, either as a project participant, project leader, mentor, caregiver, end user, or donor. Please contact us at enable@coe.neu.edu, or visit our website at http://www.neu.edu/enable. Thanks for your interest in Enabling Engineering!

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The need: By some estimates, 28 million people in the U.S., 9% of the population, have a severe disability, including difficulties seeing, hearing, moving, or completing daily living activities without assistance. Insurance often fails to cover expensive devices or services needed to carry out everyday tasks, and end users often prefer to be independent of caregivers.

Enabling Engineering is focused on enabling and empowering such individuals. We are working to build low-cost devices that improve the lives of the elderly and individuals with physical or cognitive disabilities, help family members and nursing care professionals care of people with special needs, and empower affected individuals by giving them greater independence, reducing medical errors, and increasing social connectedness, at minimal cost.

Enabling Engineering is a student-led, self-sustaining organization focused on achieving our goals. Students develop proposals for design projects that uses engineering technologies to improve the lives of individuals with cognitive or physical disabilities. Project groups work with end users and caregivers at local nursing homes and special education schools to assess a specific need, research potential solutions, and develop a detailed proposal for a project. Project groups are matched with product design mentors who guide groups through the design process. Seminars cover relevant topics including surveys of specific physical and cognitive disabilities, and the applicable engineering technologies.

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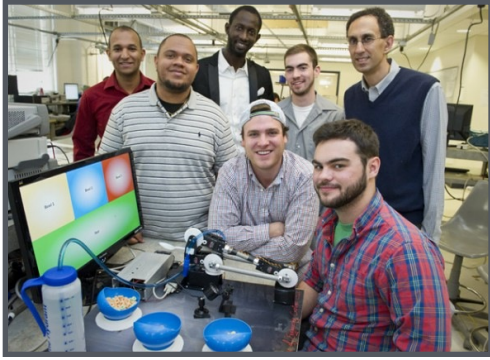
The group represents a unique partnership among undergraduate students, faculty researchers, alumni, mentors, caregivers, and end users. We use an innovative online project management system to bring all these participants together to discuss, plan, organize, and implement our projects.

Recent group milestones:

- Became an **official NU student group** and welcomed our first group of **dedicated officers**.
- Worked with **3 project partners**: Lifestream Inc., South Shore Educational Collaborative, and the National Braille Press.
- Supported **11 design projects**, three of which were completed.
- Over **30 students** contributed to one or more design projects.
- Assigned **design mentors** to project groups. Mentors are professional product engineers and designers who work at local companies, and who donate their time to advise project groups.
- Conducted more than **10 site visits** to meet with end users and caregivers.
- Acquired **lab space**, generously shared with the NU Wireless Club. Group members participated in a **STEM Education Summer Camp** for middle and high school students.
- Developed a **new course** that allows undergraduate students to get technical credit for working on an Enabling Engineering project, in addition to credit towards **honors, service-learning, experiential learning, and civic engagement**.

Recent project milestones:

- Built and tested a **keyboard-based communication system** for an individual with a traumatic brain injury. The system allows him to communicate more quickly and privately.
- Built and tested an eye-gaze tracking communication system for an individual with locked-in syndrome, based on **electroculography (EOG)**. This project won second prize in the ECE Capstone Design Competition.
- Used Google Glass to enable individuals with memory impairment to recognize others and complete tasks using **facial-recognition technology**. This project won third prize in the ECE Capstone Design Competition.
- Received **$1,000** from Northeastern's Venture Accelerator (IDEA) and **$5,000** from the National Collegiate Inventors and Innovators Alliance (NCIIA) to support **commercialization** of iCraft, our award-winning project that enables a disabled individual to feed himself using eye-tracking technology.
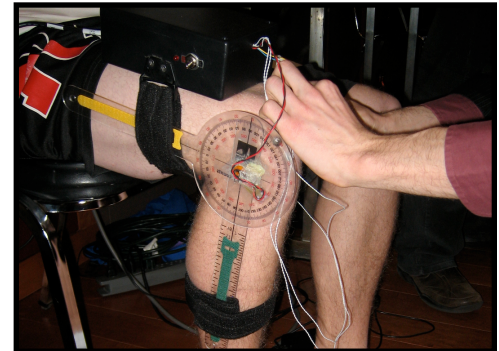
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Officers

2013-2014		*2014-2015*	
President	Aaron Cooper	President	Jake Holstein
Vice President	Jake Holstein	Vice President	Adora Jackson
Secretary	Willie Marvin	Secretary	Aaron Zannini
Treasurer	Adora Jackson	Treasurer	Dan Song
		Public Relations	Jason Hendy
		Public Relations	Isabel Welch
		Student Activities Rep	Lauren Grant
		Student Activities Rep	Ellie Schachter
		Webmaster	Burak Aslan

Project Leaders

Mohammed Kante (iCraft Project)
Aaron Cooper (Communication Mounting System Project)
Spencer Wenners (EOG Project)
Michael Harrington (Memory Assistive Glass Project)
James Ferrara (Touchscreen Guard Project)
Darren Lee (Reducing Medical Errors Project)
Rocco Farrell (Sensing Glove Project)
Alexander Greene (Help Me Get There Project)
Robert Shore (Home Automated Living Project)
Dan Thompson (Hospital Sleep Tracker Project)
Ellie Schachter (Hair Washing Project)

Mentors

Kurt Maw, Essential Design(Sleep Tracker Project)
Paul Sabin, Fikst Product Development (Touchscreen Project)
Josh Gomes, Fikst Product Development (Hair washer Project)
Adrienne Jalbert, Fikst Product Development (iCraft Project)
Steven Domenikos (Sensing Glove Project)

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Enabling Engineering:
Communication System Mounting Project

Project summary

Goal:
Enable faster communication for end user with a traumatic brain injury.

Project:
Build adjustable tray mounted to wheelchair with keyboard and monitor

Leader:
Aaron Cooper

Partner:
Lifestream Inc.

Cost:
$99

Status:
Complete

The Need

Larry Christy is a 42 year-old man originally from Quincy and now living in New Bedford. He was in a car accident and experienced a traumatic brain injury (TBI). He moves around by controlling a wheelchair using head movements. He lost most of his ability to move his legs and arms, and can no longer speak clearly. When he does speak, it is very slow, and requires a lot of energy from him. He typically communicates by having support staff members interpret messages that he types by pointing at letters on a printed keyboard. This approach is also slow and does not give Larry privacy in his communication.

The Project

Our goal was to build Larry a communication system that lets him communicate more effectively without the help of a support staff member. We built an adjustable keyboard and monitor tray that attaches to his wheelchair. The tray can be raised or lowered, and the mounting arm swings out of the way to let him in and out of the wheelchair. Larry types on a special computer keyboard with large keys that connects to a personal computer. The keyboard is attached to the tray by velcro.

Current status

This project is complete! Larry is using the communication system regularly to talk to his family, friends and support staff members. He loves using it, and finds it to be very convenient.

Next steps

Larry would be interested in having the output from the keyboard be directly connected to other programs, like an email client or Skype, to make communicating even easier. He wonders if it would be even better if the monitor could be mounted on a wall so he wouldn't have to move around with it attached to his wheelchair.

Enabling Engineering: iCRAFT Project

Project summary

Goal:
Enable an individual to feed him or herself without use of their arms.

Project:
Build a robotic feeding system and eye-tracking GUI

Leader:
Mohamed Kante

Partner:
Lifestream Inc.

Cost:
$800

Status:
Complete

The Need

Tim was in a car accident that left him unable to use his arms. He needs to be fed by caregivers who must be present throughout the feeding process. He would like to have the independence and freedom to feed himself.

The Project

Our goal was to design and build a robotic system that allows Tim to feed himself. The system consists of a robotic feeding arm, food bowls and a water bottle, eye-tracking, and a custom GUI. The simple GUI lets the user select one of the bowls to eat from by looking at the appropriate section of the GUI. Based on this command, the robotic arms moves to the appropriate bowl, scoops food, and delivers it to the user's mouth. The user can chose to return food on the spoon if not all of it is desired. The software system remembers which bowl was selected last and how many times each bowl was selected, allowing the system to estimate the amount of food remaining in each bowl. If the user would like a drink, they can select that option from the GUI. The robotic arm swivels to offer a drink straw to the user. The straw has a valve attached at the end that prevents water from spilling until the valve is squeezed open with the user's mouth. The GUI is simple an intuitive to use. The design focuses on bright colors with large selection regions. We implemented a simple, multi-level menu system.
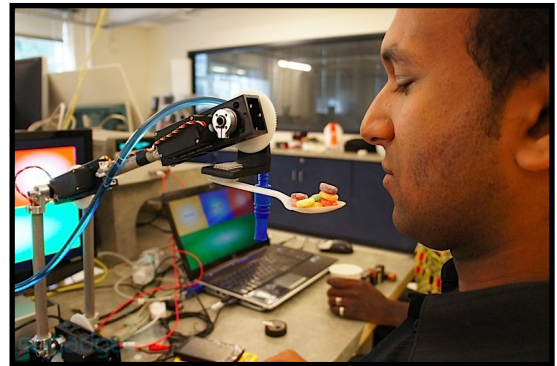
Implementation

This project was implemented through the use of a M100RAK robotic arm kit, a

Lynxmotion SSC-32 servo controller, a GUI created through C# and XAML and ITU Gazetracker software. The M100RAK robotic arm kit gives four degrees of freedom, and is scaled to the size of an adult human arm. This allows the motions to be as natural and fluid as possible.The

Current Status

The project is complete and was successfully tested by end users at Lifestream, including Tim. The project was also received widespread media attention, including a CNN feature, and articles by Engadget, Forbes, PCWorld, and Herald News. The project also won first prize in NU's ECE Capstone Design Competition.

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Enabling Engineering: EOG Project

Project summary

Goal:
Enable an individual with locked-in syndrome to communicate more quickly

Project:
Build a gaze-tracking system based on EOG

Leader:
Spencer Wenners

Partner:
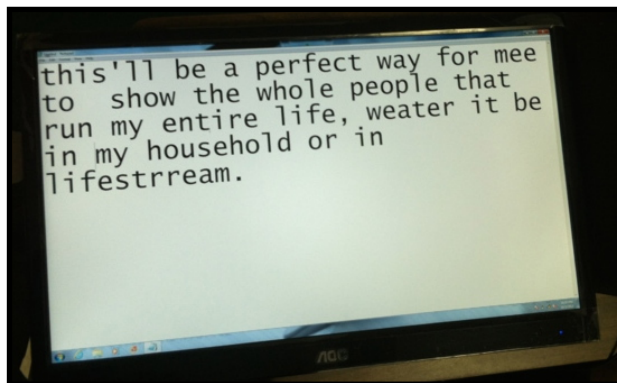Lifestream Inc.

Cost:
$204

Status:
Complete

The Need

There are currently about 50,000 people with locked-in syndrome (LIS) in the United States. Locked-in-syndrome is a condition that results in complete paralysis with the exception of the eyes. This condition reduces the patient's ability to communicate with the outside world using conventional methods. The current communication methods for these patients are limited, time consuming, and dependent on other individuals.

The Project

Our goal was to build a system that allows the user to express approximately 1.25 words per minute, which is twice as fast as the current best approach, partner-assisted scanning. Our system uses a computer to run an on-screen keyboard application. Our system uses a clinical measuring technique called electrooculography, or EOG. The technique relies on the physiological property that the front of a person's eyes is more positively charged than the back of the eyes. We use this standing voltage difference, called the corneoretinal potential, to determine which way the uses his or her eyes. By looking at the desired character on the screen and then blinking, letters can be selected. Our GUI keyboard application contains letters A-Z and numbers 0-9 as well as common punctuation, text-to-speech functionality, and saving to a text file.

Current Status

This project was tested by John, an individual with locked-in syndrome, who is supported by Lifestream. He was able to type a paragraph of text much more quickly and without the help of a support staff member. The project also won second prize in NU's Capstone Design Competition.

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Enabling Engineering: Memory-Assistive Glasses Project

Project summary

Goal:
Enable an individual with memory-impairment to recognize others and complete tasks

Project:
Use Google Glass to implement facial recognition and task reminders

**Leader:**
Michael Harrington

Supporters:
ECE/COE

Cost:
$1500

Status:
Complete

The Need

Memory loss is a serious issue for both the affected individual and those who surround them. Today, an estimated 5.2 million Americans have some stage of Alzheimer's, a disease that attacks the brain and causes memory loss and dementia. People with Alzheimer's or other forms of memory loss often struggle with recognizing faces and remembering how to perform basic tasks. These individuals are often required to be aided by family members, nurses, and are sometimes forced to live in assisted living residences. According to the Alzheimer's Association, "in 2013, 15.5 million caregivers provided more than 17.5 billion hours of unpaid care valued at over $220 billion".
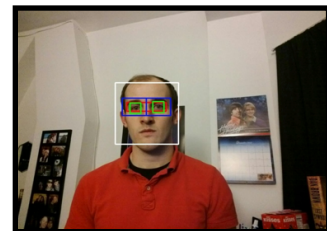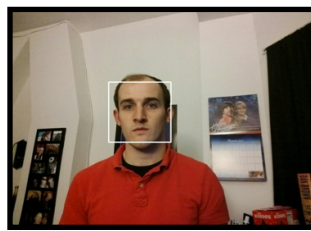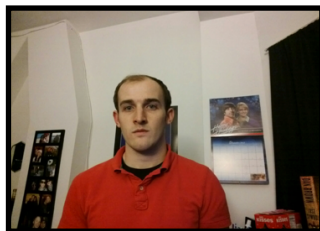
The Project

Our goal was to help memory-impaired individuals, such as early stage Alzheimer's patients, by identifying people they come in contact with, identifying objects, and displaying step-by-step instructions for simple tasks. Our design uses Google Glass to interface with the user, which includes a small display, a 5MP camera, a bone-conduction speaker, and a touchpad. Using Google Glass and an Android application, the user takes a picture of people they would like to recognize and adds the picture to a database. When the user would like to identify someone, they take a picture of the person and Google Glass displays the matched person's name and relationship on Glass's display. If that person is not found in the database, the user must add the person to the database via our Android application. Memory-impaired individuals also have difficulty remembering steps for simple tasks, such as where to put the dishes after unloading the dishwasher. Using our application, the user scans the QR code and the corresponding steps are displayed to the user on the Glass's display .

Current Status: This project is complete and won third prize in the NU Capstone Design Competition.

Enabling Engineering:Touchscreen Guard Project

Project summary

Goal:
Enable individuals with disabilities to use tablets

Project:
Implement touchscreen guards

Leader:
James Ferrara

Partner:
South Shore Educational Collaborative

Mentor:
Paul Sabin (Fikst)

Status:
In progress

The Need

Children with developmental delays take therapeutic classes that use iPads. However children often have trouble pressing buttons on the screen of tablets, and sometimes press the wrong button. Teachers would like tablet covers that make it easier for children to only select the items on the screen being used for a lesson. The covers should be easy for teachers to place and remove, hard for children to remove, and should be cheap enough to be customizable for each application.
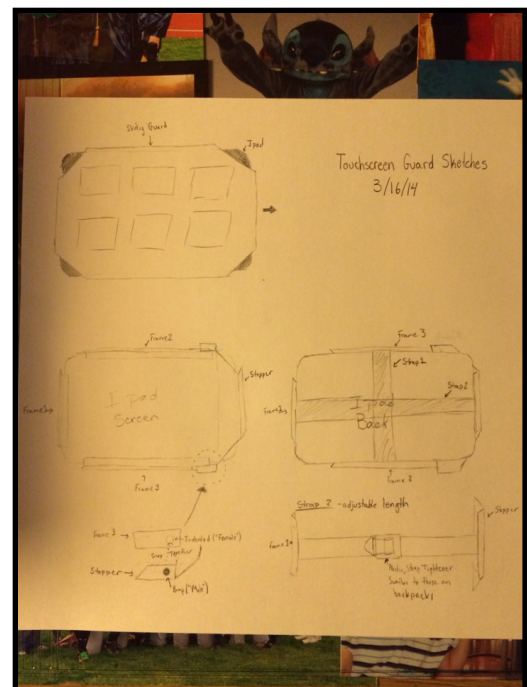

The Project

Our goal is to develop a design for iPad covers to make it easier for children for developmental delays to learn using tablets. The covers should be transparent, minimize screen gap, connect securely to the iPad, and should not impede access to the buttons or charging port.

Current Status

This project is in progress.

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Enabling Engineering: Reducing Medical Errors Project

Project summary

Goal:
Reduce errors in medicine delivery

Project:
Implement new protocols and technology to make it easier to give medicines correctly.

Leader:
Darren Lee

Partner:
Lifestream

Status:
In progress

The Need

Nurses and other caregivers deliver large numbers of medications to patients. For each event, the correct medicine must be given to the correct patient, at the correct time, in the correct dosage. The number of medication delivery events and patients that a caregiver must manage makes it harder to ensure that errors to not take place.
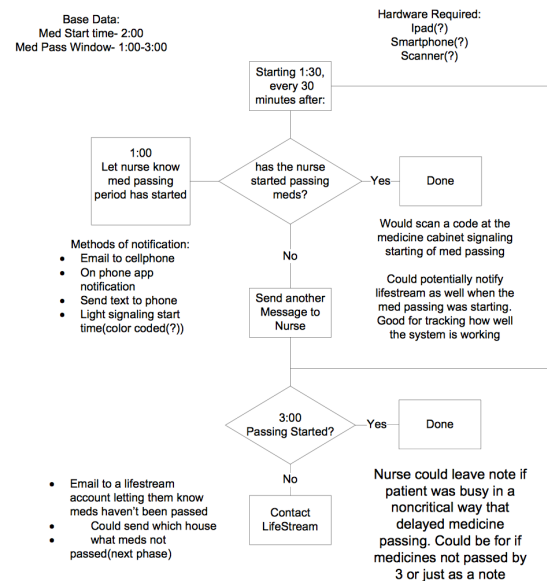
The Project

Create a system to better organize and structure the existing system for passing medications. The solution must prevent nurses from finding ways to avoid using it, and not create an overly trusting attitude of nurses instead of double-checking and using common sense. It also must comply with laws and regulations about medicine transfers and record-keeping.

Current Status

This project is in progress. Group members have had several conversations with caregivers to gather information about the nature of the problem. Group members have also visited a caregiving site to observe how medications are delivered and develop more specific ideas.

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Enabling Engineering: Sensing Glove Project

Project summary

Goal:
Transmit tactile sensations over the internet

Project:
Build tatcile gloves that capture, transmit, and recreate tactile sensations

Leader:
Rocco Farrell

Partner:
Steven Domenikos

Status:
In progress

The Need

Individuals with autism often feel disconnected from the people around them. Online social media can provide a means for these individuals to connect with friends and family. However the lack of physical interaction in online communication can be isolating. By capturing a sense of touch and recreating it social feedback can be created in a comfortable environment. This allows those with social interaction issues to feel tactile sensations that they enjoy.
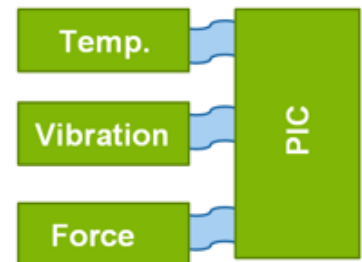
The Project

Our goal is to create a wearable glove with the ability to absorb the full spectra of tactile information that the human hand senses, and then transfer that information wirelessly to a glove that replicates these sensations for another person. Our device will aim to quantize three of the key elements present in a sensation of touch: pressure (force applied over an area), vibration (frequency of motion perpendicular to the surface being felt), and temperature (difference in temp. between the sensor and the surface being read). Pressure will be read by a constructed Hall-effect sensor enclosed within a rubber dome, capable of realizing the forces in both the normal and shear directions. Vibration will be recorded using two accelerometers, to gather the frequency of vertical oscillations as the sensor is dragged across a surface. Finally, temperature will be read using the difference between two temperature sensors on the sensing apparatus.

Our final product will consist of these three sensor arrays constructed into a rudimentary glove-based device. Each of the three sensor arrays will be designed onto a PCB, which will then each be placed on a finger of the user. Using this configuration, the user can then contact the surface with the sensors, at which point the three quantities will be recorded. This data will then be processed and packaged properly to be sent to a receive device, where the sensation of the surface can be recreated.

Current Status: This project is in progress.

Enabling Engineering: Help Me Get There Project

Project summary

Goal:
Make crossing the street safer for individuals with vision impairment

Project:
Use RFID tags and readers to transmit intersection information to the user

Leader:
Alexander Greene

Partner:
National Braille Press

Status:
In progress

The Need

37 million people in the U.S. are blind or have a visual impairment. For these individuals, travel within a busy city can be dangerous. The urban infrastructure often fails to convey the information necessary for the visually impaired to travel safely. Our goal is to make crossing the street safer.

The Project

The Help Get Me There application will identify a user's location with RFID tags located at both ends of crosswalks communicating with an RFID reader and Bluetooth transmitter located on the user. The RFID reader located on the user will forward this information to the smartphone allowing the application to pull up information about the intersection. The application itself will then fulfill a variety of roles to provide the user with information necessary to cross the street easily, including:

- Intersection Identification: The application will be capable of informing users what intersection they are at, by announcing the two intersecting street names using RFID tags.
- Crosswalk Alignment: The application will use the compass within smartphones to align the user so the he or she may safely cross the intersection.
- Crosswalk Signal Alignment: When arriving at an intersection the user would like to know where the button is for crossing the street without needing to ask. The direction of the button will be sent to the user using the same method as crossing the street, by giving the user a direction from the smartphone compass.
- Intersection Description: The application will send information about islands, number of car lanes, and if the road is one-way or bidirectional at a crosswalk.
- Button Identification: Our application will be engineered to announce the name of the button when pressed and only activate the button's function on release.

Current Status: This project is in progress.
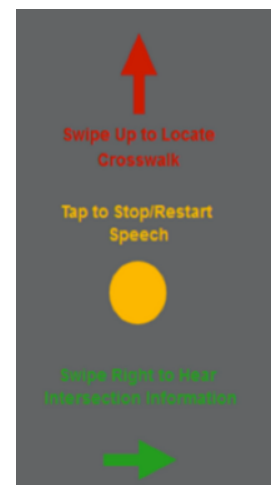
Enabling Engineering: Home Automated Living Project

Project summary

Goal:
Makes homes safer for children and individuals with disabilities

Project:
Allow caregivers to monitor and control devices remotely

Leader:
Robert Shore

Status:
In progress

The Need

Homes can be dangerous places. Perhaps not to most people, but to small children and persons with disabilities homes can pose great risk. The fixtures and appliances that usually offer great utility and convenience create numerous potential sources of harm to both the household and its members when used improperly. The ability to control and manage access to home fixtures and appliances that can cause harm would ensure the safety of the home and its occupants. Our system will provide parental controls and childproofing to the home at reasonable cost.
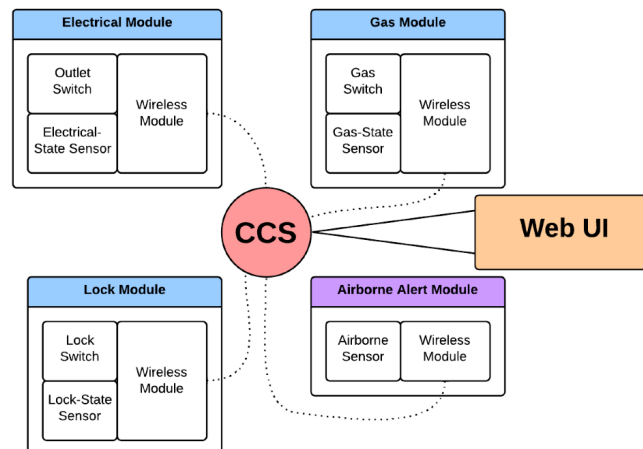
The Project

The system will allow caretakers to monitor the use of different devices and appliances as well as control access to them based off of the presence of responsible household members thus providing caretakers greater peace of mind about the safety of their homes and loved ones. The system uses a central control system (CCS) in conjunction with an array of wireless control and sensor modules. The CCS is the brain of the project; it will monitor if responsible adults are in the house based off their cell phone's presence on the wireless network, as well as control and read information from the different modules. It will use this data in conjunction with userdefined rules to disable and enable different devices via their control module. The system will be also able to use data collected from its sensor modules to send notifications via email, text, or push to defined recipients about the use or status of devices.

Current Status: This project is in progress.

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Enabling Engineering: Hospital Sleep Tracker

Project summary

Goal:
Enable nurses and caretakers to track a patient's sleep cycle for optimal waking and to watch for any bed disturbances

Project:
Develop a device that can track sleep patterns based on a patient's movement

Leader:
Dan Thompson

Mentor:
Kurt Maw (Essential)

Status:
In progress

The Need

Caregivers and nurses often have to watch over several patients at once. There are certain times that a patient may have to take medication or need to be moved in order to prevent bed sores. If they are asleep, however, nurses will have to wake them. Patients may become grumpy, groggy or difficult to wake if they are in a deep sleep. If we can track which sleep cycle a patient currently is in, caretakers can take advantage of a light sleep cycle to wake patients. Patients may also leave the bed unbeknownst to caretakers so the device could double as a bed alarm as well.

The Project

Our goal was to design a device that can track a patient's sleep cycle based on movement. Using an accelerometer feeding into a microcontroller, an algorithm analyzes the accelerometer data from a patient's movement on the bed to translate it into what sleep cycle he/she currently is in. We plan to be able to plug in the data into a computer alongside all other data in a patient monitoring system. This way a nurse can monitor multiple patients from a central location.

Current Status: This project is currently in progress and is rapidly making progress. We hope to have a working prototype by the end of the year with reliable data.

Enabling Engineering: Hair Washer Project

Project summary

Goal:
Enable an individual without use of arms to complete simple tasks independently

Project:
Develop a system of washing all types of hair without using hands or arms

Leader:
Ellie Schachter

Mentor:
Josh Gomes (Fikst)

Status:
In progress

The Need

Individuals with physical deformities suffer from the inability to complete simple daily tasks that many take for granted. Washing your hair and eating are two of the many daily tasks that require hands that most people don't even think twice about. People born without hands or arms have an especially difficult time because so many tasks require the use of your hands. In some instances, getting help can be frustrating or even embarrassing for people. Having someone come to the bathroom and help with showering or brushing teeth is a struggle that can be eliminated.

The Project

This project aims to solve one of the many struggles in the life of someone without arms. This hair washing system will enable any individual who is unable to wash their hair without help to easily complete this simple task. This system will incorporate a shampoo dispenser, scrubbing tools, and combing tools. Currently, various methods of scrubbing are being investigated to find a good balance between functionality and cost for the overall system. The next steps will be to create up to three different prototypes to experiment with to identify a final design to move forward with.

Current Status: This project is in progress.

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Northeastern University

Support Enabling Engineering at Northeastern University!

I would like to help Enabling Engineering enable and empower individuals with disabilities with the following donation:

        ☐ $1000

        ☐ $500

        ☐ $250

        ☐ $100

        ☐   Other (please indicate donation amount $_____)

Contact Name: _____

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Please make checks payable to Northeastern University, with Enabling Engineering in the memo field, and send this form and your donation to:

Prof. Waleed Meleis
Northeastern University
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Please click on *Give Now*, select the *Other* designation for your gift, and enter Enabling Engineering in the box for *Special Instructions*.

Thank you for supporting Enabling Engineering!

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