Capstone Design Abstracts

Spring 2016

Concussense

Team Members: Will de Rivera, Alex Dillman, Richard Lamourine, Brian Rose, Michelle Suk
Advisor: Professor Masoud Salehi

Abstract

The Concussense team has designed and built a device to be used to diagnose concussions. This device is cost friendly, and portable enough to be used by a sports team on the field.

In issues related to sports injuries, concussions have been brought to the forefront of the conversation. With that in mind, a device that could diagnose injuries on the field have become more relevant and desired. In addition, a device that could track the recovery of a concussion could help prevent a condition called Second Impact Syndrome (SIS). SIS occurs when one experiences a second concussion before they are fully recovered from an initial one, which could lead to serious and fatal complications such as rapid brain swelling.

Our system is designed to diagnose and track the recovery of a potential concussion, using a biological signal known as cerebrovascular reactivity (CVR), the rate of change of blood flow to the brain. Studies have shown that when a patient's blood flow is reduced, the rate of recovery in a healthy patient will be greater than that of a patient with a concussion. Our device uses a simple test where a patient is asked to hold their breath, which causes a decrease in blood flow in the brain. When a sufficient decrease is detected, the patient resumes normal breathing and our device is capable of measuring the amount of time it takes for the patient's blood flow to return to initial levels.

No clinical levels of CVR have been established as thresholds for the diagnosis of a concussion, however, a number of medical journal papers have shown a correlation between reduced CVR and concussion. As a result, our device is designed so that a measurement can be taken on a healthy patient and then used as a baseline to compare future measurements against.

Our system uses near-infrared spectroscopy to measure the amount of blood in the brain. We use a small LED to shine light into the brain through a fiber optic cable, and then have a second cable mounted on the skull near the first which brings light emitted from the skull to a photodetector mounted in our device. We then perform hardware filtering and input the data to a Raspberry Pi through an analog-to-digital converter, where we calculate the CVR.

The user interface of our system is an Android application. It displays the CVR measurement calculated on the Raspberry Pi and sent via Bluetooth.

The WASP Pot

Team members: Hashem Khalifeh, Wenshu Huang, Armando Lopez, Ekposuoemi Koroye, Nouf Almutairi, Mingting Chen

Advisor: Professor Waleed Meleis

Most people today are constantly on the move; taking time out to maintain a house plant or garden is discouraging, therefore they avoid owning one at all.

By combining automation with planting, we merge the ease of modern technology with the benefits of nature. Automated irrigation systems exist, but they are mostly space-consuming, aesthetically unappealing, and lack the integration present in today's technologies.

Our solution is the WASP pot. There are three main layers to the physical pot; the top layer is the soil with subsurface drip irrigation pipes built into the device; the middle layer is the water storage tank; and the bottom layer is the electronics and battery compartment. The device has a built-in solar panel that can charge the battery for off-grid operation and sustainability. The rechargeable battery, at full charge, will be able to power the device for four full days. There are also two sensors; the moisture level sensor, which is positioned inside the soil; and the water level sensor, which measures the amount of water within the tank. They are controlled by an Arduino board, which also powers the water pump to irrigate the plant. We also have an Android application, which serves as the monitoring system for the user; it displays plant details and sends alerts to the user when necessary. Data is sent remotely from the device to the mobile app, also using the Arduino. Through this device we present an easy, elegant and efficient solution to plant irrigation and maintenance.

Impedance Plethysmography Non-invasive Blood Pressure Monitor

Team Members: Andrew Blum, Kevin Ethier, Andrew Martone, Ajay Patel, Kenneth Smith, Oleg Vaskevich

Advisor: Professor Bahram Shafai

Abstract

We designed and built a device and system for monitoring an individual's blood pressure (BP) through the use of impedance plethysmography (IPG). Our device makes significant improvements over current non-invasive blood pressure (NIBP) monitors that solely use pressure transducers to obtain a BP reading.

Traditionally, automatic NIBP monitors measure BP by inflating and deflating a cuff, and then measuring the pulses that are superimposed on the cuff's pressure transducer as it is deflated. The largest superimposed pulse is the mean arterial pressure (MAP), and is used to empirically derive systolic and diastolic BP values. This is done by using a population-based algorithm to relate the MAP, found oscillometrically, to BPs found with a stethoscope or an arterial catheter. The significant shortcoming with this method is that it is not guaranteed to be accurate in all patients, and may provide incorrect results.

An alternative method of obtaining BP measurements that provides superior accuracy involves measuring the bioimpedance of the brachial artery while inflating and deflating a BP cuff over the arm. This is done by characterizing the physical phenomena of arterial occlusion of the brachial artery and restoration of blood flow corresponding to cuff inflation and deflation. Using bioimpedance as a method for measuring BP also opens the potential to measuring other parameters, such as the pressures of blood vessels other than the artery, as well as the perfusion index, the speed that it takes for blood to transfer to peripheral tissue. A device using this method can also provide better motion tolerance by corroborating data from multiple sensors.

Bioimpedance has the advantage of being an active measurement of stimulus response which allows the designer to optimize the signal to noise ratio; in contrast, the conventional use of a stethoscope offers a passive method of the measurement of korotkoff sounds. We propose using IPG to make an automated NIBP monitor that is more accurate and robust while opening the potential to collect more useful parameters. Our device is also integrated with a web-based system that makes it easier for patients and physicians to interact with each other and for physicians to keep track patients' health over time. The system also allows patients and physicians to track readings over time.

To use our device, the user places a cuff on his or her arm—the same type that is used by current NIBP monitors—along with 2 electrodes placed on the shoulder and forearm, and then starts the device. First our NIBP monitor inflates the cuff to the industry-standard target value. It then proceeds to increase or decrease the target pressure based on whether a pulse can still be measured, which signifies that an occlusion has occurred. At that point, the cuff starts to deflate. Until it is fully depressurized, the cuff discretely deflates, in order to obtain the most accurate data. During this entire process, it records pressure and impedance measurements. At the end of the process, the raw measurements are compiled and then the user's BP is computed, as well as relayed to our web-based system.

For testing and validation, we built a NIBP monitor and a web application. We tested using simulated sensors, as well as on the arms of consenting individuals, following medical safety guidelines for electrical current passing through a human limb. The results indicated that IPG can be used to obtain an individual's BP readings. We believe that not only can IPG be used to obtain BP readings, but that it can also be used to obtain additional helpful cardiac measurements. Overall, the results of the NIBP monitor offers a superior method of measuring blood pressure over conventional means, and is a useful contribution to the industry of physiologic monitoring.

Campus Security with Facial Recognition

Team Members: Michael Brunetti, Valerie Charry, Ethan Kaley, Nicholas Lade, Michael Stent, and Christopher Thompson
Advisor: Professor Masoud Salehi

Northeastern University's current method of securing its residence halls is both out of date and inconsistent. Its use of paper logs and magnetic stripes is not only slow and frustrating for the students, but it is also wildly variable, depending on who is proctoring and how strictly they adhere to the security protocol. For a large university in a major city, it is of the utmost importance that the safety and security of its students be monitored in a consistent and reliable fashion. That is why we have designed a system which is not only more reliable and efficient than the current method, but also reduces the risk of lax proctoring standards and loose security protocols.

Our system is both modular and scalable, allowing it to be employed by a variety of institutions varying in size, location, and necessary security protocols. However, we have designed the initial prototype and demonstration to be fitted to Northeastern residence hall's needs. For this purpose, the primary method of security relies on a two-tier identity verification process, employing NFC chip technology and Fisherface algorithms to recognize the residents' faces via a live stream from a nearby camera. Simply speaking, the camera pulls images of the students and compares them to the faces saved to the students' profiles on our student database. If the face in the camera matches the face in the database, then the door is unlocked and the student is admitted to the building. However if there is a mismatch, or if a student is trying to enter a building that he or she does not have access to, then the proctor will be alerted and he or she will take the appropriate action (i.e. either overriding the system as a facial recognition failure or alerting NUPD of a security breach). This forces the proctor to take action only when there is a potential security threat, decreasing the risk of proctors falling into lax security practices.This system is implemented using two main nodes, a Raspberry Pi and an AWS instance. The Raspberry Pi is used primarily as the data acquisition node, while the AWS instance is operating as the computational node. Connected to the Raspberry Pi, we have our video camera, NFC reader module, motion detector module, and the electronic door lock (which for the purposes of demonstration will be represented by red and green LEDs). The Pi sends its video stream as well as all of it NFC data to the AWS instance where all of the computationally heavy facial detection and recognition code is run. The AWS instance will then make all of the necessary database calls and send an admit signal to the Raspberry Pi, which will unlock the door, or it will send an alert signal to the proctor's UI, who will then handle the situation accordingly. The proctor's UI is a simple web app which will allow proctors to use any internet accessible device they choose as their interface device.

Finally, in an effort to save paper and space, all guests entering the residence hall with permission on a resident will have their identity confirmed by the same system (if they are an NU student) and will be electronically logged in our database regardless of NU affiliation. This will create an easily searchable record of all guests who entered any NU residence hall, which is far superior to the current paper log system.

GlucoSense: A Portable, Non-invasive Salivary Glucose Monitoring Device

Team Members: Daniel LaBove, Matthew Stelma, Christian Grenier, Bradley Howe, and Munachimso Ihionu

Advisor: Professor Waleed Meleis
Collaborators: Wenjun Zhang, Yunqing Du, Interdisciplinary Engineering Program, NU; Ming L. Wang, Ph.D., Civil Engineering Department, NU

Abstract

The most common method to self-monitor blood glucose levels for hundreds of millions of people who suffer from diabetes requires invasive, painful finger pricking that can lead to bruising, loss of sensitivity, and blood-borne infections. Due to these adverse effects, many patients do not monitor their blood glucose levels as often as they should, which can have dangerous repercussions to their health. We propose an accurate, portable, non-invasive method to detect salivary glucose levels that can ultimately be used to determine the linear, but individually dependent, correlation between salivary and blood glucose concentration for diabetics.

Our custom-designed device measures glucose concentration from a saliva sample detected by a biosensor developed and patented by Northeastern professor Ming L. Wang and Ph.D. candidates Wenjun Zhang and Yunqing Du. Our design features a potentiostat circuit that interfaces with their three-electrode electrochemical sensor and performs an amperometric measurement by applying a constant bias potential between the working and reference electrodes via a digital-to-analog converter (DAC). The sensor signal, which is a current on the order of 10^{-7} A, is conditioned through a three-stage amplification and Bessel low-pass filtering circuit that features high signal-to-noise ratio (SNR) voltage in order to achieve high resolution when sampling with an analog-to-digital converter (ADC) internal to the microcontroller (MCU). The signal is sampled at a rate of 20 Hz for thirty seconds, after which a section of the signal is integrated in firmware to acquire a current density that is linearly proportional to the concentration of glucose present in the saliva sample applied. The correlated salivary glucose concentration in mg/dL is then displayed on the LCD via SPI communication.

Ultimately, our device could then be used for a calibration procedure to correlate a user's salivary glucose concentration to their blood glucose concentration. This correlation has been shown in previous studies to be linear but individually dependent, and is beyond the scope of this capstone project. However, to lay the groundwork for this potential next step, an iOS app was developed that takes in a user's correlated blood glucose level and interfaces with Apple's HealthKit to provide secure data storage and features such as temporal plots and sharing of glucose readings with family members and health professionals. This capstone project is a successful step in the development of a commercial product that allows hundreds of millions of people to non-invasively monitor their blood glucose levels.

The Eos Link: Pneumatic Augmented Reality Tactile Feedback Platform

Team Members: Amery Cong, Neil Dave, Sean Kerr, Alejandro Ramirez, Theodore Stoddard
Advisor: Professor Bahram Shafai

Abstract

The Eos Link is a wearable pneumatic electronic system designed to simulate tactile sensation in a virtual environment. To accommodate applications ranging from gaming to physical therapy to remote instrumentation control, the Eos Link was created as a cost efficient platform with a high temporal and scalable spatial tactile resolution to provide the best deliverable for each need.

The Link uses a high flow diaphragm pump and an array of pressure sensors and valves to inflate individual pouches placed on a user worn glove at key sensory locations of the hand. The appropriate pouches on the glove inflate and notify the user of collisions caused by their avatar hand in virtual reality, enabling a user to feel virtual objects. The array of pressure sensors monitor the pressure in each pouch and allows for variable pressure control in each pouch based on the force of each respective virtual collision. This variable pressure feedback allows for users to not only feel the size and shape of virtual objects but additionally feel the relative weights of objects constructed in each virtual environment.

The Eos hardware currently consists of a main PCB and a set of peripheral valve PCB's stacked in an array customized to the number of pouches needed for each application. The main PCB contains a set of 15 pressure sensors, a microcontroller and voltage regulation circuitry to generate the power rails for the entire system. The current microcontroller, the Arduino Mega was chosen due to its high IO and for quick design verification within the constrained design timeline, however the board has an existing empty footprint, to place the microcontroller directly to the board and program via JTAG, which will be implemented in the next product revision. The main board supplies power to and controls the inflation circuitry for each individual pouch on up to three peripheral boards. Each peripheral board has the components to support up to 6 pouches, allowing for the Eos to be a truly scalable platform with a form factor that matches each application. For instance only 1 peripheral board is needed to support 5 fingertip pouches, for lighter physical therapy and remote instrumentation applications, 2 boards can support 12 pouches for moderate physical therapy application and low end gaming and 3 boards can support up to 18 pouches for a maximally immersive experience for intensive physical therapy and high end gaming.

The augmented reality integration is provided by the Leap Motion which obtains hand tracking data used to render the users hand in the game engine Unity. Serial communication is established between the Eos and Unity using the Microsoft Net 2.0 framework which transmits the virtual collisions between the player avatar and objects in Unity to the Arduino to actuate the appropriate hardware. A lightweight implementation for the hardware to software interface was used for the communication protocol so that it could easily be ported to different virtual engines such as Unreal or Source, work seamlessly with libraries used for other tracking hardware such as OpenNI and the Microsoft SDK for Xbox Kinect, and easily work with future in house developer augmented reality hardware and software. The protocol implements a simple messaging scheme which enables the platform hardware to easily migrate communication from Serial to BLE, WAP or GPRS in future revisions of the product with minimal changes to the Eos Link firmware.

White Cane Assistive Device (WCAD)

Team Members: Sam Chandler, Nick Materise, Mark Mossberg, Jeff Simon, John Sullivan, and Marc Thomas

Advisor: Professor Masoud Salehi

Abstract

The complications associated with blindness call for a tool that extends one's perception of their environment such that they can navigate safely and effectively. The white cane is one solution, though it does not identify objects above waist level and fails to detect sudden drops. We intend to tackle these issues in the least invasive way, not hindering the current use of a cane, or replacing it, but effectively extending the cane to assist the user. We propose a mobile device that provides haptic feedback to alert the user of head-level objects or unsafe drops: the White Cane Assistive Device. This device will use a LIDAR distance sensor for the detection of drops and one ultrasound range finder to detect suspended obstacles. The device will be sufficiently mobile, securing to the handle of the cane unobtrusively, and maintaining power for all-day use. To attain this battery-life, the WCAD will employ power efficient processing and a high capacity rechargeable battery. The White Cane Assistive Device will enable visually impaired users to navigate new environments with confidence.

Smart Walker

Team Members: Lukuan Yu, Kwesi Abakah, Hamdalla Issa, Anjalika Goyal, Wenbo Liang, and Joscelyn Stonis

Advisor: Professor Waleed Meleis

Abstract

Many people go through physical therapy involving a walker if they've suffered a stroke or an injury hindering their ability to walk. There exists a walker that can keep track of a person's dependency by measuring the weight applied when using it. These walkers, however, are limited due to their bulkiness, excess of wires, and lack of user access. The downside to this method is they may not progress as quickly as they don't know what holds them back. For example, they may lean towards one side without them knowing or someone who monitors their rehabilitation process may want information on their progress without having to watch them attentively for some period of time. As a solution to this dilemma, we present the Smart Walker. This device will put the aforementioned problems to rest.

This walker will allow the patient and the therapist to see what they can improve upon to expedite the process. The Smart Walker has S-type tension/pressure sensors to indicate whether they are leaning towards one side significantly. The sensors will allow the user to closely look at their movement. There is a bar mount to hold a tablet that has an installed app we developed, providing user-friendly graphics to indicate the problems that arise. It also keeps track of the data in a SQL database that a therapist can look at once wifi is available. The problem with current designs of 'smart walkers' is that they don't provide feedback to the user which is important, as a therapist can't always closely follow the patient around. Our app will allow the physical therapist and the user to receive real time feedback through visual graphs and text on the app, which will collect data as it is being used. This will allow the both sides to more effectively monitor the rehabilitation process and create better plans for the future, while also allowing the user to be a more active part in their own recovery.

By designing an updated version of a walker with smaller, accurate, sensors, a user-friendly design, and an attached tablet with an Android app for wireless communication between the walker and Android app, we hope to expedite the rehabilitation process, resulting in a smoother and shorter process for the user and physical therapist.

SentSys: AN ALL-TERRAIN ROBOTIC SENTRY

Team Members: Elizabeth Amyouny, Ben Beckvold, Andrew Musto, Jonathan Sullivan, and Matthew Teetshorn

Advisor: Professor Bahram Shafai

Abstract

SentSys is an unmanned ground vehicle (UGV) developed over the last year at Northeastern University, with financial support from the Air Force Research Lab. Given an externally generated waypoint, SentSys autonomously proceeds to a location of interest in order to provide real-time video surveillance. Utilizing stereo vision cameras, an inertial measurement unit (IMU), and other sensors, SentSys is able to perform robust Simultaneous Localization and Mapping (SLAM) tasks in order to build and navigate within a map of its local environment. The UGV's high portability and weather resistant housing is designed to operate in environments that include snowdrifts, puddles up to a foot deep, and uneven terrain. The design and implementation of SentSys encompassed five major design blocks: software architecture, communications, mechanical integration, perception, and power control systems.

SentSys consists of the UGV and its base station. The primary focus of the base station is to provide a human machine interface and communication to the sentry via standard TCP/IP over a dedicated wireless network. The UGV itself is equipped with two antennas: one for GPS information and one for wireless data transmission over 2.4GHz WiFi. The UGV is also equipped with a rechargeable battery system that provides the power requirements for the motor drive and the SentSys subsystems. The management and distribution of power to the subsystems is administered through a customized printed circuit board assembly that provides intelligent control to the UGV's various DC components. Encoders, situated on the axle of each tread, provide the primary source of odometry data. Additional data from the IMU and other sensors is fused in an extended kalman filter in order to produce robust and accurate odometry data for navigation. The UGV's primary external sensor is a stereo-vision camera that provides raw image data to the on-board computer and graphics processing unit via a USB 3.0 protocol, whereupon depth images and point clouds are generated. This data is used to detect obstacles and to generate a planning map. The on-board computer serves as the system core, compiling sensor inputs and allowing SentSys to conduct SLAM while autonomously moving towards its designated goal.

SentSys allows for observation at large, dispersed, or remote facilities without the need for onsite personnel. The autonomous capability of this system reduces the need for human guards to be physically present. This increases the number of facilities that can be monitored at any time and ensures around the clock surveillance with limited personnel.

Lockr: Self-sufficient mobile-based locker rental system

Team Members: Kevin Scalabrini, Ali Hyder, Luke Mino-Altherr, Sean Holmes, and Eliot Johnson

Advisor: Professor Masoud Salehi

Abstract

Locker systems are commonly used to provide secure storage space in shared or public venues. They can be extremely valuable assets to venues providing services to a large number of people, such as gyms, universities, and municipal buildings. Existing locker solutions are cumbersome; they often depend on a dedicated staff, or feature outdated kiosks relying on credit card swiping to check in and out. Lockr solves this problem by offering an autonomous locker system that users access and pay for through a smartphone app.

Lockr hubs have very low energy cost, allowing for them to be powered by a small solar panel that can be placed on the hub. They can be run over hotpot devices to allow for placement anywhere that people could need storage. This makes them perfect for shared public venues such as parks and beaches that often lack a secure storage area.

Users simply download our free mobile app onto their smartphones in order to gain access to the locker systems. They register a single time with their payment information and no longer have to worry about payments every time they go to use a locker. The app contains an interactive map that directs users to nearby Lockr hubs and helps them locate available lockers. Once a locker has been rented, a user's smartphone will function as the key. When finished renting, the user simply checks out through the smartphone app and will be automatically billed through a third-party vendor. Should a user wish to store their phone, they can set a personalized pin on the locker and unlock their locker through a pinpad at anytime.

We believe that the Lockr offers an appealing solution to vendors looking to draw more customers to their venues. It is extremely low-maintenance, very scalable, and incredibly easy to use. Its ability to run on solar power is an especially enticing draw, as very few contemporary systems are capable of running completely off the grid. We also believe that the basis of our platform has tremendous potential for expansion. We envision our functionality could be easily adapted for use with safe deposit boxes, bike locks, or other secure storage units.

Virtual reality-based therapy for hemispatial neglect: development of an Oculus Rift and Leap Motion-enabled application to promote scanning and sustained attention strategies in adults recovering from stroke

Short title: An oculus rift application for hemispatial neglect

Team Members: Peter Scannell, Michael Gertz, Jesse Michel, Adam Westerdale, and Alex Hersh

Advisor: Professor Waleed Meleis

Abstract

Hemispatial neglect is an impairment following right-sided parietal lobe stroke that hinders a survivor's ability to participate in rehabilitation and daily activities. Neglect is the inability to report, respond or orient to stimuli in the contralesional space. Treatments for neglect include promoting visual scanning strategies and sustained attention of the affected limbs. However, therapy sessions are short, and patients often need additional, safe therapy. Virtual reality (VR) offers the potential to replicate and enhance therapeutic exercises in a motivating environment, with the ability to progress practice challenge and track usage metrics. Following a needs assessment with therapists and researchers, our goal is to develop a prototype for a game integrating a VR headset (Oculus Rift) and a body motion tracking system (Leap Motion) to achieve the same goals in person therapy achieves.

Methods: A needs assessment was undertaken with therapists at Spaulding Rehabilitation Hospital. Development included integrating the Rift, Leap Motion and Unity, and a front/back end for data storage. We demonstrated our prototype to Spaulding and a hemispatial neglect researcher for their feedback; each provided beneficial advice. The prototype tracks and displaces in the first person, the user's body motion. Following calibration, a scaling difficulty algorithm predicts optimal challenge level and records performance data.

Next steps: We will consult with our end-users and plan for a feasibility evaluation with patients with neglect. Ultimately, our goal is to create an effective intervention for patients and caregivers to augment practice dosage in an inpatient rehabilitation environment.

Quadcopter Control with Leap Motion (QCLM)

Team Members: Jon Butler, Adam Dierkens, Dan Jamison, Kevin Kelly, Dan Sheehey, and Bryan Sveum

Advisor: Professor Bahram Shafai

Abstract

The QCLM team has successfully designed and implemented a system that allows user control of quadcopters with nothing but natural free hand movements. The control is ergonomic, utilizing an IR-sensor along with a microcontroller to directly map the motions of one's hands to the motions of the quadcopter. The system is completely modular in terms of hardware and software, which allows for the expansion of our project into larger numbers of quadcopters and other potential fields of use. Such a system has a wide range of applications ranging from photography and video to emergency response to commercial uses.

The system works by utilizing the infrared Leap sensor. Using software to calculate average hand positions, an output can be generated to represent the position and orientation of the hand in three-dimensional space. This output then corresponds to four controls associated with flight: roll, pitch, yaw, and throttle. Independently controlling signals to these inputs of the quadcopter allows for total control. The signal from the Leap is first sent to the MinnowBoard microcontroller, which performs the necessary calculations of hand positioning. The generated output of the microcontroller then passes through a PWM module that creates a pseudo-DC signal by adjusting the duty cycle of a PWM wave to create a range of output voltages. The output between 0 to 3.3 volts was found to be the voltage range sent through the joystick controls that were removed. The PWM signal is then smoothed using adjusted low-pass filters and sent directly to the transmitter microcontroller, which sends the signal to the quadcopter wirelessly. Through this integrated pathway, hand motions are shown to be able to control quadcopter flight.

This system was built and tested extensively, and the sensitivity and range of the hand motions were adjusted for optimal performance. The results of this testing were a great success, as complete control of the quadcopter was obtained with the hand movements required. This functionality was even extended to control multiple quadcopters at the same time, as well as alternating between multiple quadcopters one at a time, with no degradation of performance.

Wireless Parking Detection System

Team Members: Yuecan Fan, Weining Zou, Mengfei Zhang, Xi Zhang, Sining Liu

Advisor: Professor Masoud Salehi

Abstract

The Wireless Parking Detection System team has designed and built a system for detecting available parking spot in the city, which can simply deployed and used by drivers. This system can both be used to find available spot in garage and street parking. Knowing the place of available parking spots can save plenty of time for drivers who trying to park their cars. Wasting lots of time without find a parking place is what drivers complain about nowadays. Wireless Parking Detection System team using sensors node putting on curb or ground to detect parking vehicles' movement and send simultaneously the information to online server, which drivers can see on a mobile app.

To build the Wireless Parking Detection System, the magnetic sensor is used to detect magnetic field change that is caused by a vehicle movement. An Arduino Uno can read and print out the three axis value of the sensor. We wrote a code and upload on the Arduino Uno, which will let itself shows "1" or "0" depend on the magnetic change of sensor. "1" means there is a car stayed while "0" means there is an available spot. Once the data has been collected, the Arduino Uno communicate with the Gateway through an XBee. In general, a sensor node includes a magnetic sensor, an Arduino Uno, an XBee, a logic level converter and a 9V battery. The converter is used because the output voltage of Arduino Uno is larger than the XBee's operating voltage. The Gateway gather data from all sensor nodes, then push them into the Device Cloud. The Device Cloud shows real time raw data with a chart. To visualize the data and let user look the information. We develop an IOS app called "Park Your Car". We built the functions of sign in system in the app, such as user register, sign in, confirming registration and resetting password. After user sign in, a Google Maps graphical user interface (GUI) will show the user's current location and the available parking spots that are gotten by sensor node installed on the parking spot. The parking spots will show as red markers on the map view of app. We also considered our system may not include all available parking information, thus, a user report available parking spot function was created to let user add marker on the map.

For testing and validation, three fully operational sensor nodes were built into boxes. Testing was conducted in a parking zone near Northeastern campus, and a video demo was recorded to show the procedure of street testing. After testing with the real time data, which shows the detection of a car movement on the street, the markers changing accordingly on the map view of app indicated that the parking system is valid. On the competition day, a car model will be the test tool instead of real cars. The red markers should be showed on the location of curry student center to prove the parking system is valid.

EyeTrack

Team Members: Alejandro Ramon, Alex Lobrano, Andrew Simpson, Christopher Hughes, Christopher Mohen, and Nicholas Berger

Advisor: Professor Waleed Meleis

Abstract

Current methods of measuring Blood Alcohol Content (BAC) are non-continuous, susceptible to external variables, or require invasive procedures. A portable, continuous, and reliable blood alcohol monitor could increase safety and awareness of the effects of alcohol on the body for the general population, as well as expand on the current digital health monitoring trend. Using field testing and direction provided by H.G. Giles in his paper, “Non-invasive estimation of Blood Alcohol Concentrations by Eye Vapor Analysis Using An Electrochemical Fuel Cell Detector,” we have developed prototype goggles that measure the ethanol content evaporating from the tear film of the eye to provide a real-time, continuous estimate of BAC in a body. In addition, we have developed smartphone applications to provide real time data directly to the user. Further development of this device could provide solutions for quicker and more reliable BAC measurements, as well as provide a platform to increase awareness about the effects of alcohol for the average consumer.