

WATERLOO | ENGINEERING

ELECTRICAL AND COMPUTER ENGINEERING

PROJECT ABSTRACTS

**FOURTH-YEAR DESIGN PROJECT SYMPOSIUM
DC BUILDING ATRIUM, UNIVERSITY OF WATERLOO**

WEDNESDAY MARCH 19, 2014

OPEN TO THE PUBLIC FROM 10:00AM TO 5:00PM

2014.001 Student Success Network (SS-Net)

Seeking and participating in extracurricular opportunities for student success can be a difficult process for both the student and the administrative staff across different departments on campus. Coordination of the International Peer Mentorship program at the University of Waterloo currently involves a manual process of matching hundreds of students and mentors which is highly time consuming and inefficient. Student Success Network is a web application solution that allows international students to be matched with student mentors on campus through a matching engine. The solution will reduce the manual work performed by administrative staff and provide statistics on the matches performed between students. The system will allow definition of programs and individual offerings of those programs. Applicant registration data from other sources is imported into the system and associated with a program offering. The matching engine employs Lucene to use student eligibility and compatibility criteria such as interests, language, gender, and ethnicity to quantify the suitability of a match. Finally, the system is able to export match results in a format suitable for mass communication of the results to students. The application can be potentially expanded to assist in other mentorship programs across campus.

2014.002 Vehicle Collision Tracker and Recorder (VCTR)

Over 10 million car accidents occur in the US annually. Investigators face difficulties in determining the cause of accidents and recreating the final moment before a collision. The Vehicle Collision Tracker and Recorder (VCTR) is a device designed to be added onto an existing vehicle to allow drivers and investigators to determine the root cause of a collision. It collects data from its accelerometer, cameras, and the vehicle's diagnostic port. The accelerometer determines if a collision has occurred and its severity. The vehicle's on-board diagnostics are used to gather information from the vehicle's sensors and to identify if there were any malfunctioning components prior to a collision. The cameras, located on the vehicle's rear-view mirror, record the driver's actions and the vehicle's surroundings. The central system is contained in a crash-resistant enclosure that ensures data recovery regardless of damage to the vehicle. The system also allows the driver and investigators to view the reports and videos generated by the VCTR on a computer using an interface. The advantage of this device over existing solutions is that it collects both video and diagnostic data, makes the data accessible to drivers and investigators, and is compatible with any vehicle.

2014.003 Voice Controlled Home System

One of the biggest concerns in the 21st century is the conservation of energy. Many people forget or disregard turning off electronic appliances in their homes which wastes a great deal of energy. Our solution includes a Wi-Fi controlled power strip which can be accessed with any device via a browser. The power strip has a Wi-Fi module that can shut off specific power outlets via relays. Multiple appliances can be connected to this power strip, those include lights, chargers, and microwaves etc. A website hosted on the Wi-Fi module communicates commands from the device to the power strip. Important software functions include estimation of energy spending and showing the benefits of using off peak electricity rates. The scope of the project is the design and construction of an analog circuit, and the development of the accompanying website. Electronic components such as Wi-Fi receivers and relays are used to aid the design. Compared to similar products, our design allows a wider range of accessible devices and has the unique software function to display energy costs.

2014.004 Zonal Energy Metering

Ontario's electricity prices have been increasing steadily over the past 5 years. The off-peak time-of-use price has seen the most drastic increase, costing consumers 109% more in 2013 than in 2007. Using electronic appliances during off-peak hours is no longer sufficient to lower electricity bills; consumers can better achieve this by tracking and identifying problem areas in their daily energy usage. The ZEM's interactive interface provides feedback based on usage goals, and allows users to view electrical characteristics of separate circuits terminated at electrical panels. The ZEM uses current and voltage sensors to measure the power flowing through each zone. The output from the sensors is encoded, transmitted, and uploaded to a server. Data collected will be stored, trended chronologically, and manipulated to graphically illustrate zonal usage patterns. With the collected data, ZEM calculates and displays the instantaneous power, power factor, and total harmonic distortion. Furthermore, users will be able to gain understanding in the various elements that affect power usage beyond current and voltage. ZEM's ability to be used in a wide range of environments makes it a flexible product that provides interactive feedback for energy-conscious users.

2014.005 Turn It Off!!! Power Management System

Recent studies suggest that as much as 10% to 15% of household power-consumption is wasted by standby devices. Such energy "vampires" are composed of lightly used devices, such as microwaves and chargers, consuming more power in standby than during the short periods of use, leading to high operating costs. The "Turn it Off!!! Power Management System" dramatically reduces this wasted power throughout the home by controlling the power to every circuit right at the source. This embedded system, located at the service entrance, provides complete control over individual circuits via an internet based scheduler (Google Calendar) through relays installed after the branch circuit breakers. The system allows scheduled automated circuit control based on a variety of inputs including motion sensors and door/window contacts. This solution allows the homeowner to restrict non-critical loads to off-peak hours to further increase energy savings. It differs from competitors due to the low cost centralized installation and low power consumption offering control functionality for all circuits in the house. Furthermore, it provides the homeowner with complete control over their electrical system, giving a new level of convenience while reducing the power consumption previously wasted by idle devices.

2014.006 Integrated Battery Management System

Modern mobile robots use lightweight lithium-ion batteries which require monitoring to plan around battery life. A separate management system is often used for monitoring, adding extra complexity and weight to the robot as well as difficulty in battery replacement. This project presents an all-in-one plug-and-play battery and management solution that comprises traditionally separate components. This management system allows for tracking and storage of battery conditions and prediction of remaining battery power. The system has the ability to communicate with other batteries and report data to the robot's central control hub. Emphasizing on ease of use, the solution allows for battery exchange and the introduction of additional battery units with limited user involvement. To meet the needs of mobile robotics, the product also reduces the size, weight, and cabling when compared to external management systems. This integrated battery and management system provides improved usability during mobile robotic field testing, development, and operations.

2014.007 Accurate Marathon Trainer

In 2012 there were a total of 2650 international runners coming from 61 countries who took part in the Budapest Marathon. It is optimal for marathon runners to train in the same route they will participate in but economic constraints prohibit this for international participants. The Accurate Marathon Trainer is a prototype treadmill device. It addresses the aforementioned issue by simulating the topography of the selected marathon. The device automatically adjusts the incline and decline according to preprogrammed marathon routes. This project is implemented using microcontrollers, motors and other peripherals. A graphical user interface is integrated to allow the user to be able to easily navigate through the different modes. The scope is limited to major North American marathons and does not take outdoor environment into account. Nice-to-have features include the ability to dynamically add new marathons routes, integrate other environmental factors such as weather and entertainment features. No other alternative allows the user to train indoors while still being able to experience the topography of the marathon route.

2014.008 Intuch

Institutions face considerable fundraising challenges, since they rely heavily on their alumni body for monetary donations but do not have an effective way of communicating with them. The primary reason for this disconnect is that most alumni are not actively involved with their institutions. In other words, institutions are not able to stay “in touch” with their alumni. Our project, which is called Intuch, aims to solve this problem by giving institutions and their alumni a way to interact. Intuch will be a cloud platform, which will give institutions an application that will keep their alumni engaged and deliver accurate donor data. Intuch will essentially be an alumni social network that will provide alumni with easy access to their peers and other members of their educational institution. This will offer alumni an effective way of making meaningful connections and seamlessly looking for peer-recommended job opportunities. Using this design solution will supply institutions with a web-based analytics platform, which will monitor alumni, identify high-potential donors, and deliver real-time alumni data. By using Intuch, institutions will never lose the connection with their alumni body.

2014.009 Fitness Electricity Generation

Due to obesity awareness and the rise of health-conscious lifestyles in North America, the use of gyms and fitness equipment has become extremely common. The kinetic energy generated from use of fitness equipment is wasted because most machines are unequipped to harvest it. The team addresses this problem by creating a method for the storage and utility of energy generated from fitness equipment usage. The proposed design of the Human Fitness-Powered Green Generator (HFPGG) integrates fitness equipment with a generator, battery and outlets, allowing for the collection, storage and use of the energy -generated by its user. The prototype accepts input from a modified bicycle, but the design can be repeated for larger machines. The final prototype will include a screen to display system progress and other information to users. This prototype avoids difficulties encountered by existing “green” gyms, which are unrealistic with their high aims of power provision. Although the energy produced from fitness equipment usage is not enough to power large systems and buildings, it is sufficient for charging small devices and appliances. This design contributes the Green Movement by utilizing the small and commonly wasted energy generated from human-powered systems for achievable purposes.

2014.010 IDE Enhancer

Development environments have remained largely unchanged for the past decade. Most environments display code in an identical manner while providing little insight to a software project's control flow. In order to completely understand a program's control flow, developers must read through multiple files while maintaining a mental model of the project. Our proposal is to solve this problem by building a plugin that modernizes Visual Studio. The solution breaks a code base into code fragments such as methods, rather than files. This allows the plugin to visualize dependencies between code fragments, making it easy to understand control flow visually. The user can both edit and debug their code on the basis of function calls. Our project is implemented using the .NET Framework and incorporates concepts from compilers, data structures, networking and user-centered design. Our solution is superior because alternative solutions are implemented as an entirely new IDEs and require developers to give up functionality they are accustomed to in their primary IDE. Our solution is an add-on for Visual Studio and will display C# code in a more efficient manner. This allows developers to work with an industry programming language while retaining the familiar capabilities offered by Visual Studio.

2014.011 The Mood Monitoring System

Emotional driving leads to accidents on the road. According to a report from the AAA Foundation for Traffic Safety, nearly 1500 people are seriously injured or killed every year due to aggressive driving in the US. To make the roads safer for everyone, the Mood Monitoring System recognizes the driver's frame of mind and responds accordingly. The system takes inputs from the driver's physiological responses by integrating heartbeat and tactile pressure sensors into a digital controller. If the measured levels indicate that the driver is angry or anxious, the system plays music according to the users' preferences and/or adjusts the temperature in the car, making them feel more comfortable and relaxed. The detecting algorithm is generalized such that it identifies the mood accurately for the majority of drivers. The Mood Monitoring System is smart, interactive, and can be easily integrated into any car. This system is intended for vehicle operators but the technology can be extended to other applications.

2014.012 AirHub

There is an average of 5.7 Internet-connected devices in a household; a number that is expected to rise. These devices integrate with various home electronic resources, but granting them access requires users to constantly readjust their system configurations. AirHub acts as an intelligent hub, allowing for the wireless reallocation of available resources. The output systems can connect to AirHub in the same way they connect to a smart device. Using a wireless protocol and dynamic resource allocation, AirHub routes smart devices' video and audio streams to a requested output. Users connect to AirHub and determine the resources they want to access using a customizable user interface. The supported resources include video and audio devices, such as monitors, projectors and speakers. AirHub promotes scalable setups and allows for easy integration of shared resources. It can also be expanded to include different user profiles with set permissions. Alternative solutions are niche-specific and too inflexible to be used in conjunction with a large variety of smart devices and output systems. AirHub makes interaction between home electronics effortless and intuitive, while eliminating tedious system adjustments.

2014.013 Precision DJ Controller

DJ performances have not significantly changed since their introduction into mainstream culture. The initial cost for even a basic DJ setup consisting of a MIDI controller and sound card continues to remain high as well. Due to the high costs, DJing is off-putting to many individuals that may have otherwise been interested. The project emulates fundamental DJ controller techniques and basic DMX-networked lighting control by using a user's hand gestures. This input is then converted into instructions that control the operation of the DJ software or DMX-networked lights. The solution allows for concurrent effects. The system includes a motion recognition interface, a desktop application, and compatibility with existing DJ software. Event-driven programming is employed in the solution to integrate audio and visual lighting which are traditionally managed separately. By giving the DJ the ability to dynamically control the lighting, they now have a more complete control of the crowd and can add a new dimension to their live performances. The solution is cheaper, allows for a more interactive and spectacular live performance, and will introduce DJing to a whole new generation of individuals.

2014.014 Intelligent Parking Management System

The commute to Toronto is ranked as the most arduous in the world — with Los Angeles, New York and other metropolises in similar straits. Strained parking resources arising from increases in population, development and automobile use have resulted in a great demand for efficient parking management. Delays and frustration are mitigated with an intelligent system to monitor and provide feedback on the availability of parking space. Our solution aims at augmenting existing multi-storey parking lot electronics with sensing and reporting capabilities under the management of a central server. The logical organization of distributed parking spaces is the key to our solution. The system uses sensors to detect the presence of vehicles in individual parking slots and the movement of vehicles through the parking lot as input to the software suite. Prediction algorithms are then used to determine the time of next available slot and provide a revenue model based on current parking lot information and past customer parking behaviours. The implemented system enables the administrator to efficiently manage the flow of traffic through the parking lot, analyze peak hours and determine profit-maximizing rates. From a driver's perspective, the system minimizes the time spent looking for a vacant spot.

2014.015 Automated Driving System

Driving has become a major necessity in our society today, yet car accidents are one of the main causes of premature death. Worldwide, an estimated 1.2 million lives are lost every year due to traffic accidents and fifty-seven percent of these accidents have been attributed to human factors. The Automated Driving System (ADS) is a completely autonomous system that will navigate through an environment and adhere to traffic rules and regulations to transport passengers safely. The control environment simulates traffic signals and signs that are detected by a model car equipped with an ADS. This system retrieves the destination provided by the user, as well as the inputs from the surroundings. The model car determines its location within the environment and plans the most efficient route to the destination. Outputs include driving through the environment safely and following the planned path. This solution incorporates electronic devices including sensors and actuators that must be mounted on the model car, as well as other devices that need to be built into the control environment. The ADS marks the beginning of a safe and efficient era of road transportation for the entire human population.

2014.016 Leg Motion Monitoring System (LMMS)

Parkinson's disease (PD) is a slowly progressing disease of the nervous system that causes people to lose control over their muscles and the end stage of this can lead to pneumonia, choking, severe depression, and death. To prevent patients from reaching the end stages of PD, it is vital for doctors to monitor the development of the disease and the effectiveness of treatments. Current technologies are limited in qualitatively collecting tremor data in the limbs, a symptom of PD, in hospitals by visual inspection. This project builds a long term monitoring system that continuously collects the frequency, pattern and severity of tremors in a patient's leg without visits to the doctor's office. The system collects long term real-time data from a wireless inertial measurement unit (IMU) strapped onto a patient's leg. The IMU provides acceleration, orientation, and gravitational forces using accelerometers and gyroscopes. The collected data is uploaded to the cloud via an android phone using Bluetooth connection and users can remotely monitor and study tremor characteristics of patients through a web interface. This system provides accurate, real-time, quantitative data which allow doctors to provide better diagnostics and treatments for PD patients.

2014.017 Handheld LCR Meter

Typical handheld professional LCR meters are expensive, with entry-level units ranging from \$300 to \$500. In addition, they have obsolete user interfaces and are bulky. Businesses, institutions and students will benefit from an affordable, convenient and intuitive meter. Our solution resolves these issues by integrating the measurement circuitry of an LCR meter with the user interface and display capabilities of a mobile device. The system is comprised of a battery-powered probe and embedded measurement subsystem which communicates with a user's mobile device. A cross-platform application running on any major mobile operating system displays measured data and allows convenient control of the meter. The application utilizes the device's available resources to store data and perform useful functions for the user. The meter is capable of precise measurements of inductance, capacitance, and resistance as well as other measurements such as impedance, ESR, Q factor, and diode characteristics. The main advantages of the system over existing alternatives are low cost, portability and ease-of-use. The system combines advanced measurement features with mobile technology to deliver an effective solution.

2014.018 Remote Water Management System

According to Environment Canada, an average Canadian household consumes 120,000 litres of water per year. Monitoring water consumption and detecting leaks is a difficult task, for which the current market does not offer an easy solution; however, the amount of water wasted by a household has a high monetary cost to the homeowner and can be reduced by implementing a monitoring and control water system. The Remote Water Management System allows a homeowner to monitor and control water flow in key areas of the house. The system integrates a microcontroller and a software interface that allows a homeowner to generate water consumption reports, and control water flow at shut-off locations within the house. The system is implemented using solenoid valves and wireless flow sensors. The solution is compatible with high flow devices, such as washers, and with low flow devices, such as taps, ensuring feasibility. In comparison to current monitoring techniques, the proposed system allows consumption data to be narrowed down to key areas of the house. Furthermore, the ability to control water flow itself allows for a more comprehensive water conservation plan, reducing water utility bills.

2014.019 Just the Trip

Since global positioning systems (GPS) have become commercially available as navigation devices, the arduous task of planning road trips has become obsolete. Current GPS units are portable, save time and money, and reduce the stress involved with travel. While most devices optimize routes for the shortest distance or travel time, they often fail to take into account other important variables such as the oil and gas levels of the vehicle, potential rest stops for the driver, and the upcoming weather. Just the Trip implements this functionality based on vehicular on-board diagnostic (OBD) data, online weather forecasts, and traffic reports in addition to recommending points of interest (POI) defined by the user. This system consists of an Android device that interacts with the user, a database server, and a wireless OBD-II connector attached to the OBD-II port. Functionally, this system encompasses standard GPS features while dynamically improving route planning and POI recommendations, enhancing safety and increasing the user's awareness of their surroundings. Unlike existing alternatives, Just the Trip can reroute you around storms, recommend gas stations based on upcoming frequency and prices, and provide you with a more informed route, leaving you feeling more confident than ever about your next trip.

2014.020 BluePoint Connection Manager

There are more than 3 billion Bluetooth devices in the world, and with the advent of gesture control technology such as Thamlic Lab's MYO, there is a need for effective context switching between Bluetooth connected devices. Currently, alternating between Bluetooth connections is an arduous process. There is no method for switching device connections without traversing through a settings menu to open and close connections. The BluePoint is a wearable embedded system that facilitates efficient connection management by opening and closing Bluetooth connections based on a user's pointing motion. The user wears the BluePoint on his/her arm, and by gesturing towards the target device, a Bluetooth connection will be established between the host and target devices. This allows a host device, such as a MYO or phone to swiftly alternate between connections to several devices. Target devices are equipped with an interface that communicates with the BluePoint, and sensors are used to identify the correct target device. Furthermore, the BluePoint interfaces with the host device to communicate the intended connection to open. This solution is much faster than manually switching between Bluetooth connections, and will allow gesture control technology to seamlessly interact with multiple devices instead of just one.

2014.021 Workout Posture Coach (WPC)

Incorrect postures during workouts are one of the most common causes of workout injuries. Severe workout injuries can have prolonged or lifelong effects. Workout Posture Coach (WPC) aims to rectify improper postures to reduce the chance of injuries. To do so, WPC uses infrared and depth sensors to perform skeletal tracking and compares captured data to a set of correct (golden) data. If the detection offsets from the golden data by a large margin, the system outputs audible messages warning improper postures. In addition, users can visually compare the captured data to the golden data to determine necessary posture adjustments. The system also offers real-time video feedback for users to view their movements during workouts. Implementation challenges of WPC include finding the most optimal time interval for sensors to sample input and developing algorithms for pattern matching that adapt to different physical attributes and positions. The scope of this project is limited to ensuring that users are aware of improper postures and are able to make adjustments. Overall, this project offers an idea that has yet to be commercialized. WPC reduces the chances of injuries during workouts making it an indispensable tool at the gym.

2014.022 The Spartan Voting System

As Canada attempts to modernize its voting infrastructure, electronic voting machines have emerged as a replacement for paper ballots. However, recent implementations have failed to meet the basic requirements of integrity and security expected in such systems. For instance, usage in Florida resulted in delays, miscounts, and failures, whilst eavesdropping vulnerabilities were found in a system in the Netherlands. The Spartan Voting System addresses these problems by providing a robust, reliable, and secure system. The design uses custom software and hardware that caters to a wide variety of election environments and formats. The system is created with secure, yet accessible endpoints, a limited attack surface, and is backed by a secure communication channel. In addition to the secure design and implementation of the system, The Spartan Voting System provides users and administrators with an audit trail, enabling independent verification of votes. This solution offers quick vote tabulation, and is flexible to changes in voting practices. A few alternatives exist that meet some of these design goals, but they rely on the user's personal computer, which is vulnerable to viruses and malware.

2014.023 High SNR 3D Visualization for Ultrasound Technologies with Real-time Image Processing

Ultrasound technologies are commonly used in the medical field for affordable medical imaging and detection purposes. Currently, for the sake of real-time, the image visualization in many ultrasound imaging devices have relatively low Signal-to-Noise Ratio (SNR) and limited 3D visualization capabilities. Therefore, there is a need to have access to raw signal from the instrument to improve the SNR and visualization of the data. The current approaches for generating 3D scans from 2D ultrasound transducer arrays are rather limited in image quality and difficult to implement. This project involves implementing a novel way of driving 2D arrays and addressing some of the limitations of the previous methods. In addition, the raw signal from the instrument will be used to construct high SNR visualizations in real-time via image processing techniques that take the real-time requirement into consideration. The method proposed here looks to improve the lag, SNR, and the visualization quality. The benefits of this project are to provide higher resolution, higher SNR images in real time.

2014.024 Trashbot

Each year \$11.5 billion is spent on litter cleanup in the United States, with over 51 billion pieces of litter landing on roadways alone. Using automated means, this garbage can be gathered more efficiently and affordably. Trashbot is an autonomous garbage collection robot. It is designed for common terrains such as grass, gravel, and sand. The robot implements a pathfinding algorithm in conjunction with GPS to sweep the required territory. Garbage is collected into a bag until full, at which point the robot returns to a home station to drop off its collection, seat a new bag, and charge. Each round of garbage collection attempts to path over a different section of the territory in the case battery life is not sufficient to cover the required area. The path boundaries can be configured through an external application. Digital control systems are used to operate motors controlling drive systems and mechanical subsystems which manipulate the garbage into the bag. Sensors are used to detect various faults in the system as a result of wear or foul play. Trashbot will provide communities with an affordable and reliable means of maintaining the cleanliness of their public spaces with minimal human intervention.

2014.025 Wireless VGA Adapter

Wires are binding. They tie people to a spot and are restrictive. In today's world, people want their electronic devices to be wireless. Projector as the most commonly used display device for presentation with large audiences nowadays still uses cables for power and data. The wires create untidiness, safety concerns, and difficulties with setting up and switching inputs. The C9 wireless video adapter is made to replace the data cable. The adapter uses a wireless receiver to bring the projector into the wireless network for data transferring. The adapter is plugged into a projector's video input port to feed the received and processed video data to the projector. The system also includes software that can be installed on different input devices which allows the users to access and control the connected projector. The user input device can be a computer, a tablet, or a mobile phone, as long as it is connected to the same wireless network as the projector. The C9 wireless video adapter is cost-saving, flexible, and convenient comparing to existing solutions. It makes projectors easier to install, reduces the time and work for setting up and switching inputs, and gives the presenters more choices on input devices.

2014.026 Hydrosense Smart Water Monitoring System

The average North American uses approximately 400 litres of water every day. To sustain this kind of lifestyle globally, we would need more than three times the amount of fresh water we have on the planet. Currently, there is no convenient way to monitor the water consumption of the various appliances and faucets in the home. Individuals looking to reduce their water consumption have a difficult time determining where to start and how effective their efforts have been. Hydrosense is an economical, accurate and minimally invasive flow monitoring system that can easily be fitted to household water pipes to monitor water consumption. This information is wirelessly transmitted to a central station which provides consumption metrics to the homeowner. Water flow is measured using battery powered flow sensors, transmitted wirelessly, processed, and presented to the homeowner on a web interface. Currently, home water meters only provide total consumption without specifying how the water was used. Hydrosense provides the homeowner with a convenient way to monitor household water usage at a micro level, making it easier for them to adjust their consumption habits or discover leaks in their household water system. This will aid in the conservation of water.

2014.027 Guided Infrared Locating Fan

Current fan control systems require manual setup to position the fan in a desired direction. There are points in the room that the fan will not always cover. One of the many issues is that a person will often leave the area of coverage and is left with the only option of manually adjusting the fan. The rotating option is inefficient since it is not always directed towards a person even though the fan covers a large area. The problem is that most fans come with two modes of operation in terms of direction; either stationary or swiveling. The ideal fan detects humans in the room and adjusts itself to point in their direction. Through the use of infrared sensors, the system can track the movement and location of people inside the room. The implemented software dynamically controls the direction of the fan with the use of simple motors. This fan control system will provide optimal coverage which is superior to the current fan systems in today's market.

2014.028 ScantIt

On average it takes experienced 3D model artists 10 hours to model a detailed object. By scanning physical objects, 3D scanners can provide basic models easier than if they were to be produced from 3D modeling software alone. The upfront cost of current commercial 3D scanners and the time spent learning the software to create these models make it difficult for hobbyists to adopt scanning technology. Project S is a robust 3D scanner that captures images of static objects from various angles using structured light and reconstructs those images in 3D on any platform. Project S removes the steep learning curve and time associated with porting physical objects to animation software. By encapsulating the target model in a black box and rotating the model, the number of environmental factors decrease and simplify the amount of processing required. The input will be collected from within the black box and then later processed. The reconstructed output will be an animation ready 3D model. Project S provides the fast scanning and processing required for 3D modelling at a price point that is affordable for hobbyists and enthusiasts. Project S will allow everyone with a creative vision to express the depths of their imagination.

2014.029 Q-Xposure

One of the most common complaints at large public venues such as amusement parks, conventions or festivals is the long queuing times. These wait times can turn an otherwise pleasant day into a long and wearisome ordeal. This project provides a system for these venues to monitor queuing times in real-time and efficiently communicate the information to a customer's mobile phone. Strategically placed real-time maps throughout the venue further facilitate the communication of this information. The software also allows for the creation and configuration of a venue layout, allowing unique designs for different venues. Infrared grid array sensors deployed at queue entrances automatically detect queue length to provide data to the applications. By providing customers with this real-time information, the system allows customers to determine the shortest wait times across the venue and plan their day accordingly, allowing them to spend a greater percentage of time out of the line enjoying other aspects of the venue. Giving the customer greater control over their time improves their satisfaction, making it more likely that the customer will return another day. Furthermore, the system provides venue management with useful queuing statistics, letting them advantageously improve their venue layouts.

2014.030 Sound Localization and Amplification System (SLAS)

Communication in a conference setting is impacted by surrounding noise and distance from the speaker, which reduces the effectiveness of the exchange of information. The audience often cannot clearly hear the speaker, resulting in time wasted for repeating the message. The Sound Localizing Amplifier System (SLAS) facilitates the communication process. The sound localizing device in the system pinpoints the signal's source using digital signal processing techniques. The control module adjusts the orientation of the microphone autonomously by applying control theory. The module then captures and amplifies the sound throughout the auditorium. The input to the SLAS is the aggregated audio signals from the conference room where only one person is expected to be speaking at a time. The desired speech signal is amplified and broadcasted to the audience. In addition, administrators have control over the configuration of the SLAS using a user-controlled interface. The SLAS enhances the experiences by clearly emanating information and provides a flexible solution to reduce the difficulty of listening to a distant speaker in a noisy environment. The SLAS will improve the audience's experience in a conference.

2014.031 OneShot

Paintball players endure the heat of battle with very little information beyond what they can see and hear. This lack of awareness and feedback can severely limit their ability to strategize. First person shooter games demonstrate that real-time knowledge of weapon and player status is essential for making superior tactical decisions. This project introduces a system that attaches to paintball guns, and provides users with key information to improve their gameplay. Ammo count, rate of fire, and projectile velocity are tracked by on-board sensors and processed by a centralized controller. Immediately relevant information is presented to the user through an electronic display in real-time, while data useful for post game analysis is stored in memory. Other “nice to have” features include tank pressure monitoring, system generated audio cues, effective range estimation, inter-device communication, and aiming assistance. There currently is no system on the market that accomplishes this. The system benefits players by providing them with information that allows them to better strategize and develop their skills. It will grant access to a tactical edge that was never before available, and ultimately pave the way to the next generation of paintball warfare.

2014.032 Echo: Audio Editing Version Control System

In 2012, independently recorded records accounted for 32.6% of all record sales. Independent artists typically record in home studios and edit their recordings collaboratively. This collaboration is often achieved by emailing digital audio workstation project files between artists. This process is archaic and inefficient. Our Echo software simplifies and optimizes this collaborative editing process. It does so by providing an effective version control mechanism for audio projects. This solution is based on a distributed client-server architecture wherein audio files are stored on a remote server that is easily accessible by all project collaborators. Additionally, metadata that details all modifications to the audio file are stored such that all changes are atomic and can be undone with ease. Other features include the ability to maintain a local working copy that is unaffected by changes made to files on the server as well as the ability to split a project into multiple branches. Furthermore, the features that Echo provides can be utilized with multiple digital audio workstations. This software will allow your music to Echo around the world.

2014.033 Better History Search: A Contextual Timeline

People cannot easily find or conceptualize historical event context. Modern search engines work well when you have a precise target, but fail to illustrate the temporal context. Vague search terms fail to produce semantically relevant results. Better History Search is a search engine designed for curious, history-conscious users, with a focus on students, who want to learn about the context of events in history. It uses language processing and knowledge of Wikipedia’s structure to gather and catalog information from Wikipedia articles which describe events. Natural language techniques are used to process dates, keywords and event details from user queries to find relevant events. These are then organized along an interactive timeline with considerations to significance and other factors. The significance of events is determined by algorithms that examine the content and importance of articles. Event data is presented to the user through a web interface that can adjust to new display constraints dynamically and make arrangement decisions based on the content. The added temporal context and flexible querying provided by Better History Search allows users to gain a greater understanding of the events they care about.

2014.034 ArmTrack

Shooting a basketball accurately requires a correct fluid shooting motion. Enthusiasts up to professional athletes have taken many measures to develop the quality of their jump shot. Professional athletes seek the help of expensive shooting coaches but the average enthusiast or amateur athlete cannot have access to that sort of support for each shooting session. The “ArmTrack” provides the wearer with a quantitative summary of shots that were scored and compares that to the angles and motion of the arm when shooting through the use of sensors. The design includes the use of accelerometer sensors strategically embedded into the user’s sleeve that are connected to an embedded programmable microcontroller. The microcontroller is then paired via Bluetooth to the user’s mobile device and the accelerometer data is streamed from the microcontroller. At the mobile device, the data is parsed and summarized comparing the shots made to the quality of the arm motion. This data is then displayed on the mobile device using a user friendly Android Application interface. Through the understanding of this information, the user can see when they have shot well, what sort of arm motion created such shots, and work on improving the quality of their jump shot in this manner. This is a cost effective, personalized, comfortable manner of tracking the quantitative progress of the user’s basketball shooting motion and can be worn both indoors and outdoors.

2014.035 Silent Jam Kit

One of the defining attributes of rock music is the use of deafening volumes, with many bands playing louder than 120 decibels. Unfortunately, rehearsing with these instruments is also extremely loud. This makes practicing in most residential areas, especially at night, nearly impossible due to noise bylaws and complaints from neighbours. The Silent Jam Kit allows multiple musicians to practice quietly, at any hour, without disturbing those around them. Each musician has a unit featuring an instrument input and an output for headphones. These units communicate wirelessly to combine the individual instruments into a full ensemble, which is made audible via each unit’s headphone connection. Although similar products exist on the market, this kit is the only one that features wireless communication, making it more flexible and convenient to use. The Silent Jam Kit allows musicians to rehearse together at any time without waking the neighbours.

2014.036 Renaissance

Project management does not easily scale across locations due to the challenge of organizing documents, ideas and conversations. Current project management platforms allow project managers to take control of a project and its deliverables. They are focused on the needs of large organizations with mostly localized teams and are not catered to individuals working together at different locations. Renaissance is the collaboration platform for groups without a project manager. It provides a separate space for each project where users can add collaborators and integrate an existing file sharing service. This space also allows for collaborators to comment and discuss ideas. Conversations are intelligently organized based on their topic, allowing teams to spend time maximizing their output rather than organizing. In addition, users can view projects made public by others and filter them by category and location. This enables individuals to collaborate on a project of common interest effortlessly without the need for anyone to initiate the process. In comparison to existing solutions, it is lightweight, and designed for a team working at multiple geographical locations. Renaissance enables a small team to carry a project from inception to presentation without the need to put on the project manager cap.

2014.037 Physical Presence Analytics System

The technology to gather and analyze online shopping behaviour has improved significantly over the past decade, yet gathering the same metrics in the offline world has not. Our Physical Presence Analytics System gathers statistical data about people's physical presence in a given zone. On average, companies spend 10.4% of their annual revenue on marketing, and in many cases over 15%. This presents an opportunity to find a cost-effective solution to provide insights for streamlining marketing efforts. The input to the system is human traffic across a zone; a camera-based sensor system is used to track customer flow in a retail store. This captured data is analyzed using OpenCV, an open-source library for image processing and recognition technology. There are many potential applications for this technology including applying the idea of online user analytics to the offline world by generating statistical information to help extract meaningful insights to a retail storeowner such as customer traffic into the store. Our scope consists of the application of the system in a consumer retail store, with a predetermined subset of potential analytics. Existing solutions in the space are mostly smartphone based; however, not every shopper may have a smartphone. Our system provides more rigorous analytics by being able to monitor a larger customer population.

2014.039 Robotic Arm Project

In areas of engineering and hazardous chemical treatment where precision is needed, there are limited ways to guarantee the safety of workers. The Robotic Arm Project (TRAP) implements a cost efficient real-time control system for a robotic arm, which allows users to do dangerous tasks from a distance to guarantee their safety. TRAP is human operated, meaning it allows the user to control a robotic arm with their own arm, maneuvering it with precision; this allows its operation in uncontrolled environments where traditional preprogrammed robotic arms cannot be used. The project includes a physical robotic arm as well as a sensor system worn by the user to provide input. The scope of the project will be limiting the robotic arm to three degrees of freedom, which is akin to a human arm that can only bend its elbow upwards. TRAP can be mounted on a stand or other physical robotic systems. With time, the Robotic Arm Project will grow in its versatility of applications and will use next generation robotics control to solve today's problems.

2014.040 Wearable Heart Rhythm Monitor

Every year about 715,000 Americans have a heart attack, and about 47% occur outside of the hospital as many people with heart disease don't act on early warning signs. This project proposes an early heart attack detection system that monitors and warns patients to seek medical attention when early signs of a heart attack occur by monitoring heart rhythms. A controller receives inputs from sensors that detect a heart's activity and warns users when signs of a heart attack occur. This project improves on existing technology by providing a centralized device that monitors the heart, and provides real-time feedback to the patient. With our design, a heart patient's probability of survival is increased by having an early warning system to inform the patient when to seek medical attention. In the future, more sensors may be added to detect other diseases and symptoms.

2014.041 Low Altitude Kinetic Tracking Unit (L.A.K.I.T.U.)

In high end athletics, studying individual movements is important. This requires a close range video with a steady viewing angle. Existing solutions rely on stationary cameras or cameras on rails, both of which can limit possible viewing angles. Our design, the low altitude kinetic tracking unit, uses an autonomous vehicle equipped with sensors to track at close-range and a camera to film a specified object. Sensor information is analyzed by a computer to determine required movements of the vehicle. The tracker is able to keep the target object, which may be moving unpredictably at high acceleration, in frame at all times. With our project, close-range video of a fast and unpredictably moving target is possible without the usage of multiple devices or target markers, which has significant applications in sports science and photography, as well as security and military applications.

2014.042 SmartTouch Assistant

The project solves the problem with the lack of flexibility in human interface devices for computers. The traditional mouse and keyboard combination does not provide input methods that can be tailored to the specific needs of the user and their current application. For example, users who wish to use keyboard macros cannot accomplish it with a traditional keyboard. Existing solutions include specialized keyboards and controllers which are prohibitively expensive, as they can cost upwards of \$100. The system consists of an Android application paired with a Windows application. The two applications communicate via Bluetooth or USB to transfer the user inputs from the Android device to the host PC. Keyboard macros and mouse inputs are some of the supported inputs to the Android application. The Android device has the capability to translate complex inputs into Windows operations. The primary goal of the project is to give users an affordable and flexible form of input that can adapt to their application environment. With this application, users will have a natural extension to their standard computing inputs, which they can take advantage of to increase their efficiency and productivity.

2014.043 EYECane

Many of the approximately 285,000,000 visually impaired persons (VIPs) in the world require the use of white canes and guide dogs. Voice recognition and accessibility features have allowed them to use smartphones for GPS navigation, object identification, and other tasks that are routine for sighted individuals. Modern white canes improve on the inherent functionalities of traditional white canes with built-in compasses, obstacle detection and haptic feedback; unfortunately, using a smartphone's touchscreen while using these mobility tools is still challenging for VIPs. The EYECane is an enhanced white cane that utilizes ergonomically placed buttons and a trackpad to interface with mobile devices. The smartphone's accessibility features are leveraged to allow VIPs to access applications and navigate the screen. It communicates wirelessly with the smartphone through a Bluetooth module controlled by a microprocessor that mediates between the cane and the smartphone. The device has a built-in microphone and speaker to allow for wireless voice communication between the two devices. The smartphone must have the EYECane user interface layer installed to serve as an intermediary between the mobile operating system and the EYECane. These enhancements will allow VIPs to interact more easily with an increasingly mobile world.

2014.044 Project Rhino: Powerful Music Search

"Find artists from Toronto founded in the 2000s and similar to Pink Floyd." There is currently no way for a person to ask complicated questions about the music world. There are connections between artists, concert events, lyrical content, and much more. Traditional music search is based on the filtering of information, and does not exploit relationships among data. This project aims to provide an intuitive query system, converting questions into queries that can be run against a distributed graph of 12.1 million songs, 1.2 million artists, and a multitude of other attributes. There are three main components: data extraction, a distributed graph database, and query translation. The data extraction component is responsible for combining and massaging sparse datasets into a central graph database. Graph databases are a natural choice for this task because their design allows for efficient querying of relationships across distributed servers. In comparison, traditional relational databases are unable to efficiently process associative datasets. Finally, the query translation component converts plain English questions into queries to be run against the database. This project will provide a platform that allows users to ask complex questions about music in a way that is not possible with any existing product.

2014.045 AutoSky

Since its invention, the telescope has remained largely unchanged in its overall design and use, despite advances in astronomy and technology. A major problem with current entry-level telescopes is that they rely on the user to be able to accurately pinpoint and identify objects in the sky. For the novice stargazer or budding astronomer, this can be a difficult task. AutoSky aims to solve this issue by bringing the telescope into the 21st century. First, AutoSky has the ability to accurately direct the telescope to a specific point in the sky, with an accuracy beyond what a typical human could achieve with introductory equipment. In addition, AutoSky leverages the power of Google Sky to further provide information about what the user is gazing upon in the sky, allowing the user to search for an astronomical object, and have the telescope automatically find it. Finally, AutoSky can take snapshots through the telescope, enabling the user to share their experiences with family and friends via social networking sites. By enabling the novice astronomer to embrace the technology available to us, AutoSky aims to bring out the Galileo in all of us.

2014.046 Bicycle for Light System

In Toronto, 939,000 cyclists generate mechanical energy through exercise in the gym. However, this energy is unharnessed and hence goes to waste. The continuous increase in energy demand, decrease in fossil fuel reserves, and rise in environmental concerns create the need for alternative energy sources and more efficient use of energy. The Bike for Light system is realized through a combination of mathematical modeling simulation and physical implementation. The system converts the mechanical energy produced by the cyclists into electrical energy using a DC generator, which is then stored controllably in a battery and reused. The output of the DC generator is fed to a DC to DC converter, which is controlled by a microprocessor. The converter-microprocessor combination controls the charging of the battery. The advantages of this system over existing solutions are that the degree of difficulty of pedaling can be selected by adjusting the charging rate of the battery, and overcharging is avoided by monitoring the battery state-of-charge. The Bike for Light system allows cyclists to make use of the energy from the pedaling motion and provides an alternative source of clean energy.

2014.047 Keyless Entry

A common residential door-lock mechanism employs a mechanical procedure using a key. This can lead to potential security issues for homeowners if the key is misplaced. Lost keys typically result in a lock replacement. With modern digital technology available, it is possible to enhance and simplify residential security with a near field communication (NFC) system controlling an electric lock. The focus of this project is to design and implement a power efficient NFC system into a typical door handle by utilizing a smartphone's NFC antenna. Homeowners may register their android smartphone's unique IMEI number as a key to the system via the central web server. When a phone is scanned, the detected IMEI number is cross-referenced with the system's internal memory to allow or deny entry. Additional security consists of wireless communication with the cloud for control and security functions. The system shows a visual indication of the actions performed, such as when entry is granted or denied. Keyless entry removes the discomfort of constantly carrying house keys in addition to the possibility of misplacing them. Nowadays people have a smartphone with them at all times that can also serve as a house key, thereby making their homes more secure.

2014.048 Touch-Sensitive Mechanical Keyboard

The keyboard and mouse have constantly undergone usability and ergonomic improvements since their introductions. Despite these changes, unnecessary hand movements between the two devices remain a problem. Excessive hand movements lead to shoulder and elbow strain, overexertion of fingers and arms, as well as wasted time. The proposed solution is a single input device that incorporates the mechanical feedback of keyboards and the pointing capabilities of mice. Furthermore, the device allows users to efficiently transition between typing and pointer control without additional hand movements. The device accepts character input through mechanical key presses while integrating touch technology on the surface of the keys. A sensor associates the movement and position of a user's finger to a relative position on the display. Multi-touch gestures such as multi-finger swipes and pinching motions are supported. Through the use of hardware and software algorithms, the device differentiates between typing and pointer movement. An input/output interface allows the device to connect with various computing platforms such as desktops, tablets, and smartphones. Compared to existing solutions, the proposed device eliminates the need to physically move among multiple computer input devices. It is a user-friendly device with conventional keyboard input and touchpad control.

2014.049 Motorcycle Integrated Safety System (MISS)

More than 4,000 people are killed in motorcycle related accidents every year in the United States. Many of these fatalities could be prevented if riders are more aware of their surroundings. To aid riders, the Motorcycle Integrated Safety System (MISS) monitors the surrounding area and alerts the rider of vehicles that are in their blind spots via LEDs. The system monitors the environment with ultrasonic sensors, mounted on the rear and sides of the motorcycle. The information from the sensors is processed with a microcontroller and is transmitted wirelessly to the LEDs mounted within the helmet. Existing alternatives to MISS use cameras or mirrors to display the environment behind the rider; however, they don't display blind spots. Furthermore, riders need to assess the image and determine whether a vehicle is present, which diverts the rider's attention from the road. MISS is superior as it interacts with the user in a non-intrusive manner and has safety features such as blind spot detection and a rear-end collision warning system. MISS provides riders with blind spot awareness in an unobstructed manner and will increase the overall safety for motorcyclists.

2014.050 Combat Training Strike Avoidance Dummy

As the popularity of martial arts and MMA grows, more advanced training objects are demanded. The problem with the current typical combat training objects such as punching bags and stationary dummies is that they don't provide immediate feedback to the user or attempt to avoid the strike in a realistic way. The object we have created to solve this problem is a training dummy able to avoid a strike, and provide feedback on the power and accuracy of that strike. The proposed solution is a training dummy that will observe user motion and attempt to dodge the incoming strike. The dummy's avoidance ability will result from motors and pivots on the neck and waist of the dummy, and cameras placed in the eye-socket to detect motion. Upon impact, information is provided describing the given impact for key areas of the torso and the head. The physiological results of the impact are then calculated based on the data gathered from the sensors and displayed to the user. Our product provides a more advanced and accurate way for people to hone their boxing skills compared to the static dummy.

2014.051 Portable Eye-Tracking (PET)

Numerous injuries and diseases can result in the complete paralysis of the body, except for the eyes and sometimes facial muscles. While expensive eye-tracking communication systems exist, their cost makes them impractical for many patients. The current solution for most patients is to use a carbon-copy alphabet chart that allows analysis of basic eye movements to tell the "listener" which letter to select. Unfortunately, this slow process prevents patients from participating in regular conversations and can lead to isolation and depression. The portable eye-tracking communication system allows users to autonomously initiate conversations by generating speech through a low-cost virtual implementation of the latter design alternative. The system consists of an infrared imaging system, an application on a smart device and a projected virtual keyboard. The infrared imaging system tracks the user's eye movements on a projected virtual keyboard to determine the selected letter. The virtual keyboard is a projection of the smart device application, which controls the entire system and allows for enhanced communication through auto-correction and speech generation. Thus, the portable eye-tracking communication system provides a low cost solution that can easily be integrated into daily life and enables the user to have more fluent two-sided conversations.

2014.052 Emergency Localization Event

Over 30,000 assaults occur on campuses in the United States each year. Existing solutions, such as Emergency Poles, are inaccessible during times of distress, and individuals do not have sufficient time to call for assistance while their personal safety is threatened. The Emergency Localization System (ELS) is quickly able to provide authorities with a user's location in a time-critical emergency. Using a low-cost portable device, the ELS can securely and wirelessly transmit a unique serial number to a central station. Localization techniques are used to determine the user's location which is then displayed on a real-time map. An integrated database also relays identifying information and medical history to emergency responders. Potential expansion features include video and audio integration to assist with police activities. The system provides a custom solution that can be connected to campus police to provide a protective deterrent against assault on a closed campus environment. In the face of complex and dangerous realities, the Emergency Localization System provides a discreet, easy-to-use, and comprehensive solution to the community.

2014.053 Pera Smart-Wallet

On average, a consumer carries four credit cards, excluding debit, identification, and other cards. 14.1% of North Americans carry 10 or more cards in their wallet, which are generally smart or plastic cards with magnetic stripes. All banking, identification, and credit accounts are stored in these separate, static cards. Carrying this many physical cards is becoming cumbersome in an increasingly digital age. Pera is a revolutionary wallet changing the way people conduct transactions, incorporating both a dynamic magnetic stripe and NFC technology. This portable device integrates all different forms of payments into one system and is set to replace the traditional wallet. An embedded controller in the device selects the desired functionality, programming the stripe or transferring information via NFC as needed by the user. The user interfaces with the device through a touch display, selecting the appropriate method of payment, and whether to pay by magnetic stripe or NFC. This device provides the portability of a traditional wallet while reducing the large number of cards into one device, giving the user both a modern and an integrated way of conducting payments. In the future, there is potential to incorporate many features, including decentralized currencies such as bitcoin.

2014.054 PoolPal

Pool is a game with many different variations and learning to play can be a daunting task. PoolPal is a system that allows new players to approach pool by providing rules, keeping score, and assisting the player in all aspects of the game. It will explain different variations of pool to new players, and help keep track of rules as the player is playing. Using a camera to track the positioning of the balls and the cue, PoolPal predicts and recommends possible shots. This is achieved by using image processing and a physics engine. The recommended shot will be projected on the table for the user to see. This eases decision-making and provides real time assistance at each cue placement for the player. Additionally, PoolPal is able to respond to voice commands, such as “give me the score” and “whose turn is it”. All of these forms of player assistance can be enabled on a player-by-player basis. As PoolPal will be adaptable to current pool tables, it is an affordable system which will enhance the pool experience and enable any player to ease into the game of pool, regardless of skill level.

2014.055 Bluetape

Indochino, a manufacturer of custom suits, runs fitting events where customers have their measurements taken by professional tailors. Due to a large number of people attending these events, tailors are unable to process people fast enough, resulting in long wait times. Indochino has determined that the procedure where tailors manually take and record customers’ measurements is the bottleneck limiting the number of people that can be processed at an event. The speed of the measurement process could be improved through automation. BlueTape is an enhanced tailor’s tape measure that automatically measures how much tape is played out, eliminating the need for the tailor to visually take the measurement. Measurements are transmitted via Bluetooth to a tablet where it is automatically recorded. BlueTape is implemented with a measuring tape, linear sensor and battery-powered electronics. Measurements are communicated to the tablet over a custom protocol. BlueTape’s similarity in appearance and operation to existing measuring tapes makes it straightforward to operate, requiring minimal change to the tailor’s measurement process. Automatic recording of measurements reduces the number of steps required to measure a customer, speeding up the process and allowing a greater number of customers to be served at Indochino’s events.
