

Electrical Engineering and Computer Science Department

TEAM MEMBERS

Kyle Ellis
Emily Gehrke
Kegan Hackett
Ryan Soileau
Abby Strand

FACULTY ADVISOR

Dr. Steven Holland



AD2 Inspector

The AD2 Inspector is a device that will aid identification of malfunctions in the Analog Discovery 2 (AD2). Frequently, misbehaving AD2 units are returned to Tech Support. Time and resources are wasted manually determining the cause of the defected AD2. The AD2 Inspector will save many AD2 units and masses of time. Using a Raspberry Pi controller, waveforms are generated and sent to the AD2. The measurements are calculated by the AD2 and the controller reads the outgoing data from the AD2. Since the controller knows what the data should be, the outgoing data is compared to the accurate data, quickly identifying the specific problem area of the AD2. With an easy-to-use user interface platform, anyone can quickly plug in their AD2 and run a test to see what is wrong with their unit. Say goodbye to wasted time and shelves of defected AD2 units!

TEAM MEMBERS

Sara Alsudeer
Ashley Branner
Jaden DeFields
Michael English
Joshua Wankowski

FACULTY ADVISORS

Dr. Derek Riley
Dr. Gerald Thomas

Algae Bloom Detection IoT Buoy

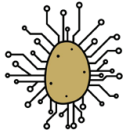
The Algae Bloom Detection IoT Buoy project cooperates with the lake manager on Eagle Spring Lake to monitor Harmful Algae Blooms (HABs). The primary device is a waterproof lake buoy with a microcontroller and two temperature sensors to monitor the lake. The sensor readings are transmitted wirelessly to a proxy server on the shore and then forwarded to the cloud. Temperature readings within 20-35°C can help indicate when HABs form. A cloud-based software service is available to query a database containing the data entries and possibly predict possible algae growth periods. The project serves as a foundation for additional sensors and artificial intelligence prediction capabilities by future teams. Existing solutions are too high cost for smaller lakes like Eagle Spring Lake and our project serves to provide a low-cost solution to an otherwise high barrier to entry market.

TEAM MEMBERS

Justin Bickman
Bartosz Karaban
Preston Makoutz
Noah Schmidt

FACULTY ADVISOR

Dr. Luke Weber

**Autonomous Irrigation System**

The purpose of this project is to improve the current methodology of irrigation for farmers who use outdated irrigation hose reels. Currently, farmers who use this method of hose reel irrigation rely on mechanical linkages for controls that tend to lack repeatability and reliability. This requires the farmer to spend numerous hours every day monitoring the irrigation process to ensure that nothing is broken, and everything is functioning as expected. Our project streamlines and automates this whole process to ensure that the system operates reliably, reduces water waste, and makes the whole irrigation process almost entirely hands-off for the farmer. Our solution is a low-cost, modular addition to the existing irrigation hose reels and water pump that monitors the irrigation process, protects the farm fields from flooding by wirelessly communicating between the water pump and hose reels, and sends the farmer progress updates via text message.

TEAM MEMBERS

Brandon Dunne
Sam Jansen
Than Win

FACULTY ADVISOR

Dr. Gerald Thomas

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TSR Solutions

**BeerBot**

This project is a self-serve beverage system which utilizes a smartphone application using near-field communication to allow users to order, pay, and pour beverages themselves. The system uses a tap controller integrated into a smart tap system to enable users to purchase and serve themselves drinks without the need for a bartender. By doing so, lines are shortened as the system can serve up to eight users simultaneously which reduces costs to serve beverages. The system will be sold as a service and marketed towards temporary or semi-permanent event venues such as Summerfest which are looking to cut costs and lines for beverages.

TEAM MEMBERS

Isaac Ballone
Seth Fenske
Rob Retzlaff
Lucas Stenzel
Joshua Vogt

FACULTY ADVISORS

Dr. Christopher Taylor

Career Pathways Kiosk

The Career Pathways Kiosk is an interactive exhibit that allows children to explore various careers they can pursue in the future. Discovery World visitors answer survey questions via a touch screen. At the end, they are presented with potential careers based on their answers, and they can learn more about each career while exploring different paths. This project involves two different Java applications: the kiosk itself and

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Discovery World



TEAM MEMBERS

Daniah Alkhunaizi
Katie Merriman
Catherine Mett
Erin Winter

FACULTY ADVISOR

Dr. Charles Tritt
(with thanks to Drs. Jeffery LaMack
and Ahmed Sayed and the rest of the
biomedical faculty)

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83 Tech Harbor



TEAM MEMBERS

Sam Forest
Alex Holt
Vincent Krenz
Lucas Larocco
Blake Masbruch

FACULTY ADVISOR

Angela Wiedenhoef



a survey editing application. To prevent the survey from becoming out of date, Discovery World staff can use the editor to update the content and graphics. The survey is stored as a simple XML file, and it can be loaded back into the kiosk.

Child Gaze Tracker

Our team is working with 83 Tech Harbor to create technology for at home use that will help parents understand and identify possible developmental issues, or detect disorders, such as seizures, earlier and more objectively. Childhood developmental disorders benefit from early diagnosis. However, they are difficult to diagnose, relying on subjective and sometimes unclear criteria, which can increase stress in parents who suspect their child may have a developmental disorder. Based on research showing that tracking eye movement may be useful in the detection of multiple childhood developmental disorders, we intend to develop a prototype for a wearable eye and head tracking device, using infrared (IR) cameras to track the eye gaze and an accelerometer/gyroscope subsystem to track head movement. This will allow gaze direction to be determined without the need for an external facing camera, reducing social and ethical concerns about capturing images of other children around the user.

Drone Link

Drone Link is a full suite of tools and hardware for drone racing management. Features include the planning of heats, finding the best flying frequencies, race day statistics, and the physical timing hardware for each drone on the track. Cost effective and readily available IOT (Internet of Things) technology allows the distribution of more timers on a track to record more accurate metrics, giving the pilots the edge to improve. On race day these metrics can be shared over a local network to spectators and pilots alike to make the day more engaging and informative. This project will be open source, allowing the community to continue developing Drone Link. It will be available for schools and individuals in the hope that drone racing becomes a more popular hobby!

TEAM MEMBERS

Bayan Almarhoon
Will Fredenberg
Deven Jakubowski
Hope Walker

FACULTY ADVISOR

Dr. Charles Tritt

SPONSOR

A portion of the project cost is covered by the Innovent Center grant



TEAM MEMBERS

Forbes Filip
John McGreevey
Samuel Wagner
John Yeksigian

FACULTY ADVISOR

Dr. Luke Weber

TEAM MEMBERS

Gagan Daroach
David Haen
Ethan Janecek
Austin Rovge
Joshua Spleas

FACULTY ADVISOR

Dr. Christopher Taylor

SPONSOR

Special thanks to MSOE Public Safety Sgt. Russell and the NVIDIA metropolis engineers and scientists.



Educational Mechanical Right Heart Simulator

Our educational mechanical heart simulator simulates the mechanics of the right heart, demonstrating specific physiological aspects of the right heart in addition to the thermofusion technique that is essential to today's Swan-Ganz catheters. Our device is intended to be highly effective in biomedical engineering education. It can be used to illustrate the performance and function of the right heart in physiology classes and fluid dynamics principles. The design has been completed and documented with open-source principles in mind with the intent to make it available to all interested biomedical engineering faculties and encourage its reuse.

Electronic Parts Vending Machine

The Electronics Parts Vending Machine is an autonomous, always-on vending solution located on the third floor of the Science Building, a location with 24-hour student access. The solution gives students in the Electrical Engineering and Computer Science Department of MSOE the ability to purchase electronics parts on any day and at any time using a Raider Card with pre-loaded funds, a major credit card, Apple Pay, or Google Pay. The machine is stocked with a curated selection of products that both support coursework and encourage extracurricular exploration. The Technical Support Center of the EECS Department has agreed to maintain inventory and accounts and to restock the machine after the project end.

Eye in the Sky: Vision Tracking in Diercks Hall

A software system that will expand on the traditional security camera software suite with modern computer programming technologies. The combination of computer vision, machine learning, and distributed metadata analysis enables the Eye in the Sky to autonomously monitor and record object behavior across campus. This information can be presented, interpreted, and shared with security officers in a dispatch control user application. The current campus security infrastructure consists of a disorganized collection of basic camera video data. MSOE Public Safety has difficulty searching for actors around specific on-campus events. Our solution proposes an individual oriented search pattern for indexing diverse n-point camera systems. MSOE's supercomputer has the compute capacity to simultaneously analyze every high-resolution camera in Diercks Hall and store relevant object information. The rendering engine superimposes guiding boxes on individuals in live campus video to assist Public Safety with human recognition of objects or people.

TEAM MEMBERS

Alexander Blake
Dylan Critz
William Dennis
Shreyesh Patel
Isaiah Zupke

FACULTY ADVISOR

Angela Wiedenhoeft



TEAM MEMBERS

Saad Alshimshir
Max Booth
Zachary Krouse
Surya Prakash Madichetti
Rilind Morina

FACULTY ADVISOR

Dr. Luke Weber



TEAM MEMBERS

Thomas Burback
Arandu Huerta
Leo Madda
Jeremy Pugh

FACULTY ADVISOR

Dr. Eric Durant

First Event Scheduler

FIRST is an education consulting company that hosts professional learning communities every year where educators from school districts can learn a variety of things that they can then employ in their teaching. However, FIRST pays several thousands of dollars to print its agenda on paper for the hundreds of participants. PLC Group will construct an application that allows the stakeholders to enter relevant information for the PLCs, removing the need for printed booklets. The application will run on Android and web browsers. The solution will be safer for the planet and easier to update upon changes to the itinerary.

Flash Charge

E-Bikes have become more popular as an alternative to public transportation in cities all over the world. E-Bikes use batteries to power the array of electronics and motors that make it function. However different brands and models of E-Bikes have different battery voltages. This difference prevents charger cross compatibility. Therefore, a fast and adaptable charger that can adapt to different batteries is needed. This charger removes the need for multiple chargers in a household and charges the battery faster than the included OEM chargers.

FreshBlock

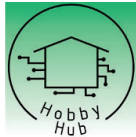
The FreshBlock is a small, rapidly deployable device that acts as a quick reminder of how much time is left before a product expires. The FreshBlock has an eInk display that changes from white, to black, and finally red to indicate the product has expired. This allows the user to quickly estimate the remaining shelf life of the product at a glance. The FreshBlock also displays the expiration date of the product for detailed information when needed. This device will help modernize product freshness solutions and reduce the burden of arduous current date keeping methods. Along with the device, the FreshBlock product utilizes Bluetooth LE to connect with a phone app that will be used for easy set up and its on-board Wi-Fi to connect to a server that provides notifications when a device is low in battery and reminders as the expiration date nears.

TEAM MEMBERS

Anthony Bartman
Rock Boynton
Declan Bruce
Andrew Iliescu
Draven Schilling

FACULTY ADVISOR

Dr. Eric Durant

**Hobby Hub**

When it comes to embedded projects, the sky's the limit and the only obstacle is people's sheer creativity. The Hobby Hub enables hobbyist programmers to create and design unique, multi-faceted solutions to automate their everyday lives. Our system allows users to run multiple independent programs simultaneously from a single piece of hardware. With a straightforward setup process delivered through our custom web interface, the user can set up their device easily and quickly. Following setup, the user can begin managing programs and accessing program development tools to make creating the software they desire a breeze. A custom pin manager tracks I/O pins that are in use while highlighting available pins, thereby saving the programmer time and effort from having to resort to referencing the manual. Motivated individuals can now let their imaginations run wild.

TEAM MEMBERS

Jeremy Gardipee
James Ostrowski
Brett Rogatzki

FACULTY ADVISOR

Dr. Edward Chandler

Kayak Control

Currently there isn't a kayak propulsion system that is easily removable and can be used on a wide variety of kayaks offering the end user a wide range of mobility, control, and enjoyment. Our solution uses a microcontroller system that takes input signals from two user control devices that each control the thrust in the forward/reverse direction on one side (left or right) of the vessel. The magnitude of thrust in each thruster is proportional to the angle-of-throw of its user control. The two thrusters are mounted on a mechanical fixture that can be easily removed from the kayak. The system is powered by a user-supplied marine-grade battery that can be stored in the design-supplied waterproof enclosure. In addition to the battery, the waterproof enclosure also houses the microcontroller system and overcurrent protection devices.

TEAM MEMBERS

Jake Evenson
Noah Horton
Alex Johnson
Greg Johnson
Sam Libert

FACULTY ADVISOR

Dr. Eric Durant

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Molson Coors Beverage
Company

**MCBC Network Access Control**

Molson Coors Beverage Company (MCBC) keeps their breweries in peak operating condition by hiring specialized outside contractors to maintain and update their brewery controls equipment. To perform the needed maintenance and updates, these contractors require access to the brewery network which introduces a security vulnerability. The current way MCBC allows access to the network poses a few problems in monitoring the activity of the contractors along with allowing easy and secure access to the network.

To resolve the issues in monitoring and accessing control, we have designed a two-part solution. The first part of the solution is a Wi-Fi bridge. This device will act as the gateway onto the network by providing an internet connection to the brewery's network and monitors and stores into a database all traffic going onto the network through the bridge. The second part is a hardware key. This USB device will store the credentials of a user and will allow for the contractor to access the network without typing a password. This two-part system will allow for easy, secure access to the MCBC network while offering strong monitoring practices.

TEAM MEMBERS

Noah Frandsen
Evelyn Kurtz
Nicholas Piemonte
Therminder Singh

FACULTY ADVISOR

Dr. Edward Chandler

SPONSOR

Milwaukee Tool

**Mesh Control of Tools**

Milwaukee Tool needs a method to control multiple One-Key lighting devices simultaneously. Currently, Milwaukee Tool's Bluetooth Low Energy (BLE) Module is not capable of mesh control and therefore does not support controlling multiple devices simultaneously. Milwaukee Tool's expectations include: The replacement module needs to forward commands to the lighting device being controlled, the solution must use BLE Mesh communication, all the code is to be in C, the replacement module needs to have lower power-source quiescent current than the current solution, and the replacement module needs to cost under \$10. The developed solution is smaller than 2" by 3"; allows commands sent to multiple devices simultaneously using a smartphone application for control; accommodates commands to turn lights on, turn lights off, adjust light brightness, and sound a buzzer at a light to help locate it; and uses the STMicroelectronics BLE Mesh application for Android and IOS devices to make commands.

TEAM MEMBERS

Caitlyn Callahan
Ashpreet Kaur
Mirnes Neziric
Hannah Rindfleisch
Jennifer Stillman

FACULTY ADVISOR

Angela Wiedenhoef

MSOE Supercomputer Challenge

The MSOE Supercomputer Challenge is a project to develop a web-based application that can analyze a multitude of inputs and requirements to produce an optimized floor plan design using machine learning that can be linked to a cost database. The goal was to determine the best configuration for the project and allow customers more knowledge to let them make more confident decisions. This would be a much faster first step in the design process to make sure the project was feasible for their customer.

TEAM MEMBERS

Timothy Buchmann
Noah Kennedy
Joseph McClanahan
Cody Nettersheim
Kenneth (Wallace) Watler

FACULTY ADVISOR

Dr. Richard Kelnhofer

NASA Remote Mining Competition

NASA hosts an annual design competition for universities. Teams travel to the Kennedy Space Center in Florida to participate in a robotic mining competition (RMC) and MSOE often participates in this event.

The Mapping, Orientation, and Navigation Kit for Ensuing Years (MONKEY) is designed to provide autonomous navigational support for the MSOE NASA RMC competition team's mining robot. The system is designed around the set of rules and regulations for the NASA RMC, as well as the current MSOE competition team's robot design. The kit is intended for future years' teams.

The MONKEY includes hardware and software systems consisting of power, stereoscopic image processing, inertial measurement units (IMU), communications subsystems, microprocessors, localization and navigational algorithms. The MONKEY will identify the mining robot location and orientation in the field of play. It will then provide the mining robot with commands to autonomously navigate to a mining location using a route that is free of hazards.

TEAM MEMBERS

Batoul Jaber
Jonathan Pacocha
Zhuocheng Qu
Katie Snyder

FACULTY ADVISOR

Dr. Charles Tritt

POTS Monitor

Our device is designed to improve the quality of life of those with Postural Orthostatic Tachycardia Syndrome (POTS) by providing real-time blood pressure and heart rate monitoring through a non-invasive wearable device. The device will allow wireless BP and HR data transmission via Bluetooth to the patient and their family's Android mobile devices. This will alert users to possible problems and help them manage emergency episodes. The system will also permit users to log their diet and day-to-day activities to aid in the discovery of foods and activities that may trigger episodes.

TEAM MEMBERS

Nawaf Althekri
Nicole Cross
Thomas Greenthal
John Greis
Rachael Kundrot

FACULTY ADVISOR

Dr. Richard Kelnhofer

PV Panel Eliminator

Green energy has become more prevalent in developing new technologies and energy solutions. Many emerging technologies rely on Photovoltaic (PV) solar panels as their main source of power. This has been seen on larger scales, like assisting in powering homes and communities, and on smaller scales, like personal backpacks that can charge phones and other small devices. As these technologies are developed, they need to be tested either with a full grid of PV panels or DC power supplies. The former can be expensive and the later does not fully replicate the true electrical characteristics of a PV panel.

The PV Panel Eliminator provides a low-cost power source that accurately and reliably emulates the output I-V characteristics of a solar panel. This device is intended to be used by electronic system designers and will provide a simple power source with the I-V curve of a solar panel to ensure the functionality of their designs. The PV Panel Eliminator can be programmed to emulate different panels and different light/shading scenarios. Multiple Eliminators can be wired in parallel or series to fully emulate a complete PV system.

TEAM MEMBERS

James Backus
Ethan Gilerovich
Kevin Kearn
Michael Silveti

FACULTY ADVISOR

Dr. Richard Kelnhofer

PV Sous Vide – The Next Wave of Cooking

Most people are familiar with hearing phrases such as, “Really? You’re pulling them off now?” or even, “I wanted medium-rare, and this is charred!” The common campfire, the culprit behind generations of bickering, is simply too difficult of a cooking method to achieve consistent results.

We introduce the solar powered sous vide cooking system. Our system eliminates the need of a campfire and produces perfectly cooked meals from simple resources such as solar energy, an insulated container, water, and sealable bags. With these few items, the user can effortlessly and safely cook with little to no guesswork involved.

Our team takes great pride in our development of such an ecofriendly, zero-carbon emitting device, as the only non-reusable elements are the sealable bags that the food is placed into.

Clearly, our sous vide is the superior option for a safe, portable, accurate, reliable, and eco-friendly culinary experience.

TEAM MEMBERS

Noah Davison
Zakary Gibson
Bailey McDaniel
Dalton Smith
Jason Urban

FACULTY ADVISOR

Dr. Gerald Thomas



Queue Up

Queue-Up is a mobile application providing music playback collaboration across multiple devices through a connected queue management system acting as an extension of one's premium music streaming subscription. This development was triggered by the physical restrictions of connecting to a speaker, whether that be via an auxiliary cord or Bluetooth. These restrictions create inconveniences in music playback management while adapting to the vibes of the listeners. Long silences are inevitable while transferring control of a speaker from one person to another or passing the aux cord to another device. The device connected to the speaker initiates a party session through this app and invites other devices to manage the queue through a contributor code. Similarly, the host and contributors can share listener codes for other people in the scene to view the upcoming songs in the queue and submit song requests.

TEAM MEMBERS

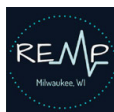
Gabrielle Hoffman
David Marabella
Alexandra Maruga
Harrison Vangellow

FACULTY ADVISOR

Dr. Icaro dos Santos

SPONSOR

Peter Spyres



Rapid Emergency Monitoring Patch

The rapid monitoring patch is an ECG electrode patch that can be applied to the patient in an emergency situation. It minimizes the number of wires and electrode attachments that need to be applied into a simple and compact package. It has Bluetooth capabilities as the signals from the patch are wirelessly transmitted to existing ECG machines through an adapter.

TEAM MEMBERS

Nicole Black
Carlos Garza
Lorrin Pondo
Joseph Schauer

FACULTY ADVISOR

Dr. Charles Tritt
with thanks to Dr. Tom Swiontek

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Real-Time Nerve Conduction Velocity Device

Our project involved the design of a nerve conduction velocity (NCV) device that allows collection and display of real-time data for more efficient detection of neuropathies. Nerve conduction velocity devices send small electrical currents through patients' skin to underlying nerves and then detect the resulting neural responses. In our device, this response is displayed on a handheld screen in real-time. Our design integrates a microcontroller for data storage and uses a micro-computer for display of the user interface. It also includes an electrical stimulation circuit as well as filtering and amplification circuitry.

TEAM MEMBERS

Katherine Baker
Mark Niewierowski
Trevor Panten
Brandon Sauve
Samuel Schmidt

FACULTY ADVISORS

Dr. Luke Weber
(Additional thanks to Drs. Joshua Carl
and Sheila Ross)



Rescue Blankets

This past winter has shown us the importance of warmth, not just in Wisconsin, but across the US. There are many car heaters, however, that work either only when the car is on or use propane/non-reusable fuel. Our heater works independent of the car and uses solar and wind energy, as well as home outlets to charge. The product can use up to three heated blankets and has two phone chargers as well. This will help users survive and stay comfortable in the case they are without heat and power.

TEAM MEMBERS

David Blank
Daniel Glonek
Erick Jansen
Lawton Wacker

FACULTY ADVISOR

Dr. Edward Chandler

Smart Clay Pigeon Thrower

There is currently no smart clay pigeon thrower available on the market that has an extended operating distance and full remote-control capabilities. Additionally, no currently available thrower can save positions and recall them when desired. A satisfactory level of safety and stability is essential to this type of product, and currently available products are unsatisfactory with regards to safety and stability. Our solution involves creating a handheld controller allowing the user to enter commands that are wirelessly communicated to the launcher. This controller can save positions and is able to create custom sequences of launch directions from previously saved positions. The controller is user friendly and will accommodate future enhancements such as creating a mesh network of multiple launchers. The controller with its capabilities and our safety and stability attributes are the distinguishing features between our product and existing solutions.

TEAM MEMBERS

Tyler Badar
Eduardo Diaz Barragan
Syed Faiz
Charles Jennings
Philip Kedzior

FACULTY ADVISOR

Dr. Eric Durant



Smart for All

Smart for All is our IoT (internet of things) hub, that will connect wirelessly to modular adapters that add smart functionality to legacy devices to easily control them from the comfort of your smartphone. The hub communicates with our custom modular devices using a wide variety of standard IR remote control formats that relay the data to the hub and in turn receive the proper commands to perform the correct functions. Our goal for this project is to create a product which will allow for devices that don't utilize an internet connection to easily connect to the internet and be easily controlled remotely from an app on a smartphone, giving them "smart" functionality.

TEAM MEMBERS

Travis Bohl
Michael McCabe
Matthew Model
Xue Vang
George Volling

FACULTY ADVISOR

Dr. Steven Holland

Smart Sump System

This project is aimed at giving users more information about the condition of their sump pump so they can make informed decisions about replacing their pump. This is done by monitoring the power to the pump and additional sensors to monitor the water level more accurately in the sump basin. It is also designed to be flexible and open source, allowing users to determine the sensor type and the number of sensors that are suitable for their situation. Since this project is open source, it also allows users to further customize the system to their needs.

TEAM MEMBERS

Robert Burkhardt
Joseph Casper
Stuart Enters
Grace Fleming
Andrew Wojciechowski

FACULTY ADVISOR

Dr. Christopher Taylor

FACULTY ADVISOR

Dr. Bruce Shapiro, CEO,
Sisyphus Industries

Sisyphus Table Expansion

Previous to the MSOE Sisyphus Design team's intervention, a combination of robotics, magnetism, a steel ball and a Neopixel LED light strip were employed by Sisyphus Industries to create beautifully illuminated patterns on a kinetic art table. These patterns provide a deep sense of tranquility and meditation for the viewer. The MSOE Sisyphus Design Team has furthered the interactivity of this table through a combination of machine learning algorithms that enable the table's lights to respond in both color and brightness to input audio mood and volume. Additionally, the MSOE Sisyphus Design Team has produced further innovations in the space of R&D for Sisyphus Industries to explore in future attempts to increase the interactivity of the table, including new light patterns and new sand tracks as well as an app to use the table to display phone notifications.

TEAM MEMBERS

Giovanni Aguilar
Megan Brock
Jonah Hinds
Jacque Pettigrew

FACULTY ADVISOR

Dr. Icaro dos Santos

Smartwatch to Detect Symptoms of Hypoglycemic Events

Hypoglycemia is a common complication of diabetes treatment. Individuals who suffer from low blood sugar have hypoglycemia. Sudden reductions in glucose levels in the blood systems may cause dizziness, shaking, confusion, and feelings of anxiousness and weakness. When a hypoglycemic event occurs, the individual experiences a drop in temperature and excess perspiration. The project goal was to develop a smartwatch technology based on temperature sensors that detect these sudden changes. Self-heating thermistors measure both the perspiration and temperature using a single temperature sensor. When a hypoglycemic event is detected, or the sensor's threshold conditions are met, the smartwatch will vibrate and sound an alarm through a speaker to notify the user of a potential hypoglycemic

episode. Additionally, a Bluetooth application was developed to alert the user and their emergency contacts on their mobile devices. The intention of the alarm system is to notify the individual before the event occurs so that the user can be better prepared.

TEAM MEMBERS

Evan Carter
Josh Czeshinski
Amanda Goff
Kim Mai

FACULTY ADVISOR

Dr. Icaro dos Santos

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Sympathetic Response Sensing Device

The sympathetic nervous system (SNS) is a necessary component of overall nervous control, helping regulate body functions. During stressful situations, the SNS increases heart rate, blood pressure, and sweat, resulting in its nickname, the “fight-or-flight” response. Individuals with certain mental illnesses, such as anxiety, may have increased sympathetic response, but with the use of biofeedback and therapy they can learn to reduce their symptoms. Our device utilizes three biosensors housed in a glove to continuously monitor physiological signals associated with the SNS (i.e. temperature, heart rate, and galvanic skin resistance) and indicate heightened sympathetic activity through real-time feedback to a mobile application via Bluetooth. The intent is for use in virtual therapy, where the therapist can use the real-time and stored historical data to learn about the patient’s condition, the patient and therapist can recognize trends, and ultimately the patient can learn to control their sympathetic response.

TEAM MEMBERS

Raunel Albiter
Brycen Hakes
Li Junxiao
Jacob Schultz

FACULTY ADVISOR

Dr. Gerald Thomas

Templ.D.

Templ.D will prioritize the health and welfare of company personnel and university students. Using infrared and contact technology, individuals can monitor their overall surface health. Wearable data provided by the sensors will be available for additional monitoring through the LCD/LED components and through a simple Android application.

Templ.D will adhere to all social distancing policies that are put into effect due to COVID-19 or similar pandemic situations. Close proximity measurements will no longer be necessary as Templ.D will have an IR device embedded for similar temperature accuracy at a safer distance. Both parties (user and health official) can acquire the temperature data and guidance needed through this device without ever needing to come within a six-foot distance.

In addition to safety, improper use of equipment will no longer be a factor for increased wait time as taking temperatures on Templ.D are done instantaneously and periodically.

TEAM MEMBERS

Morgan Balog
 Joshua Kobza
 Brittany Steinman
 Andrea Turlick

FACULTY ADVISOR

Dr. Icaro dos Santos
 Richard Dykowski

SPONSOR

Innovent Center

**TEAM MEMBERS**

Travis Graves
 Leslie Kasten
 Victor Nellessen
 Noah Seiler
 Caleb Willert

FACULTY ADVISOR

Dr. Richard Kelnhofer

TEAM MEMBERS

Cole Albright
 Jacob Boynewicz
 Nick Leclerc
 Shahbaz Mogal

Upper Limb Prosthetic for Motorcyclists

Our project was to design a prosthetic that would allow someone with an upper limb impairment to operate and maneuver a motorcycle. This allows the user to utilize an attachment that will enable them to mechanically pull the clutch when shifting gears as well as let them “hold onto” the motorcycle with their impairment. This will allow people with an upper body impairment to ride a manual motorcycle without having to attempt dangerous maneuvers or make significant modifications. The system must work in such a way that the user will be able to pull the clutch on the handlebars without affecting steering. The user must also be able to release themselves quickly from the device in an emergency. The device must also fit onto most common motorcycles to be as universal as possible.

Versiti Autonomous Sample Sorter

Versiti operates blood centers throughout southeastern Wisconsin and the upper Midwest. The Versiti Autonomous Sample Sorter provides an effective solution to a time consuming and inefficient task of sorting and recording the incoming vials of donated blood for disease testing.

Currently, vials containing blood samples are sorted into groups of four, depending on the information scanned on the barcodes attached to the vials. This information is logged and relayed to Versiti’s database of information. Defective vials are automatically detected, set aside, and the technician is alerted of this by a visual indicator. All the current containers and racks that Versiti currently uses are compatible with the Autonomous Sample Sorter. The system is user-friendly and takes less than an hour for new personnel to be trained.

This Autonomous Sample Sorter solution improves the process that Versiti currently uses and will save lab staff technicians time, so their efforts can be directed towards other important projects.

Watermen Adventurer

The goal of Watermen Adventurer is to make it easier for watermen to plan trips both far and close to home. By providing predicted weather data, we can allow watermen to plan their adventures in advance without much worry. We aim to make it easier for surfers, fishermen, divers and sailors to view predicted seasonal weather patterns for the

FACULTY ADVISOR

Angela Wiedenhoeft



wind, waves and temperature. This is accomplished by using historical aggregations and predictions through a deep learning model. The application displays historical averages of wind, waves, temperature and fish catches over a map. In addition, the prediction model predicts the waves two weeks in the future and displays the wave heights on a map. In the future, we hope our app can correctly and consistently predict weather patterns to allow for a smooth transition from laptop to adventure.

TEAM MEMBERS

Nick Brnot

Jesse Gibb

Nick Marz

Garrett Mulkerin

Connor Splingaire

FACULTY ADVISOR

Dr. Steven Holland

SPONSORS

Milwaukee Tool

**Wireless Run Detection for Dust Extractors**

The Milwaukee Electric Tool Corporation currently produces a family of dust extractors utilized to capture airborne debris generated by masonry and cement drilling operations. The “Wireless Run Detection for Dust Extractors” project aims to utilize the M12™ HAMMERVAC™ UDE as a test platform to introduce a method of wirelessly sensing the operation of an attached SDS Rotary Hammer, resulting in a signal used to activate the dust extractor device. The Wireless Run Detection Module—the core of the design project—serves as the interface, capturing the stray magnetic flux emitted from the powerful SDS Rotary Hammer motor and processing the characteristics of the induced voltage waveform. The result is a logic signal which communicates the run state of the rotary hammer to the UDE controller, allowing fully automatic operation of the dust extractor in tandem with the operation of the attached tool.