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ELECTRICAL AND COMPUTER ENGINEERING

Team 1701: E-Z Park System

From Left to Right: Shengli Zhou (Advisor), Michael Milward, Paul Mazzochi, Antonio Mudungo, Ryan Lancaster

Sponsored by: Reverge Anselmo
Faculty Advisor: Dr. Shengli Zhou

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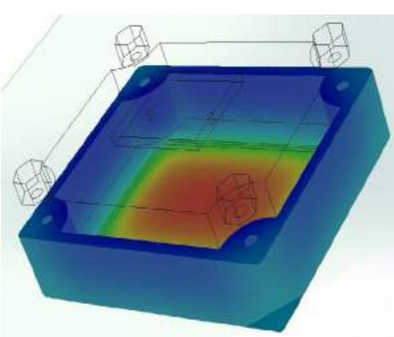
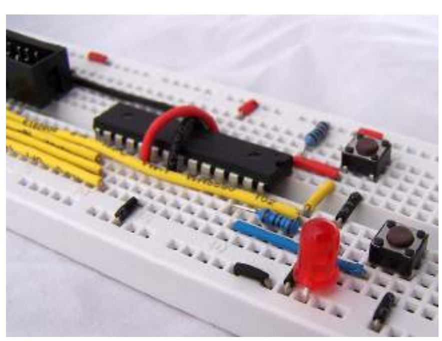
E-Z Park was invented to establish a more effective means of enforcing, paying, and finding on-street parking in an urban environment. Using the E-Z Park system, any municipality can make their parking environment more user-friendly while increasing municipality revenue. The system provides a modern upgrade to the severely outdated parking management systems. The E-Z Park system provides easy to use software which provides real-time parking updates, allowing for more efficient enforcement and secure transactions.

Current parking solutions in urban environments require the user to physically pay the parking meter for their parking instance. With this method, the user has to accurately approximate how long he or she will occupy the space. If a user overestimates or underestimates the amount of time, then he or she may overpay and waste money or underpay and risk being fined. Other methods require the user to walk over to kiosks which are hard to find and require the user to display a ticket on the window which is inefficient and inconveniences the user.

The goal of this project is to design a system that relieves the headaches associated with current urban parking. The system is realized with the implementation of an in-car device and in-ground sensor. The vehicle's orientation, velocity, and acceleration are continuously monitored and this data is used to detect when the vehicle has parked. The device's processor uses an algorithm to monitor the accelerometer output and recognizes when the vehicle parked. The processor then attempts to connect to the in-ground sensor via a Wi-Fi connection. The in-ground sensor enters full-power mode when the vehicle is parked on top of it; using a Wi-Fi connection as well, the sensor is able to pair with the in-car device and obtain the user's identification number. Once the information is gathered, the in-ground sensor sends the data to a server where the vehicle's occupancy time is monitored and the user is billed in real-time. The system recognizes when the vehicle leaves the parking space and is able to terminate the transaction.





Team 1702: QSI Simulink/TEAMS Model Converter

Sponsored by: Qualtech Systems Inc.

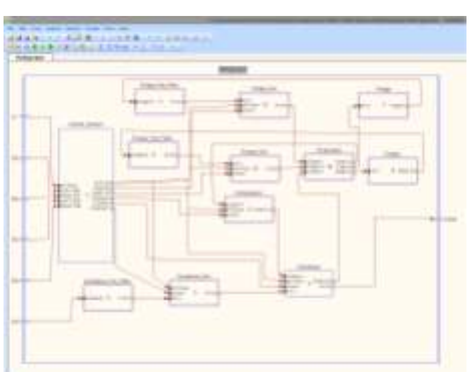
Sponsor Advisor: Clancy Emanuel
Facutly Advisor: Dr. Shengli Zhou

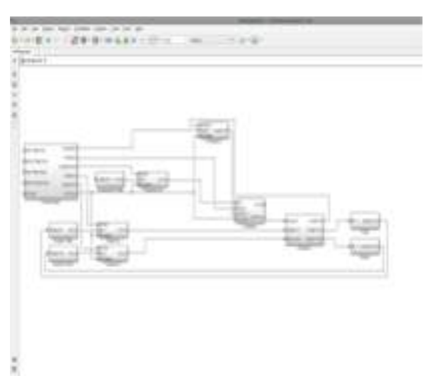
Dr. Shengli Zhou, Andrew Morse, Jay Meyer, William Salguero, Brandon Singleton

QUALTECH SYSTEMS INC.

Qualtech Systems, Inc. (QSI) ® is a Connecticut-based company that produces system modeling software specializing in the field of fault detection. Qualtech's modeling program, TEAMS-Designer™, provides tools for users to create complex models with various input and output parameters designed to detect failure probabilities, module interdependencies, required technical repair skill-sets, repair costs and more. A similar program that some of QSI's customers use is MathWork's MATLAB Simulink which is used to simulate the mathematics of complex systems. Both modeling software's use similar features, but at their roots have fundamentally different approaches to modeling and testing these systems. The details of their similarities lie in their use of eXtensible Markup Language (XML) to organize and store their models. XML documents are built with specific style and structure, which give them the capacity to compare and ultimately convert from one style to another. As both Simulink and TEAMS-Designer can store their models in an XML file format, a translation document can convert from one XML structure format to the other.

The goal of this project was to design a process that can transform a Simulink model XML into a TEAMS-Designer XML while maintaining the maximum integrity of the original Simulink model. To do this we needed to use XML's capability for transformation, the eXtensible Stylesheet Language Transformation (XSLT) which takes the XML of one model and converts it into an XML with a different structure. In order to begin working on the XSLT, we had to understand the concepts of eXtensible Stylesheet Language (XSL) and the three components that make it up: XSLT, XPath, and XQuery. Each of these components has its specific role in transforming the XML. The most important part of XSL is XSLT, which defines how the actual transformation is performed. XPath provides the syntax for a XSLT to navigate the elements and attributes of a XML. XQuery is a language for searching and extracting elements and attributes from XML documents. Using these tools, a model can be accurately and efficiently converted without the need to spend time manually translating it into the new software.





Team #1703: Power Factor Correction Input Circuit

Sponsored by: Lenze of Americas
Sponsor Advisor: Christopher Johnson
Faculty Advisor: Prof. Ali Bazzi

From left to right: Kevin Wong, Paul Glaze, Ethan Hotchkiss, and Jethro Baliao

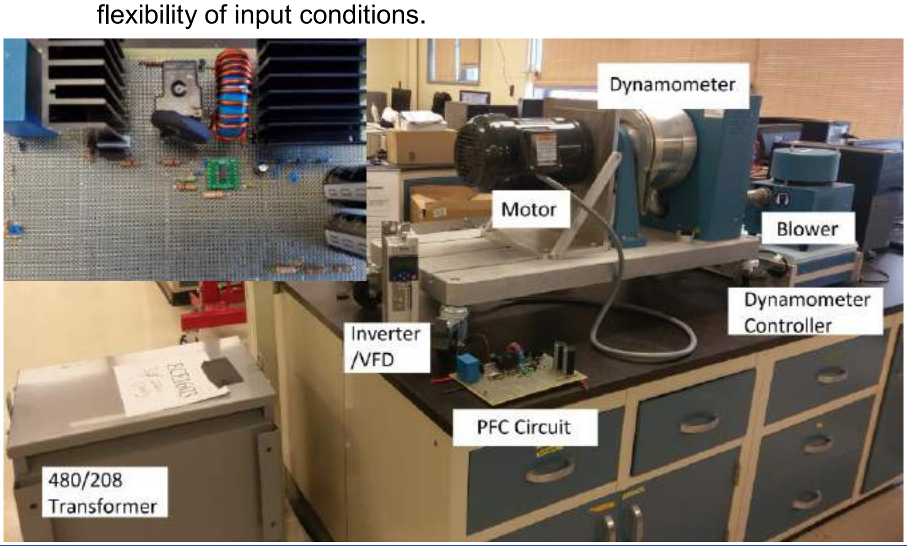
Lenze

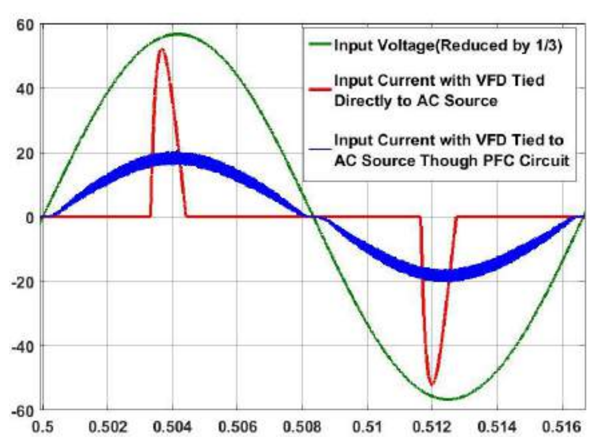
Power factor is an extremely important element in various electrical systems. We can see it as a ratio between the apparent power versus the real power we get out of it. The main goal of power factor correction is to reach a level where power factor is close to 1. To do so, reducing the reactive power consumed by an inductive load or produced by a capacitive load is necessary. It is important to note the difference between distortion power factor and displacement power factor. Displacement power factor is only the phase difference between the current and voltage. On the other hand distortion power factor is the component related to the shape of the current waveform.

Power factor correction can be exercised in various ways which consist of capacitor banks, synchronous condensers, and power electronics. Using purely capacitive power factor correction or synchronous condensers correct only the displacement power factor. However, power electronics are the most recent addition to the ecosystem of electricity but have an advantage by correcting both distortion and displacement power factor. Its small footprint can allow AC-DC rectification coupled with a power factor correction DC-DC converter which results in a power draw very close to unity power factor.

For this project, we are to design and build a circuit that will improve power factor input for a Variable Frequency Drive (VFD) provided by Lenze through a DC to DC converter. The boost converter is the DC to DC topology and will be connectable to both a prebuilt IC (ICE3PCS01G) and a microcontroller in order to control the circuit. This allows for greater efficiency given the same input which is important for Lenze to stay competitive as well as saving costs for their customers.

The PFC circuit is to convert 120VAC to 325VDC with a true power factor of 0.95 for max continuous power of 1472 watts or about 2.0 hp. We must also consider the noise induced by the switching and design a filter to eliminate it. Lenze has stressed that they are looking for a power factor circuit to use for their variable frequency drives in order to reduce peak input current. Introducing this technology will also allow for greater flexibility of input conditions.





Team 1704: Software Defined Implementation of Underwater Acoustic Modem

Sponsored by: The Mitre Corporation
Sponsor Advisor: Dr. Peter Willett

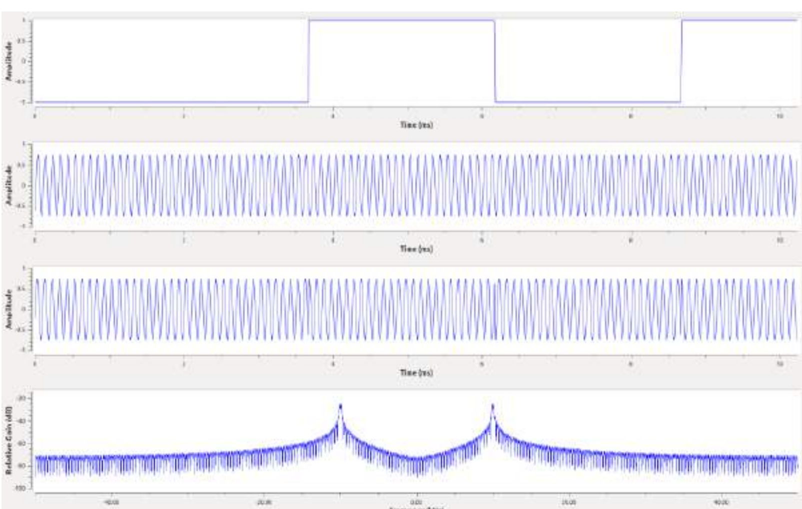
From left to right: Joseph Hamlin, Michael White, Dan Wilbanks, and Kevin Buczko

MITRE

The underwater acoustic environment is an extremely challenging communications channel. The low speed of sound, large amounts of Doppler shift and delay, and inconsistent topology of the seafloor make it difficult to establish a reliable data link. Furthermore, in the underwater acoustic environment there is a very limited bandwidth; at low frequencies there is high noise and at high frequencies there is a lot of attenuation. For these reasons, development of transmitting and receiving technologies for the underwater acoustic environment has been slow.

This project explores the use of a software defined radio (SDR) to create a platform for rapid testing of acoustic channels. The SDRs can be programmed with modular signal processing blocks using the GNURadio programming platform. Unlike radios implemented in hardware, the SDRs easily allow for changes to be made to the modulation and demodulation of signals. This platform will allow for quick probing of acoustic channels in order to characterize a particular underwater environment in addition to quick testing of different techniques for overcoming some of the challenges particular to a location.

Our hardware setup consists of receiving and transmitting SDRs, two acoustic hydrophones, and hardware peripherals used to amplify and filter signals. This platform can be built at a relatively low cost and with widely available hardware. All signal processing can be implemented using open source software.



Above: (Top to bottom) baseband signal, carrier signal, modulated signal, and frequency domain representation of 10 kHz binary phase shift key (BPSK) waveform. (Generated using GNURadio).

Right: Receiving setup consisting of SDR, Bandpass filter/amplifier, and hydrophone.

Team 1705: PHD Test System

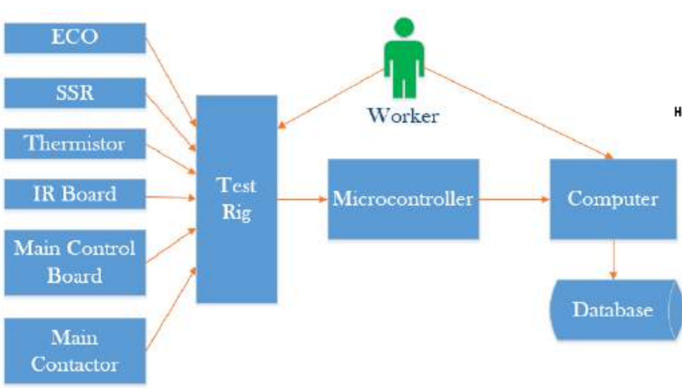
Sponsored by: Eemax
Sponsor Advisor: Helena Silva

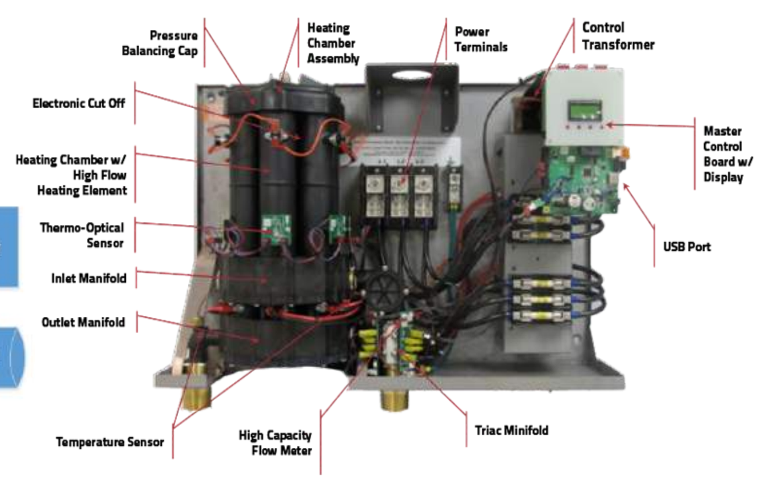
Kyle Parshall, Richard Felten, Anton Razhov

Eemax is a company that designs and manufactures tankless water heaters, with their main line of products incorporating Parabolic Heat Design (PHD). PHD tankless water heaters incorporate up to six water heating chambers, with each chamber holding two parabolic shaped heating channels through which the water flows. The parabolic shape of the heating chamber allows the water to have a larger contact area with the heating coil. This design leads to increased power density and efficiency, while also excelling at heating water to very precise temperatures which fall within one degree tolerance of the intended temperature. The power ratings for PHD tankless water heaters range from 10kW-150kW for a variety of commercial and residential applications.

Currently, the control system is tested only after final assembly of the water heater. If a component malfunctions, the heater must be partially disassembled, repaired and retested. This process is very time inefficient and costly, so Eemax has tasked Team 1705 with creating a testing platform which can test each component of the control system before entering the production phase. This setup will reduce time spent diagnosing faulty parts and increase the overall reliability of the assembled product, which in turn will allow Eemax to sell higher quality water heaters.

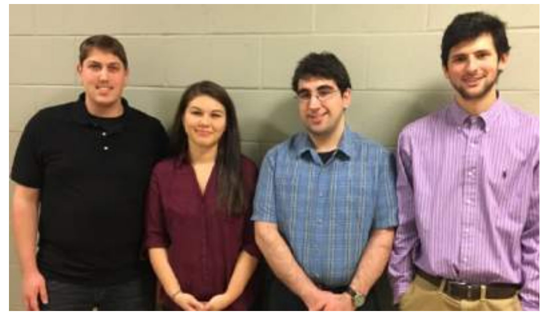
The components which make up the control system and require testing include a maximum of two thermistors, six electrical cut-off switches, six infrared detector boards, three dual-triac solid state relays, three main contactors and the main control board. Each component fits inside the test rig which is designed by the mechanical engineering team. The test rig consists of a temperature controlled water heating system which is needed to verify the functionality of the temperature sensitive components, along with all the circuitry needed to test every component. A computer with a touch screen monitor is used to allow the operator to easily conduct the required tests and view corresponding results. The computer Graphical User Interface (GUI) interfaces with a microcontroller to conduct testing. When results are obtained, they are automatically stored in a database for product traceability and data analysis. GUI software is coded using C# in Visual Studio, the database is created and maintained using MySQL and microcontroller code is written using Atmel Studio.





Team 1706: RF Laser Probe of SAW Devices using COTS Hardware

Sponsored by: Phonon Corporation
Sponsor Advisors: Max Madore and Scott Kraft
Faculty Advisor: Helena Silva



(left to right): Anthony Ciacci, Victoria Bean, Matthew Bove, Paul Molinaro.

Surface Acoustic Wave (SAW) devices operate by propagating matter waves through piezoelectric crystals. These waves are used to carry information in a multitude of communication and signal processing applications. Laser probing techniques are often used as a diagnostic tool to measure the properties of the propagating SAW.

We attempted to build a laser probe using the rail system and optical carriage of commercially available Blu-Ray players and determined the detection limits of such a probe. Phonon Corporation assigned this project in an effort to reduce cost and promote ease of use over typical systems. The laser probe follows the basic block diagram shown in Figure 1. The carriage of the optical set-up and rail system were used to create the XY mount, and the motor was controlled using an Arduino.

The optical carriage measures surface displacements using interferometry. They are designed to measure uniform pits on the surface of a CD that result in a displacement of half of the wavelength of the laser. This displacement causes perfect destructive interference in the laser beam, which registers as a digital low. In the absence of any path length difference of the two beams, the detector registers a digital high.

The goal of the measurement was to create a snapshot of a wave propagating through the crystal. This was done using a signal generator to create a wave in the crystal and the optical system measured the displacement at a particular point. The laser was then repositioned and another wave identical to the first was transmitted through the crystal. The laser made another measurement at the new point while the wave was at the same stage of transmission as the previous measurement. This was repeated until the wave at all points in the crystal was defined. Using the displacement and the distance between the two beams, the slope at any point was calculated. The laser and SAW device were modulated at the same frequency so that they were in tune with each other and we got a static surface picture.

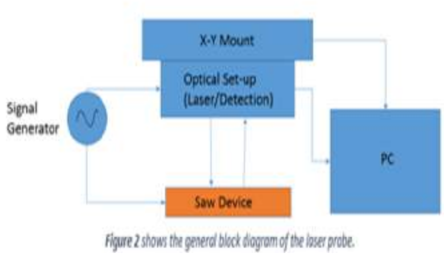


Figure 1: Block diagram of system

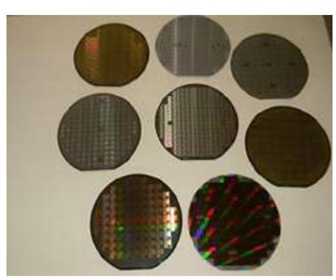


Figure 2: Wafers

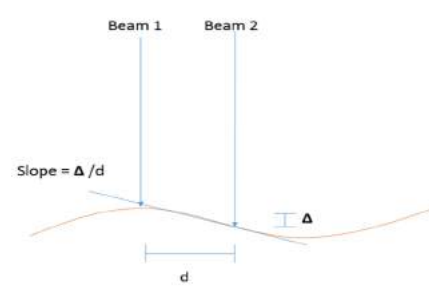
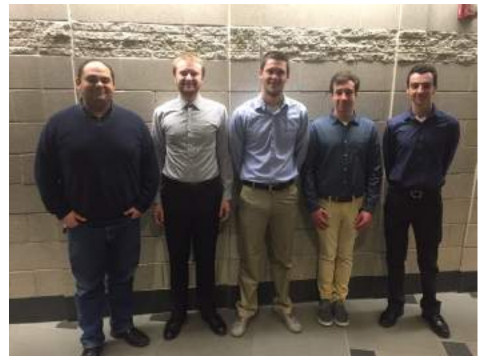


Figure 3: Probability Graph

Team 1707: Automated Test Fixture for Angular Displacement Transducers

Sponsored by: Trans-Tek Incorporated
Sponsor Advisor: Dr. Ali Bazzi

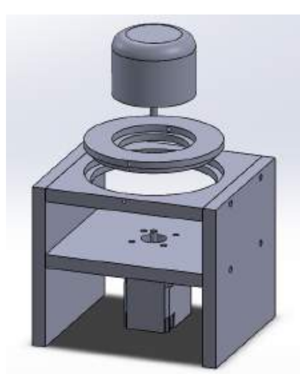


Left to right: Dr. Ali Bazzi (Advisor), Michal Zielinski, Shane Keney, Andrew DiGiugno, Michael Caiafa

TRANS•TEK INCORPORATED

Trans-Tek Inc. is a manufacturer of a variety of transducers. Chiefly among them are Angular Displacement Transducers (ADTs), which convert an angular displacement into an electrical signal. When manufactured, these transducers are calibrated to a known set of specifications. To test this calibration, Trans-Tek Inc. used a manual, hand-operated test fixture with 120 reference points. In short, the ADT was locked into the fixture, connected to a digital multi-meter, measured of voltage, and rotated within the fixture. This was then repeated 119 times. As a result, this procedure was time-consuming and prone to user error. Therefore, the scope of this project was to design an automated test system and fixture for ADTs, utilizing an encoded hybrid servo-stepper motor and controller in conjunction with a standalone PC and digital multi-meter for rotor position via voltage feedback.

The test fixture was first modeled in SOLIDWORKS. A vertical design was chosen for both ease of use and promotion of symmetry; the latter of which helps keep the fixture stable. The physical fixture was constructed primarily of aluminum, as it is both pliable upon manufacture and durable. To mount the ADT into this fixture, the user must first choose one of the two mounting brackets and couplings, corresponding to the two ADT models manufactured by Trans-Tek. The ADT shaft must be positioned within ±90° of the marked null position. To lock into place, mounting screws are inserted into each side of the fixture, and fed through the fixture until contact is made with the ADT. After it is properly mounted, the ADT is connected to the pre-existing test setup, and the test is run. Test instructions are written in Visual Basic; these instructions include aligning the ADT shaft to its null position, rotating the shaft throughout the ADT's stroke, polling the output voltage at predetermined intervals, and computing the linearity. Rotating the shaft is done by sending predefined commands to the motor over the serial bus. By default, the voltage is polled in whole-degree increments, although the user may define a different resolution if necessary. Computation of an ADT's linearity is done by running the recorded data through Trans-Tek's pre-existing proprietary software. The resulting values and curves are output to the user, and are used primarily to construct data sheets for Trans-Tek's clients.



Team 1708: DE Pump Solenoid Valve Position Sensor

Sponsored by: Stanadyne

Sponsor Advisor: Brian Cox
Faculty Advisor: Dr. Rajeev Bansal

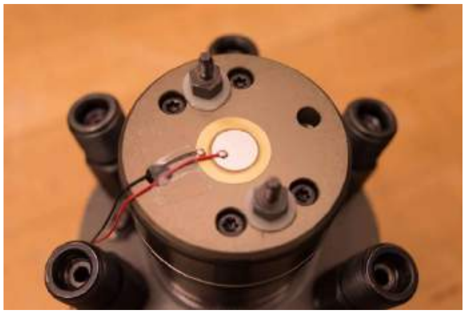
Left to Right: Colin Caruso, Adam Izbicki, Erick Syvertsen, Caleb Brownell

The objective of this project is to integrate a position sensor into the solenoid cap of Stanadyne's DE series fuel pump in order to indirectly measure the position of the solenoid valve by detecting two vibrational events. The DE pump is a rotary diesel fuel injection pump that pressurizes the fuel before it is sprayed into the cylinders of an internal combustion engine. The pump's solenoid valve is responsible for the amount of fuel delivered to each of the cylinders and is controlled and actuated through a pulse width modulation high current signal supplied by the Engine Control Unit (ECU). In order to inject the precise amount of fuel into each engine cylinder and to do so at the proper time, it is imperative to know with precision the time of the solenoid valve opening and closure events.

The solenoid valve position sensor will enable Stanadyne to calibrate and troubleshoot pumps that are already out in the field and allow customers to interface their ECUs with the pump to more efficiently control the metering of fuel into the engine's cylinders more efficiently. If this position sensor is incorporated into production units, it can lead to improved emissions and performance via accurate fuel injection control.

Our solution utilizes a piezoelectric sensor to detect when the valve armature hits against the valve and when it returns to its resting position. Piezoelectric sensors function by registering a potential difference directly proportional to the force exerted on the crystal. The piezoelectric sensor is housed in a plastic cap that acts as a drop-in replacement for the cap used on the DE pump and allows for simple installation on existing pumps utilized around the world.

An integrated circuit accompanying the sensor and housed within the solenoid cap will process the analog signal and compare it with the solenoid's current/voltage profile in order to produce a digital output which can be used by the ECU without the need for additional processing. This will enable the sensor solution to interface with all of the ECUs currently being used out in the field, providing an economical solution for Stanadyne's customers.



Team 1709: PV Capacity Factor Prediction Tool

From Left to Right: Derek McCormack, Joel Velez, Rahul Vachhani, Alsandy Jacot

Sponsored by: United Illuminating
Sponsor Advisor: Dr. Peng Zhang

UI

Our team is sponsored by United Illuminating to perform big data analytics to develop a PV capacity factor prediction tool. United Illuminating is an electric utility company located in the southwestern area of Connecticut, of which covers seventeen towns and cities in total. The amount of distributed energy resources (DER) have been growing substantially over the last few years and is expected to continue to do so. Therefore it is important for United Illuminating to have an exceptional understanding of how this will affect their distribution system. In particular we will be studying photovoltaic (PV) generation which is intermittent and fast ramping in nature and seldom reaches the nameplate capacity value in daily operations. This makes it difficult to predict just how much power they can potentially deliver back into the power distribution system.

It is essential for United Illuminating to understand how much power is flowing back into their system so they may mitigate potentially negative effects of PV, plan for upgrades efficiently, and perform analysis of their system accurately. Some of the negative effects of PV are voltage issues, conductors and equipment being overloaded, islanding effects, and protection schemes not working as designed. When planning for upgrades to the distribution system it is important to know how much PV generation is actually being supplied back into the system. If they were to base these upgrades using the nameplate rating of the PV systems alone it would result in over engineering and overspending.

Motivated by the above challenges we developed a PV capacity factor prediction tool by engaging in big data analytics. PV capacity factors are the actual power output from a PV system over a given period of time compared to that of the nameplate rating of the PV system. This powerful tool will allow a utility engineer to input specific parameters into an application which will then use an algorithm we develop from machine learning and extreme value theory to output predicted PV capacity factors in various regions for specific time scales.

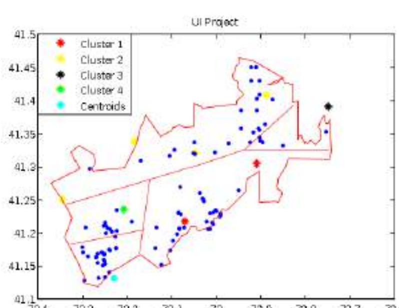


Image courtesy of Xubin Liu

Team 1710: Mobile Power Units

Sponsored by: Hartford Marathon Foundation
Sponsor Advisor: Matt Anderson
Faculty Advisor: Dr. Ali Bazzi

From Left to Right: Dr. Ali Bazzi, Rayhaan Kasliwala, Edwin Matute, Justin Hubbard, Bryan Davis.

HMF EVENTS
HARTFORD MARATHON FOUNDATION

The Hartford Marathon Foundation (HMF) is a non-profit organization located in Glastonbury, Connecticut with the mission to organize programs and events that promote health and fitness. The HMF currently uses a fleet of different size trailers to transport operational supplies to each of their roughly 30 events throughout Connecticut and Rhode Island. Among these regularly used supplies are four gas generators and a car battery with an inverter, which are all used to power various electrical equipment. This equipment ranges from inflatables to sound systems, lights to computers.

The HMF requested a partnership with the University of Connecticut School of Engineering to assist in the design and implementation of stand-alone solar array systems on HMF's event operations trailers. With this partnership, the HMF's goal is to increase their environmental sustainability effort at their events by transforming the current fleet of trailers into mobile power units. This will be done by completely replacing the generators and installing solar arrays atop the trailers to eliminate all carbon emissions. The HMF ultimately hopes to become the greenest race in the world, and this is a crucial first step.

The goal of the design is to be a completely self-sustained power system with an additional external operation view of the system's status. Therefore, in addition to solar panels, this design will implement batteries for energy storage and an inverter so that the HMF can plug in and power their equipment directly from their trailer. The full design and layout of the system will be provided, and installation is also being conducted.

This design will be in conjunction with the University's Office of Public Engagement (Service Learning). The goal of service learning is to integrate meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities. The design being proposed will have an ample positive impact by promoting awareness of sustainable, clean and affordable energy in the community. This design is approximated to eliminate 2,320 lbs. of carbon dioxide per year.

Team 1711: An Intelligent Sensor Network for Autonomous Target racking

Sponsored by: UConn ECE Department
Host Lab: LINKS Laboratory
Faculty Advisor: Dr. Shalabh Gupta

(From Left) Michael Buckson, Brandyn Young, Marquette Jones, Jay Upadhyay

LINKS
Laboratory of Intelligent Networks and Knowledge-Perception Systems

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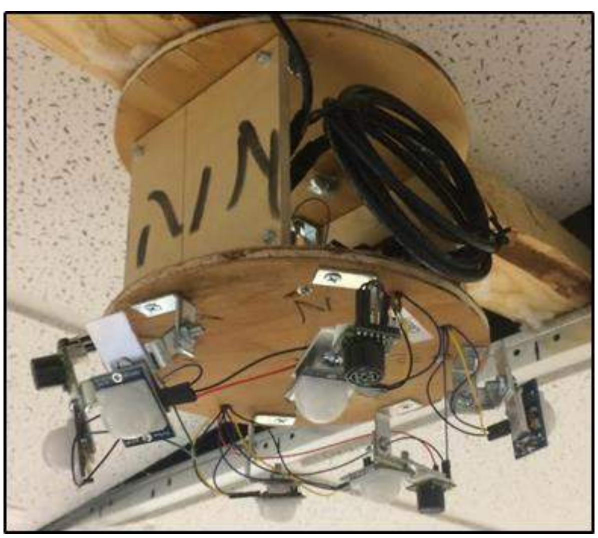
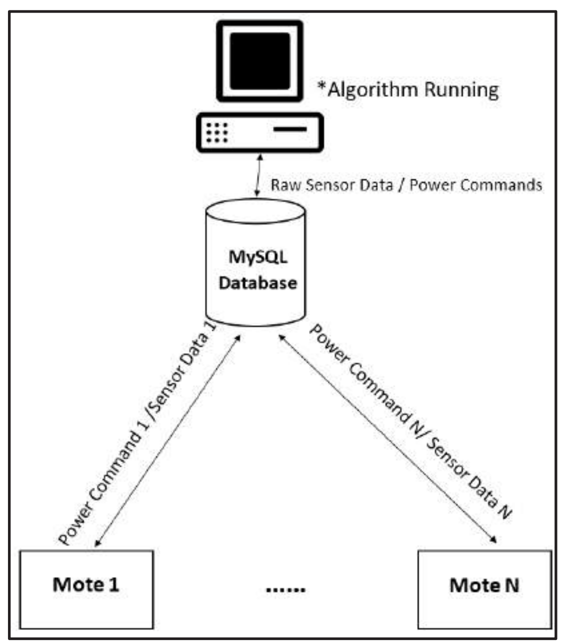
The purpose of this project is to create a smart target tracking sensor network. This sensor network will detect targets while implementing energy saving protocols. In this project we work on implementing two such protocols; a local depowering of some sensors when no motion is detected and, a remote depowering of all sensors in a certain area when no target is predicted to enter their field of view. This technology can be applied to any large environment where surveillance is needed. Possible applications for this include: border surveillance, patient monitoring in hospitals, urban environment target tracking, and general situation awareness.

The sensor network built consists of five sensor arrays, called motes. Each mote contains passive infrared (PIR) sensors and ultrasonic sensors (US) which will detect heat and distance respectively. This sensor network also contains a laser range finder for precise target detection and a camera for video surveillance. The data from each mote and the laser range finder are streamed to a database. The first smart power saving protocol implemented was to depower the US sensors on each mote until the PIR sensors detect motion. The US sensors consume more energy than the PIR sensors so minimizing the time they are on will be a first step towards energy savings.

To reduce energy consumption even further we then implement a smart tracking algorithm. This algorithm collects and interprets the data from the motes and laser range finder. This algorithm calculates the location of a target and predicts its future path. Based on this prediction, the algorithm will command the next power-states for each of the motes. Motes outside of the predicted path will enter low power (US and PIR sensors off) while those in the predicted path will enter high power (US and PIR sensors on). Power state commands are sent to the motes through the database. By scheduling the motes power mode in such a way, the energy consumption of the network should be decreased.



Sensor Mote



Network Diagram

Team 1712: Robotic Ankle Rehabilitation Device

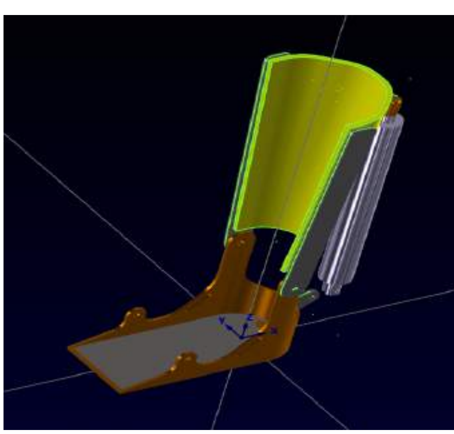
Top Row BME (from left) Lisa DeConti, Ashley Vanaman, Drew Cohen, Kristen Campbell and Sarah Vetrano
Bottom Row EE (from left) Hannah Strickland, Edward Sango, Blerand Qeriqi and Bilal Khan

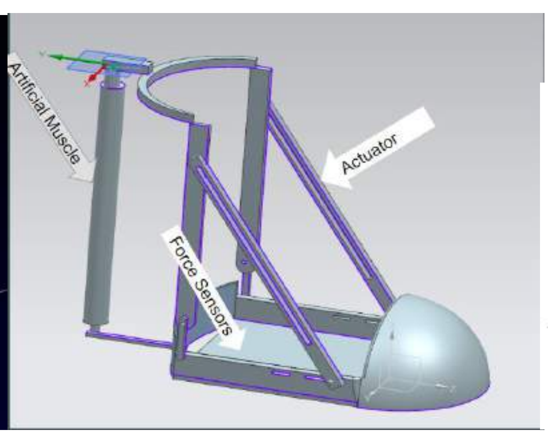
Sponsored by: The University of Connecticut BME Department and ECE Department
Sponsor Advisors: Dr.Shalabh Gupta and Dr. Krystyna Gielo Perczak

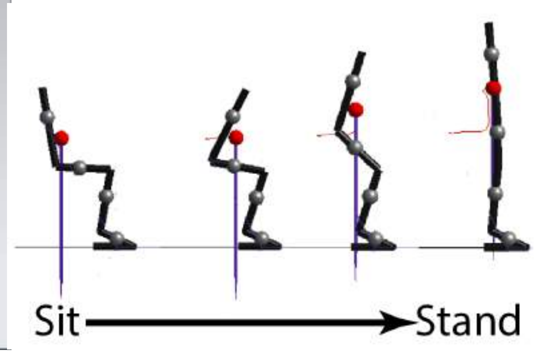
UCONN SCHOOL OF ENGINEERING

Malfunctions to the ankle can make many day to day functions very arduous. Typical malfunctions can be due to injury, disease, and muscle damage. During such instances the ankle joint is an area of concern, as it is very difficult to manage an injury to the ankle. The ankle has to be able to withstand all of the strain and pressure that is exerted from the daily tasks of walking, standing, running and so on. With the ability to move from side to side, and front to back, over extension can easily occur. For those suffering from ankle maladies standing up from a sitting position can be difficult.

The project product is an assistive device that will help a person transition from the sitting to standing position. It consists of a supportive brace to provide extra stability, as well as two actuators and an artificial muscle. These two components mimic the plantarflexion and dorsiflexion movements of the ankle. Plantarflexion and dorsiflexion are the two essential motions at the ankle. Plantarflexion is the action of pushing your foot into the ground while dorsiflexion is the action of pulling the toes up. Therefore, plantarflexion is essential when moving from the sit to stand position, as it provides a portion of the force needed to stand. Several force sensors are located at the bottom of the foot to sense the subtle changes in a person's weight as they prepare to stand. All other components, such as the microcontroller and power supply, are located at the waist to reduce the amount of weight around the ankle. In addition the total weight of the brace has been kept small. This allows the device to be smoothly integrated into the natural walking cycle of the patient. The device is intended to function in both indoor and outdoor conditions, and is designed to withstand inclement weather, as well as ranging temperatures. The product is not only durable but comfortable. Additional features such as padding have been added for the patients' convenience. These features can be altered in order to fit a range of patients.

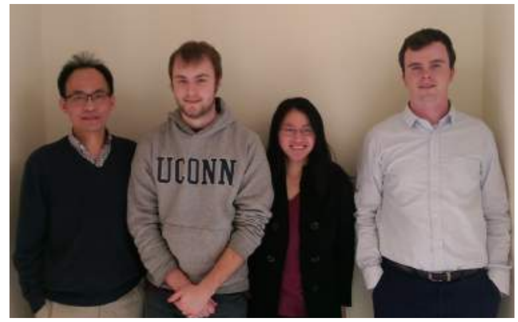






Team 1713: Internet of Things (IoT) Microserver Flight Test Acceptance Demonstrator

Sponsored by: NCPS Research
Sponsor Advisor: Shengli Zhou



Dr. Shengli Zhou, Benjamin Singer (EE), Elizabeth Baranovic (EE), Hunter Finneran (EE).

NCPS RESEARCH

HARTFORD JET CENTER

Network Centric Product Support (NCPS) Research is a company that is combining the concepts of network centric and IoT principles in the aerospace industry to improve system level intelligence. The distribution of data from aircraft to aircraft, as well as from aircraft to ground is not at a real time rate to achieve this higher level of system intelligence. NCPS is using microserver technology with dense data processing ability to create a node in a network of many aircrafts. This technology can serve to achieve many purposes from NextGen air traffic control to product lifecycle management. By constantly recording flight data, digital twins of the product data and factory models can be updated constantly improving behavioral predications. When all of these possibilities are brought into reality together, the aeronautic industry can become more intelligent than ever before.

In this project, a LattePanda microcontroller collects data from an on-board system of sensors. These include a gyroscope, a strain gauge, temperature, humidity, and vibration sensors. Data communication is performed over Wi-Fi capabilities, and a script is run on the microserver to handle noise and error in the data. This central board acts as a microserver that hosts a webserver. Under real-time constraints, live updates are provided to a webpage with the values. The end user can access the web address from the ground to see these values plotted over the course of a flight.

An alternate solution to this problem is to directly read the gauges in the aircraft using machine vision. This eliminates the need to obtain permission to install redundant sensors on the aircraft, and the displayed measurements are taken from FAA approved sensors. The experiment for detecting gauges and estimating gauge values is carried out using a matched filter, convolutional neural networks, Canny edge detection, and Hough transforms. This is also the subject of a research paper that has been submitted to the AIAA Region I Student Conference.

Team 1714: Smartwatch-like Device and Apps for Continuous Glucose Monitoring

Sponsored by: Biorasis

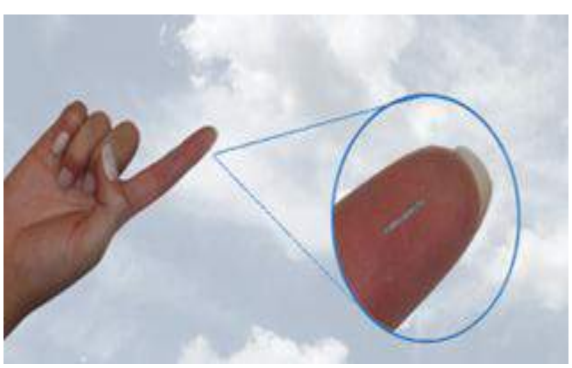
Sponsor Advisor: Michail Kastellorizios
Faculty Advisor: John Chandy

Magda Kaczynska, Brian Marquis, Ahmed Sugulleh, Evan Brown

The Smartwatch-like Device and Apps for Continuous Glucose Monitoring project is sponsored by Biorasis, located in Storrs, Connecticut. The company is developing a wireless, needle-implantable biosensor, which ultimately will be used for real-time, continuous glucose monitoring. The size of the device is 0.5mm x 0.5mm x 5mm and is comparable to a grain of rice, as shown in image below. The purpose of the device is to help patients with diabetes management, by allowing individuals to monitor their glucose level at any time, and respond with treatment when needed.

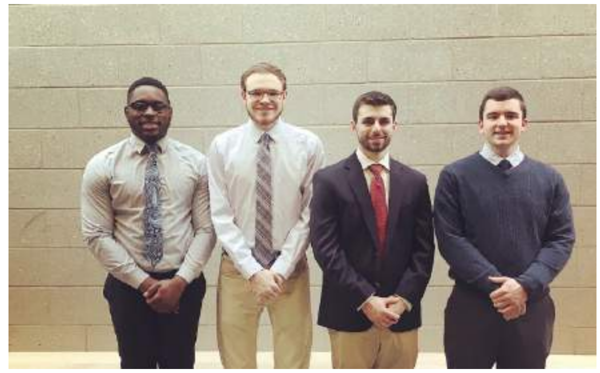
Biorasis wants to develop a user-friendly smartwatch-like device to interface with the biosensor. The device will communicate with the sensor through the patient's skin, sending commands to the sensor and receiving data optically. The user should be able to adjust the settings of the smartwatch such as the frequency of glucose readings. This device should be capable of storing glucose data points, exporting said data when prompted, and plotting glucose levels over time.

This project utilizes the TinyCircuits Smartwatch kit to create a compact, energy-efficient design. The watch connects to a user's phone over Bluetooth Low Energy to keep time and display phone notifications. Furthermore, a Kalman filter is used to process the frequency measurements to reduce noise and yield real-time blood glucose values. The firmware also monitors the user's blood glucose and other parameters to produce alerts and alarms to indicate dangerous glucose levels or potentially harmful trends. The Kalman algorithm will need to be calibrated about once every 12 hours to improve estimation accuracy. Therefore, diabetic patients using this device can monitor their blood glucose continuously with only two finger-prick calibration tests a day. Eventually, this device could be used for closed-loop insulin control by interfacing it with an insulin pump.



Team 1715: Underwater Wireless Power Transfer

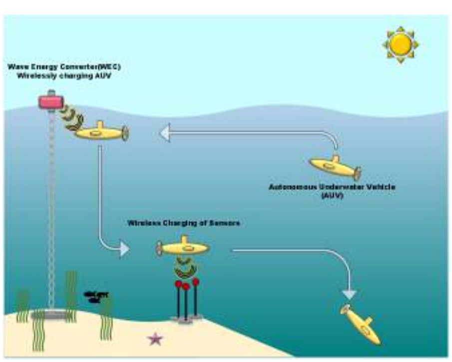
Sponsored by: University of Connecticut
Sponsor Advisor: Peng Zhang, Taofeek Orekan

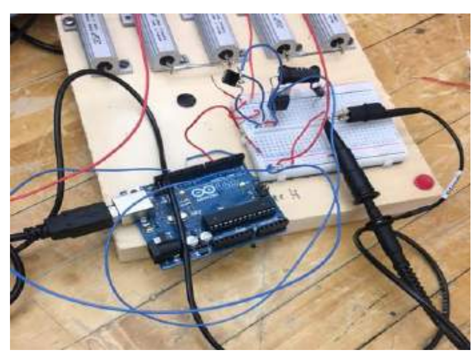


From Left: Justin Walters, Kyle Buckley, Alex Slossberg, Frank Ludorf

Senior design team 1715 is focused on transmitting power wirelessly in an underwater environment to charge Autonomous Underwater Vehicles (AUV). In order to achieve maximum power efficiency, we developed an adaptive control. Like all vehicles, AUVs require internal power sources to enable unrestricted movement into the depths of the ocean, and recharging after power is drained. The saltwater environment is very damaging to expose metal conductors, and also provides a path for conduction between charging terminals. Removal of the AUV from the ocean for conventional charging methods requires specialized equipment and active personnel to manage the operation. By creating a system which enables underwater AUV recharging, the independence of the AUV can be maximized. Coupling the source and battery inductively, exposure to salt water is minimized, and fault occurrence is decreased. The addition of an adaptive control system for charging allows the AUV more autonomy and releases personnel from charging duties.

Our major focus is the design and implementation of a control system which can compensate for the movement of the coils and maintain efficiency over a distance of 10cm. The system will be on the receiving side of the transfer network to ensure a more universal application for multiple types of underwater recharging. In the control scheme, the input voltage is kept constant and the voltage and current received by the secondary side of the system are measured. To achieve maximum efficiency, the measured values are used to estimate the coupling coefficient of the underwater wireless power transfer (UWPT) system. The estimation was carried out by a machine learning algorithm provided by Taofeek Orekan. Since the coupling coefficient is proportional to distance between the coils, the UWPT is controlled with its appropriate reference voltage (Vsmax) at every distance to ensure maximum voltage. Furthermore, a PI controlled DC-DC converter is adopted as part of the control system to adjust the load in order to achieve a specified constant output voltage.





Team 1716: UCONN Smart Ocean Wave Energy Converter

Sponsored by: UCONN School of Engineering

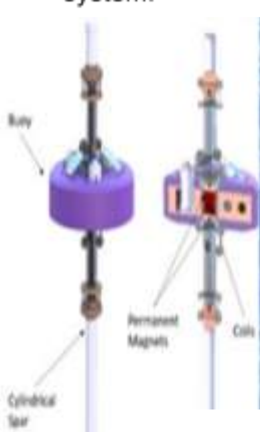
Sponsor Advisor: Dr. Peng Zhang

Islam Bilalovski, Jeffrey Brennan, Peter McBride, Christopher Stella

UCONN
SCHOOL OF ENGINEERING

Autonomous underwater vehicles (AUVs) are remote piloted, battery powered submarines used for oceanic exploration. A common problem with AUVs is the need to return to land, or a ship, to be recharged. One solution is to implement self sustaining, independent charging stations in the ocean. The UCONN Smart Ocean Wave Energy Converter (WEC) aims to be an effective solution for creating independent energy at sea. The WEC translates the mechanical energy of oceanic waves into usable electrical energy that is stored in the batteries contained within the WEC. The batteries then transfer power wirelessly to a docked AUV. As a result the AUVs are not be forced to return to their place of origin; thus resulting in longer missions for AUVs with less wasted time backtracking. Another benefit of the WEC is that underwater cables would not be needed to charge the AUVs. The underwater cables would prove to be more invasive and costly in comparison to transferring power using the WEC. Overall, this would result in greater efficiency in researching the ocean in addition to providing a less labor intensive process than the current method.

The Wave Energy Converter was designed as a point absorber linear generator. The power generation components consist of three permanent magnets contained within the spar of the converter and a coil wound around an iron rotor. These components generate current as the coil containing buoy travels up and down relative to the spar. The spar's vertical movement is dampened by a heave plate keeping it relatively stationary. This year's goal is to complete a field-tested prototype. This involves improving the design of the linear generator to produce a usable output as well as establishing an effective control system. The introduction of Maximum Power Point Tracking (MPPT) to the control system allows for optimized power extraction.The output entails a single-phase AC signal being sent through an H-bridge rectifier. The DC signal is then corrected by a Buck-Boost Converter. A PI (Proportional-Integral) controller functions to steady the output to charge 14.8 Volt Lithium-ion batteries. Thus, allowing efficient charging of the AUV relying on this system.



UCONN
Power Lab

Team 1717: Autonomous Fire Fighting Robot (Team 1)

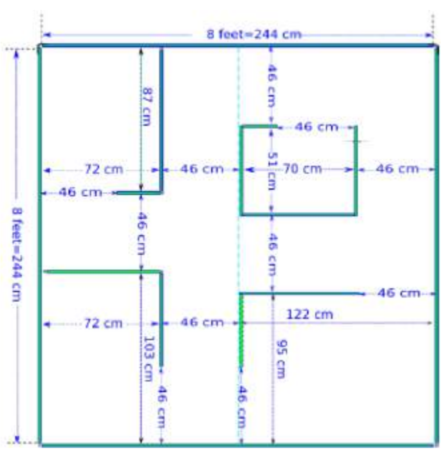
Robert Barret III, Zachary Rattet, Kevin Burke, Connor McCullough

Sponsored by: University of Connecticut
Faculty Advisor: Dr. John Ayers

UCONN
SCHOOL OF ENGINEERING

Trinity College holds an International Fire-Fighting Robot Competition that will be taking place April 1-2, 2017. The goal for the competition is to construct an autonomous robot that can navigate a designated course layout and extinguish a fire that is represented by a candle. Our general approach in designing and constructing a robot with such capabilities will to be think of the problem in terms of states. The robot will be stationary for an indefinite amount of time, then activate to navigate a maze, locate, and extinguish a flame, and finally return to its starting position to power down. The robot will be broken down into eight systems: Frame & Wheels, Power, Motors, Flame Detection, Fire Extinguishing, Navigation Sensors, Navigation Approach, and Microcontrollers. The main components are SRF05 ultrasonic range finders, a Raspberry Pi 3 installed with Ubuntu, an Arduino 2560, an infrared 64 pixel thermal sensor, a CO_2 extinguishing mechanism, and brushless DC motors.

The SRF05 ultrasonic sensors will be used to localize the robot within the maze by continuously sending and receiving data with support from the Raspberry Pi. Our five-sensor configuration on the robot will provide the robot with enough information to accurately locate and avoid obstacles with speed. The Raspberry Pi will be in communication with the Arduino while it sends pulse width modulation signals to control the motors of the robot. Meanwhile, the infrared thermal sensor will be constantly searching for the flame by looking for a significant heat difference. When the flame is ready to be extinguished, a linear actuator will activate and push the button on the CO_2 canister to release the gas and put out the flame. The robot will then realize that it has completed its mission and return to its original starting position to power down. The following images show the robot in its current build and design.



Team 1718: Autonomous Firefighting Robot Team 2

Sponsored by: University of Connecticut
Sponsor Advisor: Professor John E. Ayers

From left to right: Layne Fabian, Tanner George, Christian Walker, Robert Franchina

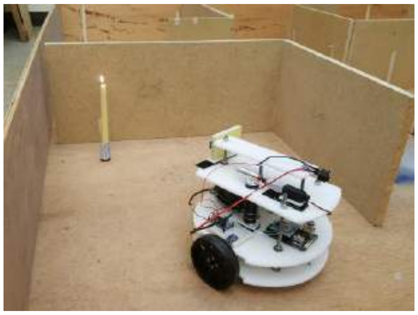
UCONN SCHOOL OF ENGINEERING

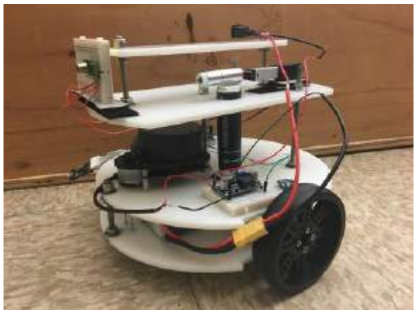
Team 1718 is building an autonomous firefighting robot to compete in the Trinity International Robot Contest held on April 1st and 2nd in Hartford, CT. The goal of this project is to work with a small team to build a robot that can autonomously search a model 8x8 ft home and extinguish a candle as quickly as possible. The contest features three levels of difficulty with Level 3 being the hardest. Each team gets five trials per level and the best three out of five completion times determine the score. For Level 1, the time limit is three minutes and the entire surface is flat plywood. In Level 2, there are rug areas added as well as additional obstacles such as stuffed animals and the time limit is increased to four minutes. The hardest difficulty adds even more obstacles as well as a 'search and rescue' mission where competing robots must pick up and carry out a baby doll before extinguishing the flame. The harder two difficulties will also have one of a few possible arena layouts so that the robots are forced to learn the course.

The team is using a 360° RPLIDAR laser scanner to continuously capture the maze layout and create a map such as the one below when searching for the lit candle. We chose to incorporate the navigation logic onto a separate ODROID XU-4 microprocessor due to the high amount of data processing needed for the laser scanner. Robot Operating System (ROS) is a flexible framework for writing robot software which we will use to navigate the course and integrate the components together.

A thermal array scanner in the front provides temperature readings to the microcontroller which guides the robot towards high temperatures. Once these reach upwards of 100°C, the device aligns the CO_2 canister with the flame and a linear actuator presses the release button. The chosen microcontroller is the Arduino MEGA 2560 Rev 3 which is responsible for thermal sensing along with driving two motors attached to the wheels.

The team's goal is to complete in the Level 1 course by finding and extinguishing the candle in under three minutes which will subsequently allow us to compete in Level 2.





Team 1719: Debugging Probe for Hardware Security Testing

Sponsored by: University of Connecticut
Sponsor Advisor: Dr. John Chandy

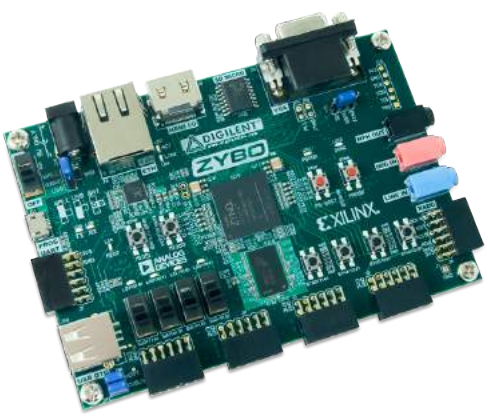
William Trautmann, Sean Barrett, Nathaniel Graichen

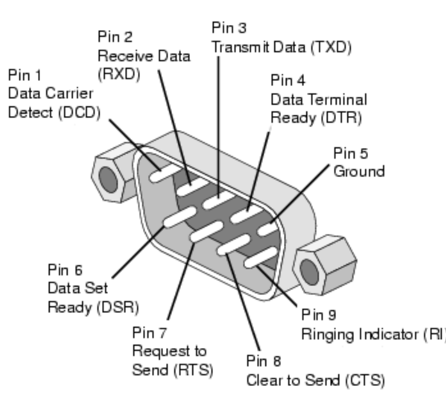
UCONN SCHOOL OF ENGINEERING

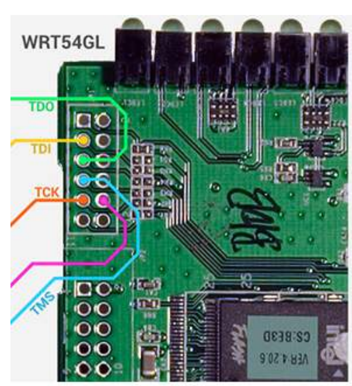
As information security is becoming a primary concern of consumers for both software and hardware platforms due to increased storage of information electronically, it is necessary for developers to start designing products with security in mind. Many PCBs for commercial devices will have open communication port headers on them, which are left on through the design process as a way to test the device, but these port headers aren't always removed. Thus, a malicious user could gain access to the flash memory of a device with only proprietary usages of the serial connection defending the system.

Some popular serial protocols used for communication headers are RS-232, Serial Peripheral Interface Bus (SPI), Inter-Integrated Circuit (I^2C), and Joint Test Action Group (JTAG). Each protocol has its own unique characteristics, whether it's the voltages of the logic levels, frequency of data transfer, clock frequency, behavior when confronted with an input, etc. The protocols focused on for this project are RS-232 and JTAG.

This probe will consist of an FPGA and a PCB and will attach to the test headers of a device such as a router. The probe will analyze the test headers and determine which protocol is being used by the device. A signal will indicate if the protocol is either JTAG or RS-232. The PCB connects directly to the device under test, it consists of comparators which determine whether the voltage level is in the range of an RS-232 signal. If the voltage exceeds 9 Volts then it is deemed to be an RS-232 signal and the PCB outputs a 1 from its comparators. To detect JTAG, the FPGA is directly connected to the test headers. Via the PMOD connectors, the FGPA puts the JTAG device into its shift mode, send many logic bits into the Test Data In (TDI) pin and checks for output at the Test Data Out (TDO) pin. Eventually this project can be expanded to include more protocols and potentially to determine what the pinout of each protocol is.







Team #: 1720 Un-Crashable Helicopter

Carlos Rodriguez, Tim Pelletier, James Hubbard, Dan Fay

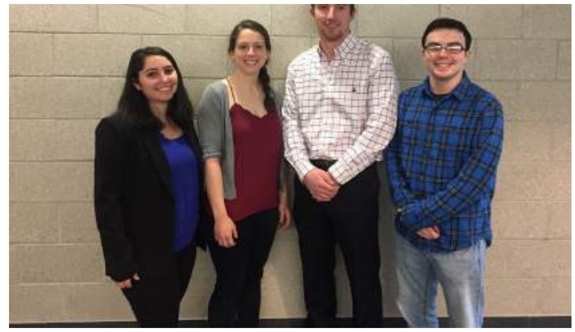
Sponsored by: Sikorsky
Sponsor Advisor: Jason Thibodeau
Faculty Advisor: Ashwin Dani

Today's helicopters and drones are entering a boom in their industries, with both military and commercial uses increasing greatly. Their current control methods are mostly based on pilot skill and reaction time, which can be problematic in several situations. If the pilot were to become incapacitated or if there is an oncoming projectile, the pilot's ability to react in time may not be enough to avoid collision. There are even more concerns in the consumer drone market where many of the pilots may have little or no experience with flight and are much more likely to have difficulties flying their drones safely. These situations may result in the aerial vehicle crashing into a terrain obstacle, often leading to near total destruction of the aircraft and possible loss of life. As most helicopters and drones are tremendously expensive and the cost of life is priceless, this is something to be avoided at all costs. While immediate full scale implementation onto helicopters has a large amount of risk involved, a small scale proof of concept project should suffice in proving that the foundation of the concept is feasible and to promote large scale future projects.

Our group was tasked with creating one such proof of concept project involving a commercial quadcopter and commercially available sensors with the goal of creating a shared-control flight system capable of avoiding obstacles in crash-determined situations. The flight control system features separate manual and autonomous flight modes, only having the latter activate when a crash is determined to be possible. The autonomous flight mode removes pilot control from the quadcopter while it calls for an emergency full stop of the quadcopter's horizontal movement and then moves away from the obstacle. If an object is determined to be moving towards the quadcopter, the system will also force the autonomous flight mode and move away from all determined obstacles until it reaches clear airspace. Once the quadcopter is determined to be in clear airspace, control is returned to the user and manual flight resumes.

Team #: 1721 Solid-State Timing Device

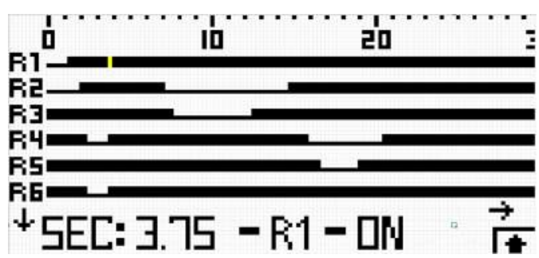
Sponsored by: Capewell
Sponsor Advisor: Andrew Smith
Faculty Advisor: Rajeev Bansal

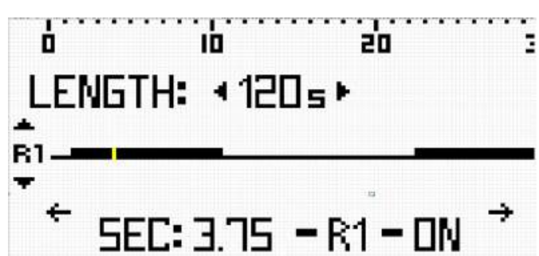


Jaileen Algarin, Nicole Hershman, Robert Endrizzi, Patrick Meres

The goal of this project is to replace an older fully mechanical timer with a completely solid-state solution in an attempt to increase the life expectancy and accuracy of the timer while maintaining similar production and manufacturing costs. The Solid-State Timing Device in development is an electronic system that operates with no moving parts and measures time in order to regulate certain electrical loads. Examples of these loads are motors, lights, pumps, and basically any device that has an on and off state. The lack of moving parts in a solid-state device typically leads to a life expectancy that is significantly longer compared with a mechanical solution.

The solid state timer is being implemented in such a way that it is able to control up to eight loads individually at a maximum current rating of 15 A. The timing and switching are controlled by a central microcontroller unit (MCU). The timer is supplied power by a custom-designed power supply that can handle both 120 and 240 VAC inputs and outputs both 3.3 V and 5V lines for various chips in the timer. Each load being controlled by the MCU is switched on and off by a semiconductor device known as a TRIAC (Triode For Alternating Current). Tests completed to assess levels of material fatigue between moving and nonmoving timers have shown that a mechanical device has a lifetime of approximately 200,000 - 300,000 cycles life based on experience from the sponsor; while a solid-state device will have a lifetime of approximately one million cycles. With both the mechanical and solid-state devices having similar production costs, the extended lifetime and improved accuracy of the solid-state timer have made it a particularly attractive design solution.





Team #: 1722 - Autonomous Battery Charging Quadcopter

Sponsored by: UConn ECE Department
Faculty Advisor: Professor Ashwin Dani

Team 1722 – Thomas Baietto (EE), Ryan Oldham (EE), Yifei Song (EE), Gabriel Bautista (CMPE)

Quadcopters have a limited flight time due to current battery supply limitations. Commercially available quadcopters typically last anywhere from 20 to 30 minutes on a single battery charge. Adding more batteries is not a desirable solution because increasing payload weight will consequently consume more power, ultimately reducing battery life and flight time. Our Design Team is developing a UAV system, specifically a quadcopter, which will autonomously recharge itself. This simply means that the quadcopter will be able to recharge its battery when needed without any human interaction.

For this design project, we plan to develop an autonomous system that can navigate our quadcopter to the charging station and then recharge the battery. Thus, this project can be split into two separate parts. First part is the software design, which will allow for autonomous flight and docking of our quadcopter on the charging station. Second part is the hardware design of the charging system that will succeed in recharging the quadcopter's battery in a time efficient manner. By the end of this project, our goal is to successfully design an autonomous battery charging quadcopter system.

To accomplish our goal we have chosen to implement an image processing based tracking system along with a GPS system. The image processing algorithm will be used for docking on the charging station and GPS system will be used for navigating to the docking station. Once the quadcopter is rested on the charging station the battery will automatically recharge the quadcopter's battery using conductive charging. The quadcopter will then resume flight when the desired battery level is reached.

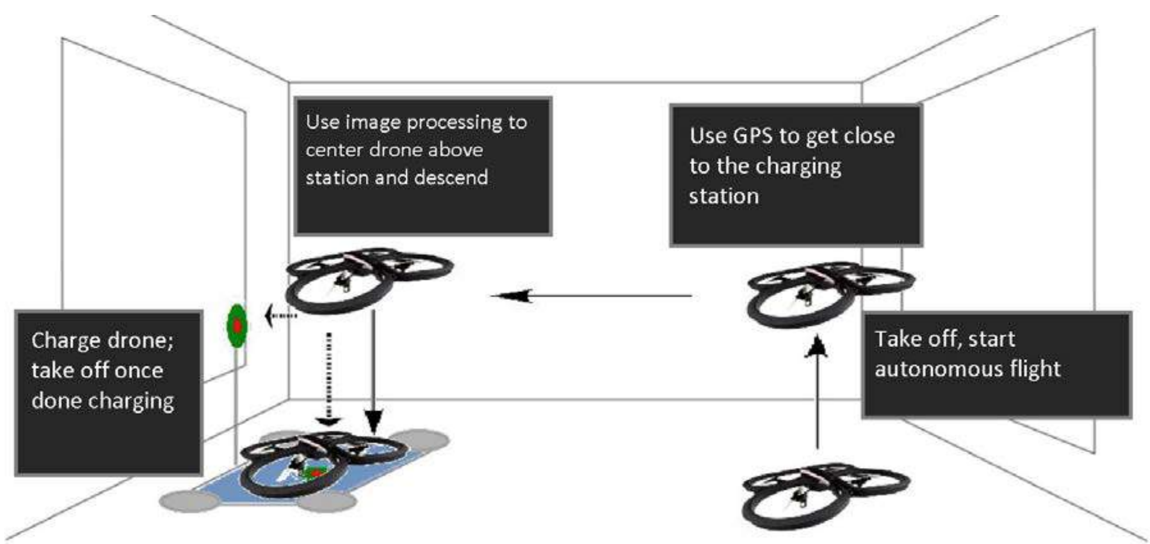


Figure 1. Project Visual

Team 1723: Sailplane Thermal Detector

Sponsored by UConn ECE Department
Sponsor Advisor: Dr. Helena Silva

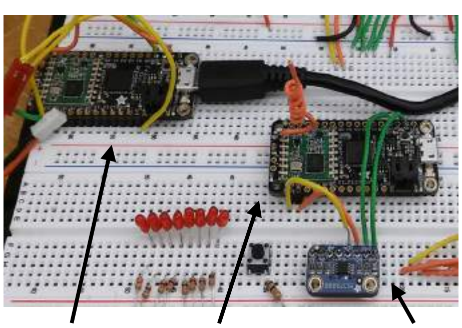
UCONN
UNIVERSITY OF CONNECTICUT

Four well-dressed engineers (L-R): Kevin Waligora, William Pawelczyk, Nicholas Chapman and Alex Dawkins.

Gliding is one of the most satisfying and exhilarating hobbies. Being able to soar over terrain gives glider pilots a whole new dimension in which they can appreciate their surroundings. There is, however, one concern which every glider pilot faces: the ability to stay airborne in an engineless sailplane. Sailplanes maintain or gain altitude by identifying and entering columns of rising warm air known as thermals. This becomes a difficult task for a pilot when gliders soar quickly and thermals are invisible. Therefore, the goal of this project is to create a sensor system that will enable a glider pilot to identify and react to thermals. This would be helpful for both learning student pilots as well as competitive pilots looking to get as much lift as possible from a given environment. These sensors will help pilots to take greater advantage of the lift provided by thermals and can lead to longer flight times in order to win competitions or just fly around for leisure.

After completing formative research with experienced glider pilots, a final sensor design was made based on their opinions. Our design is based off of a temperature comparison system. We will place one temperature sensor unit located on each wing of the sailplane. These sensors then relay their measurements wirelessly to a central processing unit inside the cockpit. There, we take the difference in temperatures and track it over time. If one wingtip shows a relative spike in temperature, it's likely that the the pilot will be indicated to turn in that direction.

Design challenges included the selection of temperature sensors that are sensitive enough to detect small changes in air temperature and determining what types of temperature readings actually indicate the presence of a thermal. Testing of our system using the side mirrors of a car has proven helpful in mimicking the fast-moving air environment of an airplane in order to work out bugs before testing the system on an actual aircraft.



Receiver, transmitter and temperature sensor.

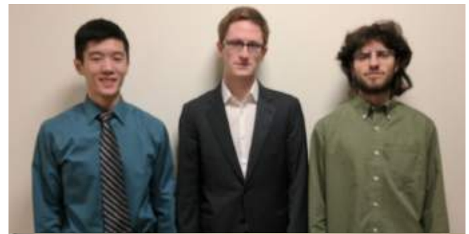
Left: testing sensors and wireless communications in the lab.

Right: A glider pilot from the CT Soaring Association shows us a glider's wingtip and where it might be safe to mount a device.

Team 1725:
Perimeter Security Device

Sponsored by: Airbornway Corporation
Sponsor Advisor: Mr. Rodger Gibson
Faculty Advisors: Dr. Diane Van Scoter (MEM)
Dr. Jiong Tang (ME)

Airbornway Corp.



ECE Top Picture, From Left to Right: Wei Kuan, Jonathon McRae, Joseph Granatosky

MEM Bottom Picture, From Left to Right: Dr. Diane Van Scoter, Alexander Wittstein, Salvatore Musumeci, Dr. Jiong Tang.

ME Not Shown: Mitchell Durkin

Project Description: Airbornway was founded with the goal of revolutionizing transportation and security. To achieve this, the concept of Eagle System was established. Operating similar to zip line technology, this device can get you or your items where they need to go – and it does it quickly. With a top speed of 40 miles per hour, Eagle will revolutionize short distance travel. If the concept gains traction, it will be able to move unhindered by rush hour traffic, accidents, or unpleasant weather. Its durable casing protects its main components from rain, snow, hail, and sand. Eagle is also able to be implemented around prisons and government facilities. It has a built-in camera that can transmit video as it travels, and is able to be outfitted with any other necessary security hardware that will make security tighter wherever it is needed.

Airbornway tasked us (in collaboration with other students and faculty from other departments) with designing and constructing this system, with a prototype provided for guidance. There were three primary requirements the team had to fulfill. First, the system had to be able to operate in a temperature range of -50°F to 134°F. Our durable chassis and internal casings protect the electrical components so Eagle will continue to operate, no matter the environment. Specifically, we needed to consider Alaskan and desert environments. Second, Eagle needed to achieve a maximum speed of 40 miles per hour (60 ft/s). Assessments were made regarding weight of the system, so the horsepower and rotations per minute of the motors could be calculated. Lastly, Eagle needed to be able to receive commands and power through its zip line. Therefore, UART (Universal Asynchronous Receiver/Transmitter) communication was implemented. UART is a communication method utilized by many systems. As long as the data ‘packets’ are transmitted at the same rate, the microcontrollers are able to communicate with each other. Zip line communication is vital as it prevents any disruption to Eagle’s control or sensors. This method also prevents the chance of a cyber-attack and allows for constant communication in the event of a damaged antennae.