

Electrical and Computer Engineering Capstone Design Symposium Projects – 2015

2015.001

ImagiMitt

Virtual reality is becoming increasingly prevalent. Since the Oculus Rift, one device that brought virtual reality mainstream, came about in 2012, it has sold almost 100,000 units. Virtual reality enhances the visual experience of entertainment, but sight is just one of our five senses. We aim to enhance the other senses in our interactions—specifically the sense of touch—and integrate it with virtual reality. We use a wide variety of electronic peripherals to simulate a believable physical environment. Strings attached to the backs of fingers and tensed by motors simulate the resistance of various materials. A wide range of temperatures are simulated by Peltier cells. These will all be controlled by a microcontroller embedded in the glove and used in a magic duelling game, giving the feeling of holding a fire or ice ball. The main advantages of our project over major alternatives are the integration with virtual reality, the incorporation of multiple aspects simulating a sense of touch, and inclusion with an immersive game.

2015.002

Notifyr: Secondary Display for Mobile Devices

Mobile notifications have become an important aspect of smartphones. Every day, millions of people turn to their smartphones to see what new notifications they have received. Over the course of a day, the amount of time that the screen is on adds up. One of the biggest power consumer in a typical smartphone is the display and its related subsystems (backlight, GPU, etc.). This means that an excessive amount of power is devoted to simply displaying notifications, reducing the time available for other uses. Notifyr is an inexpensive device that works with a smartphone to display rich notifications with minimal power draw. It uses a Bluetooth Low Energy link to communicate wirelessly between Notifyr and the smartphone, thus allowing Notifyr to be embedded onto a smartphone case. All rich notifications are displayed on a Memory LCD which has improved outdoor viewing angles than typical smartphone screen technology.

2015.003

Akobi Interview Application

Recruiting is one of the most important aspects of a company's success. To make the best hiring decisions, companies look for candidates globally, leading to remote interviews. Interviewing remote candidates involves using several applications such as Skype, Google Documents, and Microsoft Word to conduct technical interviews. Having to context switch between multiple applications during the interview causes distractions, taking focus away from the interview at hand. Our project is an all-in-one interview web application that integrates all the critical components of an interview, specifically video chat, collaborative document editing, and note taking. Our framework allows users to plug in their own custom applications, resulting in a customized interview experience. From an engineering perspective, execution of this project involves a focus on iterative and extensible software design. Engineering design decisions draw on skills and competencies developed in Software Design and Architecture, Distributed Systems, and Computer Networking courses. Akobi is a comprehensive, customizable, web application that enables interviewers to place their attention on the interview, instead of dividing it across multiple applications.

2015.004

The Serqet Oscilloscope Pen

The growing electronics hobbyist market currently has a void for a portable, user friendly, entry level oscilloscope. Current oscilloscopes on the market are expensive, have complicated features with a steep learning curve to use, and are not portable. The Serqet oscilloscope pen is a small, user-friendly, and inexpensive handheld oscilloscope. It can easily measure and display waveforms by probing any test circuit. It includes a rechargeable battery pack and uses an Android device for configuration and display. The battery design uses power electronic converter design and analog circuit design concepts that allow for portability that other scopes do not provide. The oscilloscope hardware and software uses signal processing and microprocessor theory to properly condition the signal, perform calculations, interface with the hardware, and to send measurements and receive configuration data from the user's mobile device using the wireless module. Serqet allows for an input signal range commonly used by hobbyists and other small applications. It includes options for adjusting frequency, voltage range, and triggering. The user friendly interface on the mobile device provides an intuitive way of viewing and configuring measurement settings. Compared to other alternatives, the main advantage of the Serqet is that it is simple, compact, and inexpensive.

Intelligent Ping Pong Trainer

Table Tennis is a fast sport and it becomes challenging for players to respond to shots which arrive in less than a second from opponents. The Intelligent Ping Pong Trainer targets all users from casual to professional, who wish to improve their form, shot accuracy, and overall performance. No other alternatives currently exist which provide players with an automated environment to enhance their serves and return shots. Our system presents a target to the user based on different training modes, and updates the target's location after a hit has been detected. Cameras, mounted on the table, are used to determine the current position of the ball. A microprocessor, using image processing techniques, identifies the distance from the actual ball hit compared to the target. The information is sent to a web server which stores data into a database and updates the user-interface. Knowledge of real-time motion tracking, algorithm design and distributed systems are incorporated into our final prototype. Nice-to-have features include voice feedback providing score to the user at the end of a session. The Intelligent Ping Pong Trainer can be used to improve current coaching techniques and score keeping, while providing players with a fun, interactive training mechanism.

Deckster: The Most Portable Virtual Deck of Cards

In the third quarter of 2013, 250 million smartphone devices were sold worldwide. Although technology allows people to stay connected, smartphone activities often disrupt real-life interaction. A simple method to socially engage friends involving smartphone use is through multiplayer card game applications. Deckster is a secure and modular deck of cards, allowing users to wirelessly connect and play cards in real-time. Wi-Fi Direct and Bluetooth protocols are used to establish a peer-to-peer connection among players of the game. Cryptographic algorithms ensure a secure communication of application data. Giving users control over various card decks on a mobile-sized screen requires for an intuitive user-experience, thus perfecting this is a key functional requirement. Graphics libraries are leveraged to build animations that mimic a real world card gaming experience. Nice-to-have features include support for non-real time play, player analytics, and an application for users to design their own game packages. Deckster is an all-in-one, highly customizable solution compared to existing applications and provides socially engaging entertainment. Instead of developing separate card game applications, virtualizing a generic card deck is the closest way to achieve an experience similar to physical cards.

Chronos

There are over 4.1 billion web pages as of April 2014. Looking at any point into the future, some web pages will no longer exist, or will change significantly. In most cases, there is no way of retrieving an older version of a web page after the web server changes the page. There are already existing services, such as Archive.org, which hosts the Wayback Machine, but it only archives its own selection of web pages. The problem with these archived web pages is that they are not taken frequently enough, and only more popular web pages have decent coverage. We would like a better solution that allows us to search and retrieve archived web pages from a larger and more diverse collection. Our project solves this problem by allowing users to collaboratively store archived web pages of interest on their own machines. These archived web pages are shared with others using the BitTorrent protocol, which results in a decentralized system with (virtually) no bounds on resources. The main advantage of this design is that it is more scalable than existing solutions, and allows for more frequent and detailed web pages.

PocketPass Password Management System

Today, the average person has to authenticate their identity across more than 20 accounts on a variety of web services, such as Facebook or Google. However, the passwords to these accounts are often insecure, with the 500 most popular passwords accounting for over 70% of all passwords used. Creating secure passwords and managing them so the user doesn't forget them is a challenging problem. By using PocketPass, consumers can store their passwords securely and log in to their favourite websites with the touch of a finger. As a wireless key-fob that can fit in your pocket, PocketPass stays with you and communicates with your computer in order to generate and save secure passwords. When a user wants to log in to a website, they simply have to press their finger onto the device and PocketPass automates the login process using random, secure passwords. PocketPass consists of a fingerprint scanner, for user verification, and a Chrome application to handle login. Unlike existing, complicated, software-only solutions, PocketPass provides a user-friendly authentication solution for the average consumer, backed by a unique hardware component. This allows their passwords to remain safe, and makes the process of authentication online automated and secure.

ePack

Improper backpack use is causing more than 50% of adolescents to experience back pain. Back injuries incurred by school backpacks can lead to muscle imbalance that could turn into chronic back and neck problems later in life. In the United States, experts have estimated that lower back pain costs the economy \$50 billion a year in lost wages and productivity. ePack is an intelligent backpack aiming to prevent backpack misuse. It features automatically adjusting straps and a moving lumbar support to help maintain proper posture. It includes a load sensor and display to warn against overweight and asymmetric loads. There are buttons available to manually override the automatic functionalities. The inputs of the system include load and pressure sensors placed on the straps and back of ePack. The outputs of the system control motors for the straps and back support as well as a screen displaying the system status. On top of having sensors and actuators, ePack is embedded with a high-capacity battery and an Arduino microcontroller. Compared to traditional backpacks, ePack provides a robust and ergonomic solution to preventing back injuries from a young age, thus eliminating costly medical problems in the adult years of life.

Distributed Messaging

Instant messaging systems of today simply cannot adequately safeguard the privacy of their users. Users' contacts lists, profile data, and even message histories are always logged and stored on centralized servers fully-controlled by the messaging system's service providers. There is simply no guarantee that users' data won't be searched and abused by these companies. Even if we put aside the trust issue between customer and service provider, data breaches by malicious third-parties are dangerous, ever-present possibilities on any centralized server exposed to the internet. Furthermore, recent leaks provided by Edward Snowden on NSA's overreach in its information collection practices has highlighted the fact that governments can easily and legally force service providers to hand over any and all user data available to them. We have designed an instant messaging system that protects the privacy of its users as an utmost priority. Our system implements a truly decentralized peer-to-peer architecture with no centrally controlled servers of any kind. Unlike existing centralized messaging systems, messages in our distributed system will thus travel directly from the sender to the recipient, through a completely encrypted channel, giving no opportunity for any third-party to access message contents.

Improved Projection Touch Surface System

At present, available projection-based touch screens have some issues with precision accuracy; for example, holding one's finger close to a projected surface may register as a touch. Alternatively, frame-based touch systems provide accuracy but have limited scalability. The Improved Projection Touch Surface System provides additional accuracy to the touch system while maintaining the touch surface's scalability. The system uses a simple custom glove-like system to accurately detect touches and gestures, and software control to interpret information from the device. Construction of the hardware uses knowledge of sensors and interfaces for an embedded microprocessor system. The complexity of interpreting touch information from the cameras and device involves application of software algorithms which can dynamically locate, approximate and generate 2D touch surfaces. This system provides more accurate control of projected touch systems, while adding only a single hardware device, which does not significantly impact the complexity of the system.

Coat Check

Party goers and restaurant aficionados alike lose or misplace their belongings more often than one might think. Furthermore, the wait time spent using a coat check service is far too long due to the lack of attendants and therefore, time spent at an event is reduced. CoatCheck implements an easy-to-use automated coat checking system, linking each user's personal account to their items via some form of electronic token (e.g., passcode, credit card, cell phone, keychain, phone number, fingerprint). The user simply registers at the booth and securely hangs their coat on the hanger. Upon finishing the transaction, the coat would be taken into the storage area and the location is linked to the token. To retrieve a coat, the user simply uses the same token and is prompted to open the door when the coat has been retrieved. In the event of stolen or lost items, belongings can be cross checked with the coat registration and token to determine when the coat was checked in, and in which location it was stored. The design would account for multiple users at a time by having various stations.

Moodengine Music Recommendation App

Recommendation engines have become numerous in the 21st century, convenient software to aid content discovery. "What should I listen to next?" is a complex problem for a computer to solve, since human preferences are difficult to model with data. In most large-scale recommendation systems, music is recommended based on genres, ratings, and similarities between users. However, if we judge a user's preferences based on simply "what they like," recommendations would be too one-dimensional. It is sensible that people like different styles of music depending on how they currently feel. On a basic level, the core reason humans enjoy listening to music is because it evokes feelings in the listener. What Moodengine does is capture these feelings individually as unique user preferences, and recommend users music they would enjoy for their current mood. Using machine learning and adaptive algorithms, Moodengine learns about the user's preferences as they evaluate recommendations. It uses what it has learned to choose better recommendations from either the user's music library or Moodengine's external database with global preferences for millions of songs. In comparison with existing music recommendation engines, Moodengine makes multidimensional recommendations, understanding many different moods of a user and being able to recommend music for any of these moods specifically.

Smart Baggage Claim System

Air travel has become one of the primary sources of transportation both domestically and internationally. However, currently there are many inefficient and time-consuming processes. Depending on the time of day and other factors, the wait times at the baggage claim can be anywhere from 30 minutes to 60 minutes. One of the major bottlenecks at airports is the inefficient baggage claim system. Additionally, an adequate tracking and notification system does not exist to inform the passenger about the status of their baggage. Our baggage claim system aims to reduce the wait times experienced by the passenger, while also keeping the passenger informed of the status of their baggage via email. We are designing a system which replaces the conventional circular conveyor belt with a logic-oriented linear conveyor belt with the ability to automatically sort the baggage based on the seat numbers. This design involves knowledge of real-time sensors, actuators, embedded software design, microprocessor design, and database management. Additionally, we require some basic self-study on mechanical design. Expected benefits include reduced wait time at baggage claim and improved baggage tracking.

The Renewable Energy Source Bicycle Attachment

The Kinetic Energy Recovery system is a recent addition to Formula 1 that is designed to conserve energy and improve the speed of the car for short distances using electricity. It weighs about 24 kilograms and is very costly; thus, it is inconvenient to add basic modes of transport like bicycles. Small devices such as cellphones are taken whenever someone goes outside and can provide multiple services such as communication or finding directions. During long distance cycling, the devices' battery can deplete over time and can cause problems for the cyclist. We have created an option for cyclists to store in a battery the energy they produce while cycling. This provides the cyclist a renewable source of energy that they can use to charge their devices while they are out cycling. The energy generation system consists of a generator and a current filter that are created using knowledge of AC-DC rectifiers and linear voltage regulators. The energy is stored in a battery and then becomes available for the cyclist to use to power their devices. An advantage of the system is that while being cheap and lightweight, it also provides a display to show the status of the system.

Intelligent Sensation and Eyesight Emulation Unit (ISEEU)

In the last few decades, numerous attempts have been made to aid the visually impaired with smarter technologies for better living. These assistive technologies have focused on various areas from path detection to face recognition. Our project aims at addressing the mobility and orientation needs of the millions of visually impaired people across the world. They face numerous problems with mobility and navigation every day, including bumping into objects and falling from stairs. Existing mobility aids for the visually impaired are mostly unreliable, unaffordable, or have many limitations on the users and their environments. Eliminating these limitations while better addressing the everyday mobility problems of the visually impaired is our motivation to build our product ISEEU (Intelligent Simulation and Eyesight Emulation Unit). Our product aids the user in obstacle and path detection using haptic feedback, the sense of touch. The end product of our project is a portable belt that can be worn comfortably around the waist. The belt comprises of multiple vibrating devices that vibrate to inform the user of the direction and relative distance of the approaching obstacles. Thus, ISEEU serves as an affordable, portable and intuitive solution to the mobile needs of the visually impaired.

Low-Loss Power (LLP) Transmission System

The electric power system in contemporary homes is far from perfect. The power losses associated with the residential distribution system may reach as high as 14%. These losses occur as a result of the resistance of the wires to flow of conduction current. 12% of annual unintentional residential structural fires are due to electrical distribution system components. The LLP transmission system is a breakthrough innovation in residential power distribution, allowing an increase in electrical safety and reliability, minimizing losses during distribution and decreasing utilized material. The system consists of sending and receiving Tesla transformers, a one-wire transmission line, a specialized lighting system that connects directly to the line, and a wall-socket converter at the receiving end. Any standard household load may be connected to the system output, making it a seamless change for the user. The system does not use conduction current to transmit electric power, which reduces the transmission line losses and the required transmission line thickness.

touchVision

Current medical imaging technologies only capture limited information about the inside of the human body. Specifically, they are unable to record accurate information about the inside of a patient during a surgery. touchVision is a low-profile device that can be used to record additional haptic information. The device captures position, time and pressure data based on what the surgeon's hands feel. This data can be replayed to recreate key points in the surgery, such as the firmness of a tumor or organ. To ensure that touchVision is unobtrusive, it is worn on the fingertips beneath the surgeon's latex glove. Piezoelectric sensors capture firmness data, while accelerometers measure displacement. This data is recorded and made available in a web software platform. An external mechanical device is used to replicate firmness recorded by the touchVision sensors. One major benefit of touchVision is that it can record information during a surgery that is not currently captured with existing technologies. The system can be used to "replay" surgeries at a later date. It is an additional source of information that can assist in medical applications.

Eye Spy

Approximately 5,000,000 Canadians work in a hazardous environment and each year, nearly 40% (2,000,000) are injured from preventable injuries. Many of these hazardous workplaces began to adopt robotic technologies to perform dangerous work to prevent injuries of their workers. With the outset of virtual technologies paired with remote sensing tools, robot interface techniques can be enhanced to use more natural human input. We aim to create a device that projects remote sensory input to a human subject in a form that can be naturally perceived by humans with spatial familiarity. Our design approach is to create an interface between an Oculus Rift to feed a user's head rotation to a remote embedded system equipped with a camera, and generate visual/audio feedback to the module worn by the subject. The advantage of this design over major alternatives is that this promotes safety in hazardous work environments while providing highly intuitive and elegant controls compared to traditional input peripherals. Our goal is to create a baseline for possible future technologies that wish to incorporate intuitive body movements. Oculus Rift is creating new horizons in virtual 3-D technologies, and we aim to capitalize on this industry by introducing new forms of application.

The Ultimate Immersive Webcam 3000

Since the introduction of video streaming, the experience on a whole has gone relatively unchanged. The methods from the 90s are still in use: two-dimensional videos are streamed to your personal computer or device over the internet. The capabilities of vastly improved network bandwidth and imaging devices has gone largely untapped. Our project attempts to deliver video to users in a novel way, giving users the ability to fully immerse themselves in a remote environment. Compared to existing panoramic video capture solutions, we accomplish real-time video processing, the end result being that our design is suitable for live streaming. We achieve this by creating a system that consists of cameras facing different directions, use high-speed image stitching algorithms on the multiple camera feeds, and video output which may be delivered through a device such as an Oculus Rift. Our design requires knowledge of software algorithms, hardware interfacing, signal processing, electronic devices, and networking. One advantage of this system over existing video systems is the live panoramic view—the user has full control over what portion of the environment they want to watch. The Ultimate Immersive Webcam 3000 will change the way we experience live video.

Voltage Sag Analyser

Voltage sag is one of the major problems being faced by small and large scale industries, leading to damaged products and erroneously-behaving equipment. Efficient voltage sag tracking would enable consumers to hold the utilities accountable for unexpected damages. The voltage sag analyser is an extremely cost effective device to track voltage sags. It can be installed at multiple junctions in a commercial setup for a 24x7 monitoring of the voltage. The utility companies can be held directly accountable by the consumer in case of damage caused by unacceptable voltage behaviour. This will result in an immense amount of financial savings for companies as 80% of the total power quality issues are voltage sags. The voltage sag analyser can be used in place of high-cost power quality analyzers which are not easy to install owing to financial constraints. The voltage sag analyser is connected to a smartphone application which provides the user real-time voltage information even to a remote location. The analyser makes use of highly sophisticated signal processing techniques resulting in extremely efficient measurements and readings. The voltage sag analyser is the future to low-cost power-quality analysis.

Diabetic Foot Monitor

Diabetes Mellitus is a metabolic disease where the body cannot produce insulin or properly use it. As a result, a high level of glucose develops in the bloodstream which can damage organs, blood vessels and nerves. Diabetic neuropathy, or nerve damage caused by the disease, is most prevalent within the feet of those diagnosed. Annual check-ups with a physician are required for diabetics in order to accurately monitor the health of their feet; however, there is no efficient way for diabetics to monitor their feet easily and at home. Diabetic Foot Monitor (DFM) detects diabetic neuropathy and problems with circulation within diabetic feet. DFM monitors foot sensitivity by using a haptic grid to induce vibrations to simulate a physician check-up while also obtaining feedback from the user. Additionally, Pulse Wave Velocity, the rate at which blood moves through a blood vessel, is analyzed in order to determine circulation within the foot. DFM incorporates power electronic converter concepts in the software design in order to control the vibration inducing mechanisms needed for the haptics. Moreover, signal processing is used in order to determine circulation issues. DFM allows for people living with diabetic neuropathy to easily monitor the health of their feet at home.

ePAD

Combat against regular Canadian winters has always involved wearing layers of warm clothes outdoors. Their materials often consist of animal down and feathers extracted from animals such as fox, rabbits, or goose. While the raw materials are scarce, the padding jackets are often unaffordable as the cost ranges from a few hundreds to thousands of dollars in the current market. Alternatively, should people choose to wear multiple layers of thin clothing, their outdoor activities can be restricted as the several sheets of clothing inhibit extensive movements. ePad is an economic alternative attachable to any part of the clothing for providing a heating means. The system consists of an array of heating wires controlled by the main circuit system with two operation modes: a manual control via analog dial and automatic control by embedded software in conjunction with external temperature sensors. To achieve the desired functionalities, the group utilizes theory from electric circuits, embedded software, and control systems. ePad is a disruptive and economic technology solution to provide electric heating comfort in cold settings. Ultimately, the system provides greater flexibility in controlling the inner-clothes temperature by both automatic and manual modes of operation with a simple interface.

Indoor Robotic Navigation System

Robots are becoming more and more common in society. However, even with annual sales of about 2,000,000, it remains relatively rare to see domestic service robots in a person's home. This may be due to the difficulty in determining a mobile robot's exact position while indoors. We propose an Indoor Robotic Navigation System (IRNS) that enables an autonomous robot to precisely determine its location while indoors in order to efficiently navigate an area. The system uses a set of transmitters, called beacons, installed at pre-determined locations that intermittently project an ultrasonic wave, travelling at the speed of sound. A receiver measures the time it takes for the ultrasonic pulse to travel from the beacon to the receiver in order to calculate the distance between the two points. Once data from enough beacons has been collected, the robot can precisely compute its position and calculate movements accordingly. A user can control the robot's destination and view its position via a web interface. This system is reliable and accurate in positioning where GPS (Global Positioning System) performs poorly. It also provides real-time locations in a coordinate system while some indoor positioning systems provide only a vague proximity to a known location.

VIP Pass (Visually Impaired People's Personal Assistant)

Approximately 1.05 million people in Canada are living with blindness or significant vision loss. Visually impaired persons (VIPs) rely on canes or guide dogs to avoid nearby obstacles while navigating the outdoors. However, both of these methods are incapable of helping the VIP locate and navigate to the closest hospital, restaurant or to contact the police via phone. This project gives the VIPs the freedom to explore new areas without the fear of getting lost. The device is equipped on a guide dog's harness and acts as a personal assistant. This device accepts voice commands from the VIP through a wireless headset and provides interactive feedback to the VIP. This device is advantageous over existing alternatives because the VIP does not need to wear heavy or uncomfortable equipment in order to help them navigate and to plan their daily routine.

Complete Parking System

The current parking systems in public streets and parking lots rely heavily on meters, causing many people to either overpay or underpay the required tolls. Furthermore, the established process for parking authorities to check whether a car has been illegally parked is inefficient as it requires officers to manually check each car individually. The Complete Parking System (CPS) automates the payment process for parking in public areas by utilizing zone-based parking. This system ensures accurate payments for public parking and determines the precise rate by determining which zone the car is located in. The CPS is implemented using a device consisting of a microcontroller, a Global Positioning System (GPS) module and Near Field Communication (NFC) controller which is installed in the user's car. Parking is initiated through the CPS Android application which prompts the user to tap their phone on the CPS device located in the car. A parking transaction can be ended with a second tap when the user returns to their car. Essential information such as zonal rates, duration of parking and the car's location is stored on a server on each tap. This information can be accessed to determine the monthly statement balance for the user.

O-key: One Key, Unlimited Possibilities

Lost and misplaced keys are a problem that millions of people face every day. Couple that with the hassle of finding them in your pocket or bag while trying to get into your home or even picking out the right key from a massive key ring just to open a door, and you have a pretty significant inconvenience that could be wasting hours of your precious time per year. We are in the beginning of a digital era, and the next logical step is to solve this problem with innovation, and new technology. Meet O-key, a wireless programmable master transponder that not only copies, but also stores and transmits all your data with the same encryption used by leading government agencies. O-Key not only copies and emulates any current wireless access cards you have today, but also serves as the bridge to the future of physical security by being compatible with all future "smart-locks" including deadbolts, bike locks, padlocks and car modules. Both the key transponder and phone app allow a user to remotely provide or revoke access to their locks for other parties or users, while enabling them to monitor entry times from around the world. By automatically transmitting data when within range of a reader, fumbling for keys will be a thing of the past; by sending out distress signals and automatically data wiping data when separated from its owner, physical security risks from theft or loss will no longer be an issue; and finally, by being digitally compatible with digital locks of the future, giving access or changing locks will no longer be an expensive hassle. O-key: One key, for all your needs.

SecureMind, an Electroencephalography Biometric Security System

In modern times, security is becoming more of an issue. It is becoming easier to bypass common security measures, such as using a password, due to the fast pace that technology is evolving. A challenge is to create a security system that is robust enough that everyone can use it, but also secure enough that unauthorized access cannot occur. One way to solve this problem is to use a biometric security system that relies on the user's unique properties for authorization. Our solution, SecureMind, accomplishes this by extracting the user's unique brainwave patterns using electroencephalography. Unlike the currently popular biometric security system of using fingerprints, SecureMind is not as easily bypassed. In the system, the user selects an image that will be used as a trigger to start the authentication process. Now, even if someone else were to use this image, they would not be able to access the user's profile due to the differences in their brainwave patterns that are generated in response to seeing the image. As such, SecureMind helps demonstrate the vast possibilities of biometric security.

MindCraft

The idea of a Brain-Computer Interface (BCI) has been circulated around and implemented since the emergence of the non-invasive medical imaging technology. The MindCraft project aims to use the Electroencephalography (EEG) technology to bring the BCI field one step forward. Two major challenges regarding BCI are accuracy and a suitable choice of cognitive task. The MindCraft project uses a completely novel approach to overcome these challenges. It aims to create an intuitive way to operate a BCI supported by contemporary neuroscience theories.

Automatic Wireless Guitar Tuner

Tuning a guitar is an arduous process that requires time and a quiet environment when done manually. Also, tuning a guitar to the desired pitches is impossible unless the user has perfect pitch, an ability which only 1 in 10,000 people have. The Automatic Wireless Guitar Tuner solves this problem by automating the tuning process. The solution allows each string to be tuned to any pitch quickly, accurately, and requiring minimal interaction on the part of the user. The design solution consists of a modular actuator unit and a smartphone application working in tandem to tune the guitar. The smartphone's microphone detects the string being played and sends this information to the phone's processor. The phone then calculates the amount of motion required to correct this pitch and sends this information wirelessly to the actuator, which turns the peg. The major advantage this solution has over existing alternatives is that it is cheaper and, once installed, can be used with minimal interaction from the user.

AirJockey

The field of robotic vision is evolving and progressing rapidly. The AirJockey is an autonomous air hockey robot that uses robotic vision to provide a challenging opponent without the need for a skilled human player. In order to create a viable and competitive robotic air hockey application, extensive use of optimized video processing is needed. This project would then serve as an example implementation of applied, high precision robotic vision and control using inexpensive, readily available components over a full-sized table.

Smart Fish Tank

It is always annoying to ask someone to take care of an aquarium while the owner has to be out of town for a few days. It is not convenient to let someone enter the house without supervision and they may not have the proper knowledge to control the system. Also, people should not have to worry when they are away from home and cannot monitor their fish tank. Our Smart Fish Tank provides a friendly solution to this problem by allowing the user to have control over the basic elements of the aquarium system. For example, the user can control the lighting, heating, and food, which are essential to sustain the aquarium system. The fish tank consists of a series of actuators and sensors which all communicate with a central control system. The actuators of the fish tank include lamps, heating rods, a feeder, a water filter and so on. The sensors include a temperature sensor and a device that monitors the water quality in the fish tank. These components are all controlled by a central control system, which can be accessed using Wi-Fi on a web application. This allows the user to remotely monitor and control the ecosystem of the fish tank. Overall, the Smart Fish Tank provides a convenient and reliable way to remotely manage the aquarium when owners are away from home but have access to the internet.

SleepyPanda

Over the years, the enjoyment of personal audio has fallen into two distinct categories. It can be a non-private activity involving a dispersive audio system, or else may lead to physical soreness if privacy is a concern and headphones are worn for an extended period of time. Most commercial products available fall into one these categories and there has been little progress to develop solutions that combines personal audio and physical comfort while including inputs from the surrounding environment. Users have dynamic needs when enjoying media and SleepyPanda provides a complete suite of services including audio playback, alarm clock integration via vibration feedback, and a system designed to monitor a user's head position and conscious state in order to optimize audio and haptic feedback. SleepyPanda uses a semi-rigid foam body as well as embedded speakers and microprocessors to create an audio device that harmonizes physical comfort with an exceptional audio experience. Using an analog control system, the physical motion of users and environmental stimuli is run through a feedback system to provide the best user experience. SleepyPanda competes with other lifestyle audio systems by catering to users' dynamic needs without sacrificing physical comfort, audio quality or social interaction.

Distributed Garbage Collection System

Conventional garbage bins are static receptacles for temporarily storing non-reusable and non-recyclable waste. Today, these bins are stationed at arbitrary locations and serviced by waste collectors on a fixed schedule and route. Given these limitations, time is allocated poorly such that receptacles in areas of low usage are serviced too frequently and receptacles in areas of high usage are serviced too infrequently, leading to overflow and more litter over a shorter time span. To overcome these issues, the Distributed Garbage Collection System provides an active approach towards garbage collection. Effectively, this system is a network of garbage bins, where each bin is stationed on a patrol route and capable of tasks such as load detection, autonomous movement and navigation, collision avoidance, and self-servicing. These functions are implemented through a combination of sensors, actuators, and embedded software design. Additionally, wireless communications and data storage using knowledge from computer networks and databases enable each garbage bin to transmit its usage data to a central server for performing garbage bin allocation. Compared to existing solutions, this system automatically collects garbage when full and strategically allocates bins based on usage statistics, which should reduce littering and garbage collection costs in the long run.

WattWarden Controllable Electrical Switch Panel

Today, power distribution usage for households is estimated based on heuristic analysis, because there is no reliable intermediate device that can gather detailed power usage data from each household. However, such heuristic analysis is often not reliable; consequently, the estimated data cannot be used for real-time fine-grain distribution control. A controllable electrical switch panel is designed to properly monitor and manage the power usage down to appliance level. The switch panel collects the empirical power consumption data of each individual electrical circuit within the household, and it reports the data to a management server. The power monitoring functionality is realized by installing our custom-designed power-sensing circuit on each electrical circuit within the distribution panel. The power usage data is collected by a micro-controller and reported via TCP protocol to the central management server in the local distribution network. The management server is also capable of switching on and off a circuit via relays controlled by the micro-controller. A nice-to-have feature is to enable a homeowner to monitor and control the switch panel through smart terminals such as mobile phones, tablets, and personal computers. WattWarden is robust and flexible compared to the traditional switch panels due to its programmability and controllability.

Watts On

The price of electricity in Ontario is expected to rise by 42% in the next four years. With this rise in electricity cost and increase of technologies that require power in our everyday lives, it is becoming more and more important to lower our electricity consumption. Watts On, a power management and control system, aims to improve on this issue by enhancing power consumption awareness of different devices and providing the ability to control when power is supplied to such devices. The system can recognize patterns in power usage and provide feedback to the user via power consumption graphs. Watts On is comprised of various plug-and-play monitoring attachments that transmit usage data and control information to a central server where the usage data is processed. Each device is connected to the internet using an existing Wi-Fi connection and after processing the power usage data, it is accessible via a web browser based application and mobile device application for convenient remote access. This approach requires knowledge in signals and systems, software design and architecture, power system operation and markets as well as database systems. Watts On is unique to other monitoring systems due to its ability to provide recommendations based on past usage by analyzing the user's power usage patterns.

R4 (Reduce, Reuse, Recycle, Reward)

Municipalities spend millions of dollars each year maintaining landfills and managing the environmental impact these sites have on the surrounding area. Much of the waste that is currently discarded could instead be repurposed through proper recycling practice; however, recyclable waste is often improperly disposed of. Current recycling practices are unrewarding to those that participate, and offer no immediate advantage or recognition for the additional effort. As such, there is limited participation in recycling programs, and no incentive to entice new participants. It has been shown that single-stream recycling, in which users are not required to sort their material before collection, drastically increases the amount of participation in recycling programs, but at the cost of lost material during processing due to contamination. The objective of this project is to design an automated recycling bin that can correctly sort common recyclable objects and reward users for participation. The end result will combine the ease of use of a single-stream recycling process with the sorted results of a multi-stream one.

Rover Observation Vehicle for Enclosed Regions (ROVER)

Many industrial and commercial sites feature inaccessible or hazardous enclosed spaces such as mine shafts or ventilation networks. Regular inspection of these spaces is necessary to ensure continued safety, profitability, or task progress. There is a high monetary and safety cost associated with training specialized personnel for these kinds of inspection. Our solution to address this problem is the "Rover Observation Vehicle for Enclosed Regions", whose primary purpose is to collect data to evaluate the topographical surroundings of enclosed spaces. The system is comprised of an autonomous UAV that features low-latency collision avoidance and path-finding to facilitate navigation of enclosed spaces. A plurality of modular sensors enables the recording of environmental parameters. The system uses advanced control theory and digital signal processing for the purposes of real-time collision avoidance and data collection. This provides an efficient and low-cost solution to inspect and record data within enclosed spaces. More data can be collected in a shorter time; this includes images, video, and spatial data which are used to recreate these environments in 2 or 3 dimensions. The implementation of low-latency collision avoidance enables the device to operate in a variety of conditions/environments which might otherwise be inaccessible.

Shelf-e

Each Canadian family throws away over \$1000 worth of food per year according to the Conference Board of Canada. This can be accounted for due to poor managing of expiry dates, finances, and food consumption. To address all these issues, a combination of a smart shelf retrofitted into a fridge and mobile application helps keep track of all of these things. A receipt reader and Universal Product Code (UPC) scanner built into the mobile application initialize the shelf tracker before groceries are loaded. Each time an item is placed on the shelf, its location on the shelf is tracked based on the light sensors it covers, and the amount of the item remaining is tracked based on differences in weight. All of this data is stored on a server such that the user can be notified of expiry dates, amounts of food remaining, whether an item is in the fridge or not, as well as pricing history of purchased items on the mobile application as long as they are connected to the internet. Benefits over alternative solutions include increased mobility and reduced cost due to the smart shelf being retrofitted, and an automated process for keeping track of groceries.

PhoneShackle: A Portable Smartphone Authentication Device

Studies show that more than half of smartphone users surveyed do not use a password or PIN to protect their phone. Additionally, 44% of respondents who do not lock their smartphone said that using a password is "too cumbersome". This portable smartphone authentication device makes mobile security more convenient by allowing users to unlock their phone without the necessity of user input. The device is carried by the user and communicates with the smartphone to provide an alternative user authentication method in place of a password. The system consists of a wristband with a microcontroller that uses a Bluetooth module to communicate with the smartphone. The device provides secure authentication using public key cryptography to prove the identity of the user. The smartphone uses software that prevents access to the phone unless the authentication device is within range. This approach involves embedded software design and computer security analysis to ensure reliability and security of the device. This solution provides smartphone users with a convenient method of phone locking and authentication where the user is not required to provide any input into the system beyond initial setup, which makes it more convenient than conventional phone locking mechanisms.

Simuweight

Free weights are an essential part of any complete gym, but they tend to be a hassle for both gym members and staff. They quickly become unorganized and some free weight exercises require a spotter which is not always readily available. The Simuweight is an all-in-one variable-weight system which allows users to enter a desired weight. The machine then adjusts to produce an equivalent resistance. The system uses pneumatics to ensure smooth and constant force, replicating the feel of a free weight. The Simuweight not only mimics a large range of weights but removes the need to find a partner at the gym by acting as a virtual spotter. Sensors monitor the system pressure and user's range of motion; this combined with control theory ensures a constant weight and determines when spotting is necessary. When the user struggles and spotting is activated the system initializes a weight reduction, allowing them to finish their exercise. With the Simuweight, the need for free weights is removed and users experience a much more pleasant workout.

Cognitech Solutions

Traditional online education systems use text to authenticate usernames and passwords without verifying the legitimacy of the person using those credentials. Our solution to this problem is to build a facial biometric identification platform that can be used to integrate and communicate with education systems. Our scope is to provide an API that supports facial recognition authentication for web services in order to provide services such as authentication, verification, and certification. Our approach takes the result of facial recognition algorithms and makes a one-to-one mapping with existing user credentials. We have leveraged image recognition and matching concepts, as well as upper-year networking and software knowledge. For online educational platforms, the system identifies the user during authentication and then periodically checks for detection over the duration of an online examination. After the exam the images are then processed through facial recognition to determine the legitimacy of the person taking the exam. The API allows for secure authentication of online tests to be leveraged by an education platform in a way that is both easy to integrate and use. Currently, there are no open-source platforms that do biometric identification for secure online education systems.

Powered Smart Outlet (PSO)

Approximately 10% of the total power consumed in a normal household is due to standby power. With the ever-pervasive use of technology, power sources are being strained, resulting in an increase in electricity prices and electricity waste. In identifying this issue, it is evident that there is a demand for a closer control of electricity usage. The problem is to construct a system where a user can identify specifically which electrical devices are being used, to what extent they are being used, and where the user has the ability to turn-off individual devices to ensure no standby power is being drained. PSO is the solution to this problem. PSO is a power outlet with the ability to record and transmit power usage data to a mobile app through the use of a small microcontroller and integrated circuitry. PSO also has the ability to turn on and off individual outlets as desired by the user. PSO is a combination of hardware design, power system analysis, and implementation of both high and low level software, and provides a user with seamless control of individual outlets and personalized data on power usage. With this compartmentalized control a user is now equipped with the tools necessary to reduce their use of electricity.

Self-Charging Keyboard

As the uses of small wireless electronic devices become an integral part of our daily lives, the ability to have long battery life is becoming increasingly important. Battery operated peripherals are devices that everyone uses on a daily basis. Due to the maintenance required for battery operated devices, the freedom provided by its wireless capabilities is overshadowed by the maintenance required to keep them running. Battery technology in the last several years has hit a plateau and is important to develop new ways of keeping these devices charged. Since devices are becoming low power, it is now possible to develop ways to supplement power through harnessing the kinetic energy produced by users during normal usage. This is achieved by the Self-Charging Keyboard by placing piezoelectric material under the keys in conjunction with electronic converters and power loss theory to harness the energy during normal typing. By harnessing the kinetic energy input into the device during this activity, the Self-Charging Keyboard can use the harnessed energy to help prolong battery life.

Hackberry

Documentation via pen and paper is considered a timeless method of note taking. While it provides an intuitive and natural way for recording information, it does not quite offer the same ability to save, edit, share, and back up documents— features that are readily available in electronic documentation. Thus, hand documentation, while convenient, fails to have the same intuitive editing and sharing capabilities as electronic note taking. Hackberry is a Smart Pen Module that solves this issue by transforming any writing utensil into a smart pen. By attaching Hackberry's module to any common pen, Hackberry records where and what a user has written through its onboard camera and digital signal processing. From here, handwritten notes wirelessly sync to user's smart phones, tablets, or computer. This provides users with a seamless way to store handwritten notes electronically. While competition may provide similar functionality, their designs are limited to proprietary pens or paper. Hackberry's main advantage is in its modular design, which allows any writing utensil to store and transcribe handwritten text to a smart phone, tablet, or electronic device.

Silentio

Noise pollution is a big factor that reduces work efficiency and increases stress. It slowly becomes a luxury to be able to seek out a quiet spot in a noisy environment. Silentio is a device that targets households and reduces the ambient noise from the surroundings, whether it is the neighbouring kids playing or traffic noise. It is located in front of a window and accepts all incoming noises and uses the principle of destructive interference to cancel the noise waves. The device includes the sound input and output components and a processing unit, which analyses the input sound and cancels them using the corresponding waves. We apply the knowledge from Signal and Systems, Electromagnetic Fields and Waves, Digital Signal Processing courses to analyze sound waves and effectively cancel the ambient noise from a source. The benefits include the silent environment at home and offices, which increases productivity and provides comfort.

Lawn Rover

Lawnmowers have not significantly changed since their introduction in 1827; however, they've become an important part of the modern North American household. Approximately 86% of all homeowners own a lawnmower. Modern day lawnmowers require a person to push the mower across the lawn. This is particularly disadvantageous for disabled individuals and the elderly, who account for 14% of the Canadian population. Lawn Rover is a battery-powered autonomous lawnmower that is capable of cutting grass with minimal user input. A major feature of the machine is its ability to differentiate between grass and pavement. This system uses a mobile app to give users the added capability of taking over the robotic mower and controlling its motion right from their smartphone. Control theory is used to control the electric lawnmower. The solution is implemented via a digital controller, sensors and actuators. Both infrared and sonar sensors are used, as well as a camera for image processing. The sensors recognize boundaries, allowing the lawnmower to act accordingly. Lawn Rover is robust, eco-friendly and will improve productivity. This innovative machine will help disabled and time-constrained homeowners care for their lawns. Lawn Rover will revolutionize lawnmowers in a way unseen in today's time.

Pidgn: A Home Reminder System

People are forgetful, as evident by the fact that approximately 30 percent of people forget something important each month. This motivates a solution to help people remember details in their everyday lives, thus saving them time. Pidgn monitors a home and provides reminders to occupants if it perceives a user has forgotten something essential. The system incorporates sensors to detect things people commonly forget, such as running electrical appliances left unattended, open doors, and everyday items forgotten when leaving the home. Sensors are also used to detect when an occupant leaves or enters the home. Raw data is transmitted wirelessly via ZigBee to a web service, which analyzes the data and notifies the occupant through an accompanying web application or audio alarm if, for example, he leaves home without his wallet. Designing the sensors requires knowledge of embedded systems and circuit theory. Furthermore, knowledge of signal processing, computer networks, databases and user interface design are required to implement the software components in Pidgn. Our solution differentiates itself from existing ones in that rather than focusing on the needs a specific population segment (e.g., seniors), it uses a modular approach to provide reminders that can be tailored to anyone.

WaTTaFaucet

One of the most common mistakes made in cooking a meal is either not adding enough water or adding too much water. This seemingly simple task of adding the correct amount of water is overlooked by many as being either too tedious or too trivial with respect to the final result. WaTTaFaucet is designed to allow precise control over the amount of water that comes out of the faucet, making it simple and easy to get the correct amount of water every time. With a large touchscreen display integrated into the faucet, the exact amount of water desired can be easily entered. Then using a micro-controller, a water flow meter and a variable water flow controller, the water is released for just the right amount of time – giving the perfect amount of water. Specific amounts of water can also be saved into the system to allow for one-touch access to the most commonly used water volumes. Compared to existing solutions, WaTTaFaucet is simple, easy and effective, allowing the user to focus on cooking rather than the miniscule yet important details.

TrancePixel T-Shirt

The major motivation for making TrancePixel T-shirt is giving the wearers a chance to uniquely express themselves, especially while attending music concerts. Millions of people attend concerts every year. Donauinselfest, the biggest music festival in the world, attracted 3.2 million people in 2013. A majority of the attendees at such concerts seek to express themselves via their clothing, accessories, or by carrying glow sticks. Our team believes that TrancePixel T-shirt will enhance concert goers' experience by providing them a chance to uniquely express themselves. The smartphone application accompanying the LED-embedded T-shirt will allow a person (say a visual designer for a concert) to upload design patterns on a server, which can be downloaded by others and displayed on their T-shirts. This will allow visual designers and light artists at concerts to improve the ambience of a concert.

Tagged

Little has changed in the laser tag industry since its release to the general populace 35 years ago. Initially developed for combat training, laser tag has long been limited to the indoor arena experience, involving heavy equipment and incredibly specific targets. What the console is to the gaming arcade, Tagged is to the laser tag experience. Tagged aims to provide the full laser tag experience through a portable game-play system that is easy to set up in any arena of the players' choosing. Using a laser-firing glove in tandem with a lightweight vest, Tagged cuts down on bulky equipment and allows the user to maintain flexibility and dexterity throughout game-play. Additional system elements include a central device that manages game-play settings, and a cross-platform Smartphone application that displays real-time in-game states. Each vest, lined with lightweight fiber optic cables, vibrates to alert the player when they've been hit and wirelessly communicates the penalty to the central hub for score keeping. Tagged puts a new spin on the "point-and-shoot" experience!

Virtual Reality Assisted Interior Design System

Home renovation can be a headache for homeowners. It is hard for the home owners and renovators to virtualize the entire 3D space. The Virtual Reality Assisted Interior Design system can solve this problem by rendering the room in a three-dimensional virtual reality world. The system allows user to interact with objects within the virtual environment. A Leap Motion controller and a computer are integrated within the system. The Leap Motion controller is used to capture user's hand movements. Then, machine learning knowledge is extended to help recognize pushing and dragging gestures, which are used to interact with the virtual objects. In addition, head movements of the user can be tracked by a webcam on the computer. The computer display changes dynamically as the user's head position changes. This creates the illusion of three-dimensional space. User can view the room in different angles and positions by simply moving their head around. Image processing and real-time programming knowledge are used in this sub-system. The system can offer both the designers and the homeowners an accurate representation of room after renovation. The Virtual Reality Assisted Interior Design System brings a whole new experience into interior design.

Cloud Mirror

The integration of passively-cooled and inexpensive single-board computers into household items can greatly enhance their utility and convenience. Personal and general information of relevance can be displayed on embedded displays, and sensors can be added to enable effortless and intuitive user interaction. Cloud Mirror is one such item. It consists of a mirror enclosure containing an externally visible electronic display and multiple single-board computers supporting user interface software controlled by gesture recognition hardware. Emails, daily appointments, and other configurable information are displayed as a glowing dynamic underlay to the semi-transparent mirror. Our custom-designed infrared sensor array enables the user to make multi-dimensional touchless gestures to interact with the content displayed and switch between content sets. Cloud Mirror also self-configures relevant information to display by interacting with one's phone via Bluetooth. This device streamlines one's morning and everyday regimen by making use of the vast unused space in a typical wall-mounted mirror. In contrast to similar products, it does not require any touch-based interaction, which may be uncomfortable for the user, awkward for this product segment, and requires expensive capacitive sensor arrays.

P4 (Power & Performance Profiling Paddle)

Dragon-boating is a highly competitive sport that requires synchronization of strokes and effort to execute optimal race strategy. The start must be quick, the mid-race slow and powerful, and the finish all out. A boat consists of twenty paddlers who must be applying the same amount of power, at the same time, on each stroke. Currently there is no solution to measure sync and force applied by an individual paddler. Our mission is to create a device that attaches to a paddle providing real-time feedback of a paddler's power output and technique. Teams equipped with our device can measure real-time stroke synchronization and gauge effort levels to optimize boat power at different points in the race. Our solution incorporates sensor analog and digital hardware with advanced signal processing algorithms to capture output power, and stroke pattern, deriving a variety of paddler metrics. These sensors feed into a custom designed, compact controller that performs post processing. This is truly a novel device with no existing solutions. The smart paddle will accelerate the pace of your training, and push your team to new levels of performance.

SmartSole Foot Analytics

Over 75% of Americans suffer from foot ailments over the span of their life. Most of these ailments are currently diagnosed by the human eye. The problem is there is no quantifiable data available to practitioners to assist in diagnosing and monitoring the rehabilitation of foot-related ailments. Currently, physiotherapists have no method of monitoring a patient's day-to-day walking patterns to better aid in their recovery. The SmartSole is an insole placed inside the shoe with sensors on critical pressure points of one's feet. By gathering data from these sensors, the SmartSole is able to create a real-time model of one's weight distribution. Integrating various sensors, a microcontroller, a Bluetooth Low Energy module and a host mobile app, the SmartSole assists users in tracking and improving their feet ailments. The main competitor has a solution geared towards healthcare practitioners, and not something that would be affordable for the general population. SmartSole's advantage is not only the affordability, but also the ease it provides the user to capture and view the real-time data of their walking behavior on their smartphone.

Automated Inventory Replenishment System (AIR System)

Engineering projects may often be delayed because of a lack of a specific material resource when needed. Within environments where time and money are important, it is crucial that time not be wasted waiting for required materials to be restocked. The Automated Inventory Replenishment System (AIR System) attempts to circumvent the above problem by monitoring the inventory levels of each existing component and taking appropriate measures when certain events take place. The system is able to notify proper staff about potential shortages, optionally place an order on the item, or append the item to an existing order sheet for later use. Components are to be placed in containers that deploy various sensors which feed stock measurements to an embedded system within the inventory unit. The embedded system connects via Wi-Fi to a centralized server that interfaces with a smartphone or web application. Knowledge of embedded systems, databases, and sensors is needed to implement the above functionality. The AIR system prevents the dependence on manual upkeep seen in other inventory system within lab spaces which fail because of human negligence. This system is a dependable solution that helps improve engineering project efficiency by guaranteeing the presence of any inventory material when needed.

Biometric Checkout System

The current retail credit card checkout process has a trade-off between security and speed. Chip-and-pin technology is fairly secure but pretty slow. Contactless technology only requires a quick tap of the card against the reader but this has many security issues and is hence limited to small transactions. The Biometric Checkout System aims to improve both the security and speed of the checkout process. The system uses extremely accurate iris identification in combination with a secure transaction server to process transactions without requiring any physical card or mobile wallet. At the counter, the customer simply scans their eye and selects a card (which is registered with their account). The server authenticates the customer and uses that credit card to execute the transaction. The customer never exposes their credit card details as only the last four digits and a card nickname are shown on the touchscreen. An additional benefit of this design is that multiple cards can be stored in the customer's account, enabling the customer to leave their bulky wallet at home. Overall this system provides a faster and more convenient checkout process while maintaining a high level of security.

IV Guide for Nurse Training

Intravenous (IV) administration of medication is among the most common and effective medical procedures performed in hospitals today. Over 200 million IVs are inserted by nurses at hospitals in the United States each year. Despite this, the error rate for IV placement often ranges from 20 to 30%. Many of the errors can be attributed to difficulty finding an appropriate insertion site in elderly patients with chronic vascular conditions. Incorrect IV placement can lead to blown veins, bruising, scarring and even needlestick injuries. The IV guide is an assistive imaging system aiming to reduce injuries related to IV insertion. It aims at coupling the clinical knowledge of the nurse practitioner and the latest progress in imaging technology. In order to achieve this, a suitable image of a patient's vein network is captured using a near IR sensory device which is then processed using a low cost embedded system. The system output includes an enhanced image with points clearly indicating recommended IV placement sites. Image capture, algorithm optimization, and embedded system design are the key project challenges. The primary goal of the IV guide is to reduce cost and improve portability, two factors that have impacted the success of similar devices on the market. Overall, the IV guide enhances patient safety through increasing accuracy.

Smart Bicycle System Known as Būke

Cycling is an ever increasing popular method of transportation and, unlike other means of transportations, no metrics are available that can increase safety and assist with maintenance. In Canada alone, about 7500 cyclist are injured per year. Būke is the fully integrated solution to this problem. Būke integrates current industry sensors along with sensors that provide crucial information about the safety and maintenance of the bike and rider. Through an easy-to-use and fully customizable UI along with a touch screen device, the cyclist can easily navigate through and display bike metrics that are important to them. The need to buy and connect separate sensors is a thing of the past. The Būke is an all-in-one integrated system that increases the safety, performance and experience of riding a bicycle. The Būke is the future of bicycles.

Theft Prevention Device

Statistically, over a million laptops are stolen every year in North America; however, only 3% are reclaimed. With public places, such as libraries, becoming filled with people working with laptops and other electronics, theft of these expensive belongings is a serious issue. The Theft Prevention Device aims at achieving a user-friendly solution to avoid theft of laptops, bags, and other similar belongings in public spaces. When an item needs to be left unattended, attaching and activating this device triggers an alarm when an individual tries to remove the protected object. The device uses a combination of accelerometer and gyrometer to sense the belonging being moved beyond a certain distance, and thus triggers the alarm. The system consists of a microprocessor and sensors and also uses Bluetooth pairing with a portable device to enable wireless control. The main advantage of the system is that it can be attached to different items, whether it is electronics, bags, or other personal belongings. Another advantage over alternatives is that it is simple, highly portable, and requires little user intervention. The Theft Prevention System should reduce the problem of belongings being stolen in public places.

Powerblock Elite

As the consumption of electricity in the average household has changed from a mindless task to one which requires the homeowner's full consideration and control, it's no longer enough for them to rely on monthly bills which summarize the power consumption of the home as a whole. Instead, more and more homeowners are looking for the ability to both fully control and customize their electricity usage, as well as the ability to review previous power usage data broken down sufficiently to allow them to make smart optimization decisions. Our solution, the Powerblock Elite aims to provide homeowners with these features bundled with an easy-to-use interface. The device itself is an embedded control system directly attached to a home's circuit breaker panel which can gather and process power consumption data and present the results on a web interface. The interface then allows users to monitor the electricity usage in various areas of the house as well as provide them with the ability to remotely turn on and off various circuits around the house. This gives our users the ability to not only fully analyze their power usage patterns, it gives them full control over all outlets in their home.

HaptiTouch: Feel Your Interface

Today, over 14 million touch devices and 16 million automotive have been sold in 2013 in North-America incorporate touch display technology. Focusing on a touch display to interact with the user interface is difficult and dangerous. The Haptitouch is an external trackpad plug-and-play hardware solution for touch based UIs. Embedded level theory coupled with low-level circuit design practices allows HaptiTouch users to experience a fully integrated solution seamlessly connecting software and hardware. Software API will also be developed so designers can easily integrate the HaptiTouch system with existing or new user interfaces. The trackpad maps the location of windows and buttons that are displayed on the screen and provides temporal vibrational feedback to the users to notify users that they are interacting with objects on screen. The user can feel the interface without looking at it, greatly improving the user interface experiencing by not distracting the user's visual attention and improving driving safety.

EchoCycle

Cycling as a mode of transportation is a popular alternative to cars in urban downtown cores. Cyclists often share the roads with vehicles and in the event of a collision the cyclist is particularly vulnerable to injury. Due to their limited vision, cyclists are required to make frequent shoulder checks in order to be aware of their surroundings and avoid collisions. EchoCycle adds an extra dimension of collision prevention for cyclists by increasing awareness of vehicles in the vicinity of a biker's rear. Ultrasonic sensors are introduced to sense oncoming vehicles and a microcontroller processes the signals received by the sensors to send warnings to the cyclist via wristband vibrations. The intensity of vibrations is proportional to the distance between the vehicle and cyclist. This is achieved through the use of power converter theory. Alternatives such as a mirror attachment require the cyclist to initiate a check whereas EchoCycle actively notifies the cyclist of potential hazards so they can react in time.

Power Strip Plus

Heavy integration of technology into our everyday lives has resulted in society becoming dependant on electricity. Combining this dependency with continually increasing power costs, there is an apparent need to reduce individual power consumption. This project aims to reduce power consumed by idle devices and provide users with an easy way to regulate power consumption. The Power Strip Plus provides users the option of controlling devices in groups, allows users to turn devices on/off remotely, and can automatically control devices according to set power usage patterns. This system utilizes an embedded system to monitor and control power consumed by connected devices. The system also includes a web interface and web application for power bar control. Using this application, users can group devices under a primary device so that power is only supplied to peripherals when the primary device is in use. The main advantage over existing power saving devices is that the Power Strip Plus can easily be adjusted by the user to detect different primary device modes for grouped device control. Additionally, its remote control and automatic shut-off capabilities allow users to save power from almost any location.

Smart Cart

The average person visits the grocery store once a week; spending approximately 40 minutes each visit. Most shoppers tend to use a basket or grocery cart to carry the large quantities of goods that they intend to purchase as they traverse around the store, translating to more effort required by the consumer. On top of this, grocery shoppers tend to be budget conscious, but the task of keeping a running total of the goods is inherently difficult. The Smart Cart is a fully mobile trolley that follows its respective consumer while he or she shops. An extended feature of this cart is the ability to scan items with a built-in barcode scanner to price the current total in the basket. A nice-to-have feature includes a full graphical user interface wherein the user can upload a shopping list or find a specific item. The Auto Grocery Cart leverages Bluetooth pairing with a wearable peripheral to uniquely identify one buyer from the next. The cart also has embedded systems and sensors to guide the cart towards the consumer, while avoiding collisions. The Smart Cart will be coming to a supermarket near you.

Fall Safe

Studies show that one out of three people over the age of 65 fall at least once each year. These falls can result in severe injuries. This is a growing concern in the medical world, given the current trend in the demographics in Canada. Fall Safe is a system that attempts to detect instabilities in one's motion, and mitigate its effects for people with high risk of falling. The system, which is integrated with a walker, is able to detect the motion of the user with the help of multiple sensors that are constantly communicating with each other for improved accuracy. As soon as instability is detected, feedback controllers inform the user and actuate stabilizing mechanisms. In case a fall does occur, the system alerts the user's caregivers. The design uses knowledge of embedded systems, control theories, mechanical designs, and data processing. The existing technology for fall detection is a wearable pendant, which is prone to false alarms for 10% of users. With our project, we aim to increase accuracy and reduce false alarms. Apart from this, our system will act as a stronghold for someone who is falling, rather than simply detecting after the fall has occurred.

PCB Probing Test Chamber

Over the past few decades, an unprecedented growth has been seen in the technology sector. Products and services that were unthinkable a few years ago are being churned out rapidly. Right at the heart of this big technology boom is the electronics sector. To ensure the robustness of these products, a significant amount of time is spent on the verification and validation of the software and hardware components of these products. Wide ranges of tests are performed on the Printed Circuit Boards (PCBs) that could involve multiple teams and a wide range of testing equipment. To reduce the time spent, risk of human error, and complexity in the testing process, a unified, automated solution is required. The PCB Probing Test Chamber consists of an automated probing station with probing arms that allows the tester to probe points on the PCB through a clean and simple user interface that monitors the PCB with a camera mounted in the chamber. This product also incorporates equipment to perform a wide range of tests such as thermal analysis and radio frequency analysis. This unified design provides a simple, reliable, and speedier process for the verification and validation of PCBs.

Smart Switch: Programmable Control of Electrical Lighting and Power

Throughout the twenty-first century there have been many advancements in technology across many industries. One major area that has remained relatively unchanged, however, is the way in which lighting is switched/controlled and installed. The installation of switches to control lighting throughout a home or business requires static control wiring networks that can be complex and inflexible to change. The Smart Switch removes the requirement for physical control wiring by switching lights digitally when prompted through a user interface or standard wall switch. The system includes controllers that can send/receive signals over a Wi-Fi network and a smart phone user interface that maps lights to switches in any configuration desired. In addition, the user is able to dynamically change the mapping of the devices through the user interface application without the need to re-work any physical wiring of the system. Implementation of a microprocessor with a Wi-Fi peripheral, which controls a triac switching circuit, is used in the digital controller. Smart Switch can be used in existing wiring systems or new installations to control one or more lights. This increases the utility of integrated lights and switches, eliminating the requirement of physical wires connecting lights and switches together.

Village Fare Foods Cooking Process Enhancements

The goal of the project is to increase the efficiency of a cooking process in which the company Village Fare Foods is dehydrating sweet potatoes and beef liver, to produce an all-natural dog treat. The facility in question contains ten industrial size ovens that must remain identical in functionality, therefore the solution must be scalable and be contained within the building. The current process is simply to cook the product at a given temperature for a pre-set amount of time. The current process involves venting the hot water-vapour saturated air outside and bringing in and heating new dry air. The first goal is to come up with a way to recycle the heated air this includes removing as much vapour as possible and reintroducing the hot air back into the oven. The second goal is to change the cooking process by varying time and temperature in order to make it more efficient and consistent between all ten ovens. We hope to achieve this by changing the cooking process to rely on more than just temperature and time but other variable such as air saturation and water content of the initial product.

MiCam 360

The objective of this project is to increase the quality and usefulness of recorded environments by using camera and microphone technology that allows a user to record once, and then localize the video and audio afterwards to fit their specific needs. The MiCam 360 is an all-in-one scene-recording solution that consists of a 360-degree camera mounted on a stand containing a special microphone, as well as a simple and intuitive user interface. This setup allows the focusing of video in any direction via the spherical camera, and the specific audio from the same direction is obtained using a custom surround sound microphone that is built and designed for this application. Our microphone consists of four microphones in one housing that are arranged specifically so that all four audio streams can be used, cancelled, and combined to output audio that can match any microphone type pointed in any direction, as if one was present at the time of recording. This allows an unprecedented level of control over the recorded footage, and replaces recording set ups that typically contain dozens of devices. The surveillance market better watch its back!
