

UNIVERSITY of HOUSTON | ENGINEERING

Department of Electrical & Computer Engineering

Annual Capstone Design Conference

April 27, 2018

The Hilton UH Hotel & Conference Center
Houston, Texas

7:30 - 7:55 am	Registration, Waldorf Astoria, Ballroom, Lobby
8:15 - 8:20 am	Opening Remarks by Dr. Steven Pei, Flamingo Room
8:20 - 10:00 am	Technical Program – Oral Session A, Flamingo Room
10:05 -10:30 am	Welcoming Remarks, Conrad, Ballroom <ul style="list-style-type: none">• Dr. Joe Tedesco, Dean, College of Engineering• Dr. Suresh Khator, Associate Dean, College of Engineering• Dr. Badri Roysam, Chairman, Electrical and Computer Engineering
10:30 - 10:45 am	<i>Coffee Break</i> , Waldorf Astoria, Ballroom, Lobby
10:45 - 11:45 am	Technical Program – Oral Session B, Flamingo Room
11:50 - 12:45 pm	Lunch, Conrad, Ballroom
12:30 - 1:15 pm	Keynote Presentation, “Lost in Translation: A Tragedy of our Times”, <i>Dr. Mauro Ferrari</i> , President & CEO, Houston Methodist Research Institute; Director, Institute for Academic Medicine; Executive Vice President, Houston Methodist; Senior Associate Dean and Professor of Medicine, Weill Cornell Medical College, New York
1:15 - 2:15 pm	Technical Program – Oral Session C, Flamingo Room
2:15 - 2:30 pm	<i>Coffee Break</i> , Waldorf Astoria, Ballroom, Lobby
2:30 - 3:30 pm	Technical Program – Oral Session D, Flamingo Room
3:30 - 5:30 pm	Technical Program – Poster Session, Waldorf Astoria, Ballroom
4:55 - 5:30 pm	Break for Team Preparation
5:30 - 6:00 pm	Elevator Talks by CDC students, Waldorf Astoria, Ballroom
6:00 - 6:30 pm	Awards Ceremony and Reception, Waldorf Astoria, Ballroom

CDC 2018 Technical Program

April 27, 2018

8:15 – 8:20 am **Opening Remarks by Dr. Steven Pei, Flamingo Room**

Session A: Oral Presentations

Time: 8:20-10:00 am, Flamingo Room

Faculty Chair: Dr. Steven Pei

8:20 – 8:40 am **IEEE ROBOTICS COMPETITION I**
Tiffany Ang, Blake Heslep, Viraj Patel, and Michael Van Patten

8:40 – 9:00 am **IEEE ROBOTICS COMPETITION II**
Bhavik Patel, Mayur Patel, Elliot Rohan, and Jacob Rohan

9:00 – 9:20 am **IGNITION LOCK (iLOCK)**
Enrico Aberin, Kasim Egal, Melvin Rodriguez Zelaya, and Dat Tran

9:20 – 9:40 am **TRANSMISSION LINE DRONE RECONNAISSANCE**
Sarah Anderson, Ethan Clark, Affan Imran, and Aldo Vela

9:40 – 10:00 am **3-PHASE INVERTER**
Jayraj Bavda, Alejandro Gonzalez-Alcaraz, Eduardo Hernandez, Thuan Pham, and Alexander Regal

10:05 – 10:30 am **Welcoming Remarks and Addresses in Classroom 180**

- Dr. Joe Tedesco, Dean, College of Engineering
- Dr. Suresh Khator, Associate Dean, College of Engineering
- Dr. Badri Roysam, Chairman, Electrical and Computer Engineering

10:30 – 10:45 am Coffee Break, Waldorf Astoria, Ballroom, Lobby

Session B: Oral Presentations

Time: 10:45 – 11:45 am, Flamingo Room

Faculty Chair: Dr. Dmitri Litvinov

10:45 – 11:05 am **LARVA SONIC BOAT**
Toluwaleke Ayannusi, Zulkifl Gire, Duy Le, and Ryan Norwood

11:05 – 11:25 am **SMART SHOE I**
Kaushik Mandiga, Hasti Sajedi, Ellen Stinemetz, and Jonathan Tran

- 11:25 – 11:45 am** **SMART SHOE II**
Roberto Duenez, Lillian Lin, Denny Luong, and Pavani Deepthi Tenneti
- 11:50 - 12:45 pm** **Lunch**, Conrad, Ballroom
- 12:30 - 1:15 pm** **Keynote Presentation, “Lost in Translation: A Tragedy of our Times”,**
Dr. Mauro Ferrari, President & CEO, Houston Methodist Research Institute;
Director, Institute for Academic Medicine; Executive Vice President, Houston
Methodist; Senior Associate Dean and Professor of Medicine, Weill Cornell
Medical College, New York

Session C: Oral Presentations

Time: 1:15 – 2:15 pm, Flamingo Room

Faculty Chair: Dr. Len Trombetta

- 1:15 - 1:35 pm** **NASA SWARMATHON**
Richard Johnson, Michael Lam, Akshay Kumar Mysore Sridhara, and Patrick Obanion
- 1:35 – 1:55 pm** **DEEP SPACE MULTI-CUBESAT TELECOMMUNICATION**
Shuaike "Jacob" Chen, Mejean Cline, Rosario Diaz, and Humberto Molero Villamizar
- 1:55 – 2:15 pm** **MARS ROVER**
Alamin Ahmed, Aadil Sakhyani, Sikender Shahid, and Aditi Tyagi
- 2:15 – 2:30 pm** *Coffee Break*, Waldorf Astoria, Ballroom, Lobby

Session D: Oral Presentation

Time: 2:30 – 3:30 pm, Flamingo Room

Faculty Chair: Dr. Len Trombetta

- 2:30 – 2:50 pm** **FASTR (FACE AND SPEECH TRANSCRIBER WITH RECOGNITION)**
Charles Asquith, Jordan Fail, Erich McMillan, and Benjamin Nelson
- 2:50 – 3:10 am** **EEG MONITORING HEADSET FOR POST-CONCUSSION AND TBI RELATED EVENTS PREVENTION**
Fuad Girma Abdella, Isaias Chavez Perez, Elliott Landon, and Bao Nguyen

3:10 – 3:30 pm

**VOLLEYBOAST: LONG-RANGE PERSONNEL AND
EQUIPMENT TRACKER**

*Hisham Khalid A Alshmmasi, Brandon Kirksharian, Denwis La, and
Arth Saurabh Pachchigar*

Session E: POSTER PRESENTATIONS

Time: 3:30 – 5:30 pm

Location: Waldorf Astoria, Ballroom

All posters will match talks presented by the undergraduate students in the oral sessions.

5:30 – 6:00 pm

Elevator Talks by CDC Students, hosted by Dr. Len Trombetta, Waldorf Astoria, Ballroom

6:00 – 6:60 pm

Awards Ceremony and Reception, Waldorf Astoria, Ballroom

IEEE REGION 5 ROBOTICS COMPETITION

Viraj Patel¹, Michael Van Patten¹, Tiffany Ang¹, Blake Heslep¹

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Project Summary

We will be building and programming a robot that is capable of scoring highly in this year's IEEE Robotics Competition gameplay. The strategy that we will be using is a small quick robot that will deliver tokens one at a time. We will implement a line following algorithm to navigate the game board autonomously during rounds. This project is important because it will have lasting effects on the University of Houston in the form of higher prestige for placing among the top three winners. We as a team possess the skill set needed for this project.

Problem and Need

In order to reach our goal, we must build and program a robot that will be capable of running through the IEEE Robotics course. We must also write the code in the most efficient way to keep our robot competitive. Increasing our school's reputation is something we all believe is important.

Significance

Some universities will take note of high placements in this competition, will be impressed and hopefully can boost the University of Houston's rankings on a national scale. Additionally, future UH robotics teams can benefit from our archived code as well as hardware configuration.

Goal

Our goal is to represent University of Houston at the 2018 IEEE region 5 robotics competition and give prestige to the University by placing in the top 3.

Customer/User Analysis

There is no direct customer for our project; however future University of Houston students that enter robotics competitions could use our code and possibly hardware. These users would need to have extensive coding experience and understand how to use the hardware.

Deliverables

Our final deliverable is an autonomous robot which is capable of navigating the game board using an array of infrared sensors to detect lines and intersections. The robot is also capable of picking up the colored steel tokens at each intersection using an electromagnet and correctly identifying the color painted on the bottom of the acquired token using an RGB sensor. The robot is able to pick up and drop off all tokens into their corresponding colored squares on the board and then navigate back to one of the white squares and stop moving.

Terminal Objective

The target objective of our team was to enter the IEEE Region 5 Robotics Competition on April 7, 2018 and score the maximum number of points in each of the three rounds of competition as well as in the possible tiebreaker round.

Overview Diagram

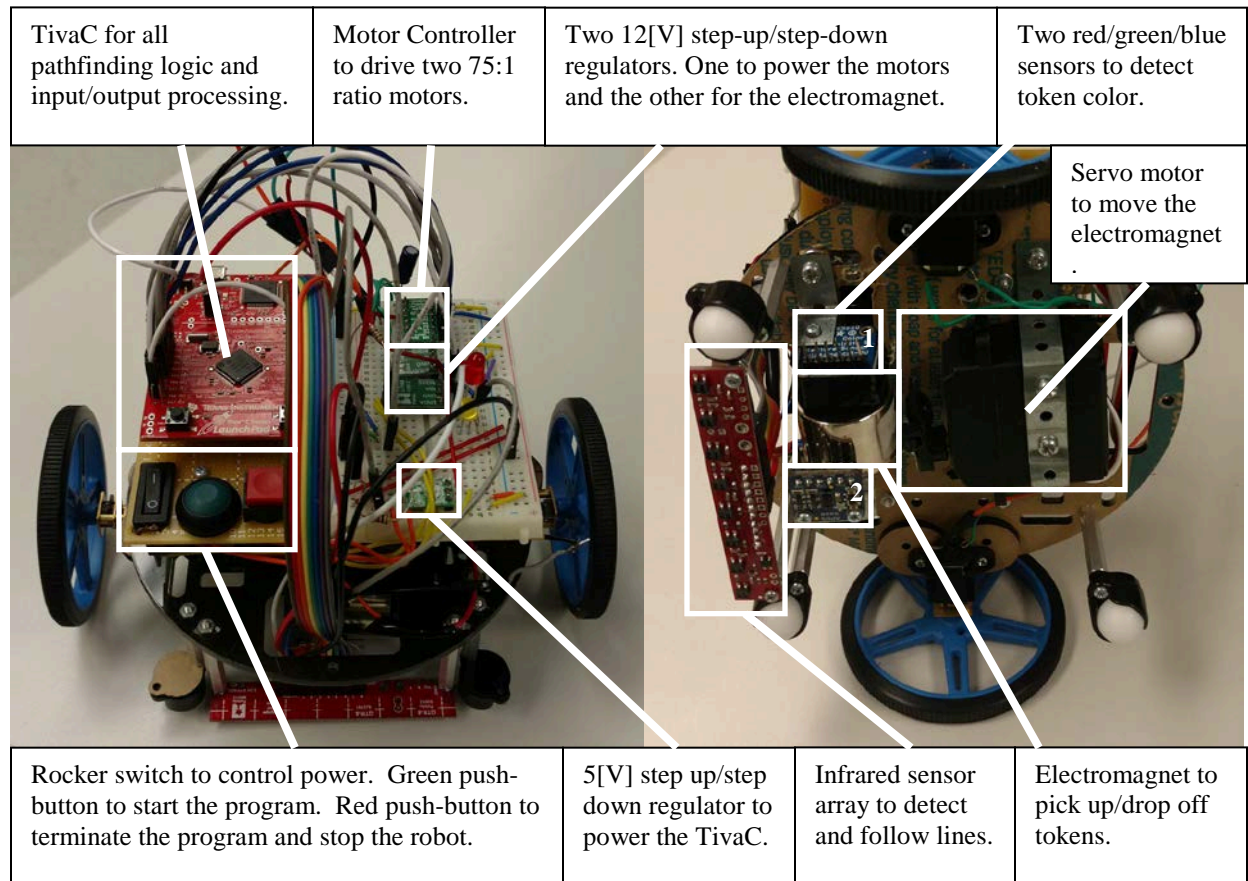


Fig. 1. Overview diagram detailing the components used in the construction of our competition robot.

2018 IEEE R5 ROBOTICS COMPETITION

Jacob Rohan¹, Elliot Rohan¹, Bhavik Patel¹ and Mayur Patel¹

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Project Summary

By competing in the IEEE R5 robotics competition, our team was granted the opportunity to represent the University of Houston as a top tier school. The competition required our team to design a robot to face challenges in navigation, mobility, and dexterity with a high level of success. Our team's 3d-printed robot featured a storage carousel and computer vision algorithms to face the challenges at hand.

Beyond achieving 6th place (out of 35 teams), our robot became the center of attention at the competition, being the only robot to compete using computer vision. Additionally, our successful carousel design commanded the attention of the spectators and established a renowned for the aptitude of students from the Cullen College of Engineering.

Problem and Need

As outlined in 2018 R5 IEEE Robotics Competition rules, our robot was required to start in one of the white squares located on the top and bottom edge of the board. The robot must then navigate the 8' x 8' playing field and pick up coins which are embedded in the floor. The underside of each token was colored, corresponding to one of the colored squares on the outer edge of the board. Points were awarded during 3 rounds based on the robot's ability to correctly pick up and deliver tokens.

Significance

This team is significant for public relations. Unlike other projects which promote a relationship with industry, this project will promote the University of Houston to the public and to future students as a school worthy of prestige and reputation.

Goal

The goal of the competition is to challenge students to design and create a unique robotic system to solve a unique problem. To succeed, students were required to have a firm understanding of embedded systems, computer programming, electronics and mechanical systems.

Customer/User Analysis

Initially, the only users for this project are the four team members involved. They will be the sole uses of the robot until after the competition. After the competition, the robot will belong to the UH ECE department as a resource for students in future competitions and classes. Likewise, future students addressing similar challenges will have access to our technology and methods.

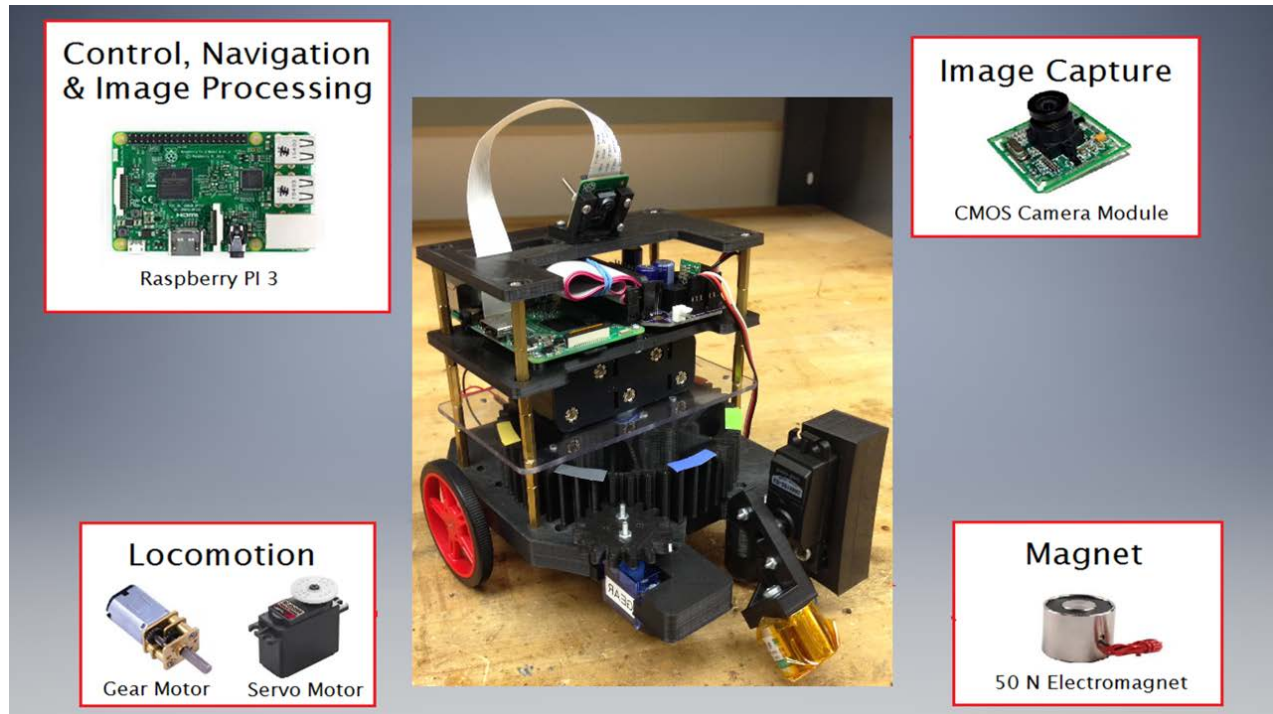
Deliverables

Final deliverables are dedicated to integrating hardware and software modules. The final deliverable was a robot free from malfunction and as a robust system to quickly and accurately complete the competition objectives. Deliverables include and overview of the computer vision methods used for robotic mapping.

Terminal Objective

The robot is fully integrated to collect, sort and deliver game tokens effectively. Our Hardware objectives included: the ability to pick up, sort and drop off the tokens, ensure power requirements are met along with locomotion. The software objectives included: the ability to interpret camera images to make meaningful conclusions, the operating system includes drivers to control hardware and lastly the program which is optimized to score as many points as possible. The integration objective included a demonstration of both hardware and software objectives working seamlessly together. These objectives included: the ability to run multiple program tasks at once, a fault-tolerant emergency stop, the dexterity is fluid and the robot can navigate the course accurately.

Overview Diagram



IGNITION LOCK (iLock)

Enrico Aberin¹, Kasim Egal¹, Melvin Rodriguez¹ and Dat Tran¹
¹Department of Electrical and Computer Engineering
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Project Summary

Our project is a thermal camera-based ignition interlock which aims to reduce the likelihood of driving crashes related to drunk driving by preventing a car from starting if the driver is intoxicated. It is based on a study that certain areas of the face show difference in temperature after alcohol consumption. However, our team is unable to further observe its effects. Liability issues limits the use of alcohol in experiments especially in school projects. Therefore, our team's focus shifted to finding other potential applications for thermal imaging. For instance, observing thermal changes induced by other means such as physical exercise and using the results as a trigger for an ignition interlock. At the end of the semester, our team aims to deliver a thermal camera-based ignition interlock which prevents a car from starting if signs of physical activity are detected from the driver's face.

Problem and Need

In 2016, 10,497 people died in alcohol impaired driving accidents; 17 percent of which were children between the age of 0-14[1]. Drunk driving accidents also impose drastic consequences to the surviving driver as they live with the knowledge that their action caused someone's injury or death. Even worse, they might have to face jail time. To resolve this recurring problem, the team proposes a need for a new design of ignition interlock devices which incorporates thermal imaging to identify drunk drivers. If the driver is confirmed to be intoxicated, the iLock prevents the car from starting.

Significance

The project is significant on a global scale as drunk driving continues to claim innocent lives not only in the United States, but all over the world. Intoxicated drivers are dangerous to pedestrians, other drivers and themselves. Certainly, anyone who share roads with drivers that consume alcohol should be concerned.

Goal

To form the basis for a thermal camera-based ignition interlock that prevents a car from starting if the driver is intoxicated and consequently reduce the probability of driving crashes due to drunk driving.

Customer/User Analysis

The target user for iLock is any individual who is eligible to drive a motor vehicle. The project aims to help users decide on their behalf when they are under the influence of alcohol. In addition, the system is designed in a way to promote ease of use. No expertise is required to operate the device. When installed, the iLock is autonomous and has no user interface.

Deliverables

The final deliverable is a thermal camera-based ignition interlock which prevents a car from starting if signs of physical activity are detected from the driver's face.

Terminal Objective

The target objective is to integrate the ignition interlock which consists of the relay, Raspberry Pi single-board computer, optoisolator, and thermal camera to the car system (see Fig. 1). The end goal for this project is to completely realize a thermal camera-based ignition interlock which tracks thermal changes on a person's face induced by other means such as physical exercise and send control signals to a relay which enables or disables a car system based on the reading. Finally, the ignition interlock must send an alert message to an emergency contact after lockdown.

Overview Diagram

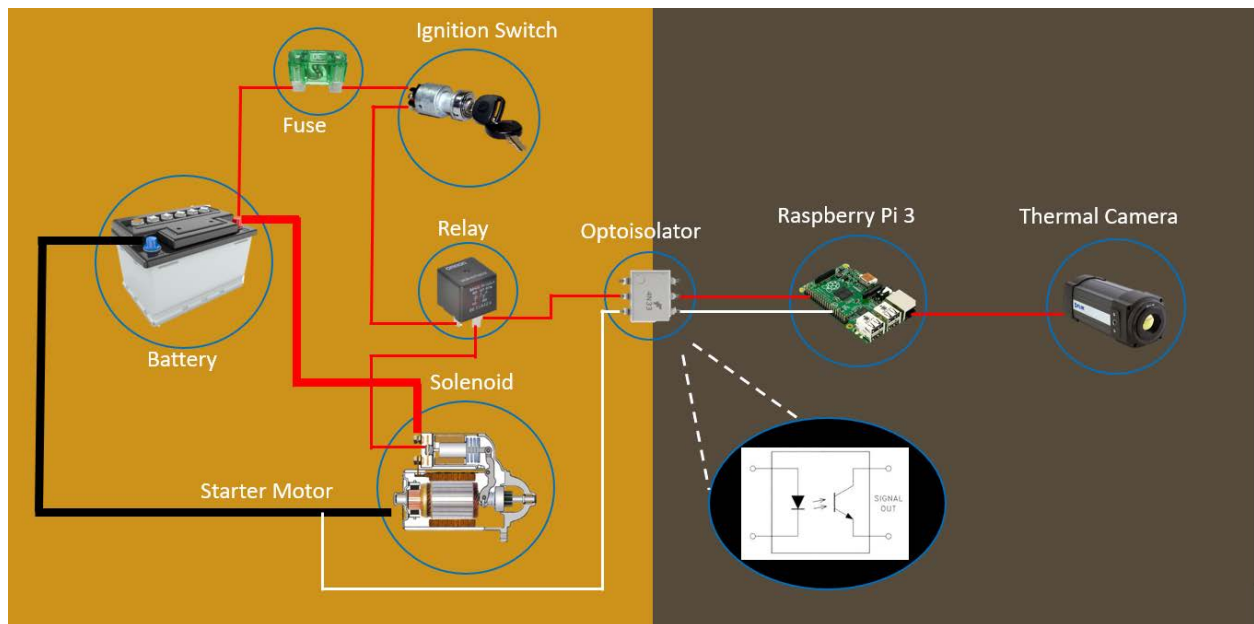


Fig. 1. Overview diagram for the iLock with car system components shown on the left and ignition interlock components shown on the right. Detection starts from the thermal camera and decision handled by the Raspberry Pi 3. If signs of physical activity are detected from the driver's face, the Raspberry Pi 3 sends a signal to an optoisolator circuit and then to a relay which disables the connection between battery and motor. The optoisolator ensures total isolation between high power (left of optoisolator) and low power (right of optoisolator) components.

References

- [1] "Traffic Safety Facts 2016 Data – Alcohol-Impaired Driving." *NHTSA*
<https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812450>

TRANSMISSION LINE DRONE: INITIAL INSPECTION SOLUTION FOR UTILITY LINES

Aldo Vela¹, Affan Imran¹, Ethan Clark¹, Sarah Anderson¹

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Project Summary

Team 14 is building an image processing software that, when used to process the data collected by a drone fitted with an infrared camera, will do the extensive initial inspection of power lines and output the location of lines that warrant further inspection by linemen.

The program will evaluate the heat signature of the line in the collected images as well as attempting to identify obstructions in the path of the line--outputting the images and location of images that have been flagged for inspection.

The current state of the project has a functioning web app that outputs a Google Drive folder containing the images that warranted human evaluation and a Google Sheet with filename, longitude, and latitude fields. Further work is necessary to properly identify obstructions.

Problem and Need

The Transmission Line Drone (TLD) solution that we have proposed addresses the Bureau of Labor Statistics finding that *electrical power-line installers and repairers* are employed in the ninth most dangerous occupation in the United States¹. While performing manual inspections on power lines, workers ride a platform extended from the helicopter and use insulation tools to reach the line, arcing to the same potential as the line. This work is costly, both for companies' bottom lines and in human life. The automation of the initial inspections will institute savings for all involved.

Excessive heat emission by power lines is an indication of the corrosion of the coating of the line. This is often a predictor that lines will soon fail to deliver the demanded power. A drone equipped with a thermal camera can take footage that can be used to identify problem areas

Additionally, buildings, trucks, trees, and other obstructions and can result in the disruption of functionality of the line or even more dangerous effects. We will determine encroachments by identifying obscure colorations within a specific radius of the line.

Significance

Our project is of great interest to powerline companies and the linemen that work for them. Because of the significant costs in maintaining the transmission lines and paying the men to risk their lives in inspection/repair, the companies would be able to save money, yet make the process much more efficient and accurate. Minimizing the amount of time that the linemen need to be flown up to the lines also makes their job safer, allowing them to inspect the lines from the ground and only needing to fly up for the actual repair of the line.

Goal

The goal of this endeavor is to improve efficiency and safety in the inspection of transmission lines and reduce the costs associated with maintenance through automated drone flights and analysis software.

Customer/User Analysis

The primary customer base for the TLD project will be transmission line repair/maintenance companies and their technically-skilled employees. Linemen, engineers, and analysts will use this solution to identify the best use of the time of the analog maintenance teams.

Deliverables

Team 14's primary deliverable will be a web application that can receive images collected from a drone flight, process them for analysis, and output the thermal result and the specific GPS location of images that have been flagged for further inspection. Secondly, we have prepared a demonstration of machine learning, a complex but useful concept that could be favorably integrated into the TLD solution in a future iteration of the project.

Terminal Objective

The terminal objective of our project is to deliver a web application using Python that is capable of processing flight images and data to analyze thermal variation, and obstructions in path of the line. Additionally, we will present the conclusions reached after a year of exploring the use of machine learning as a potential addition to this solution.

Overview Diagram

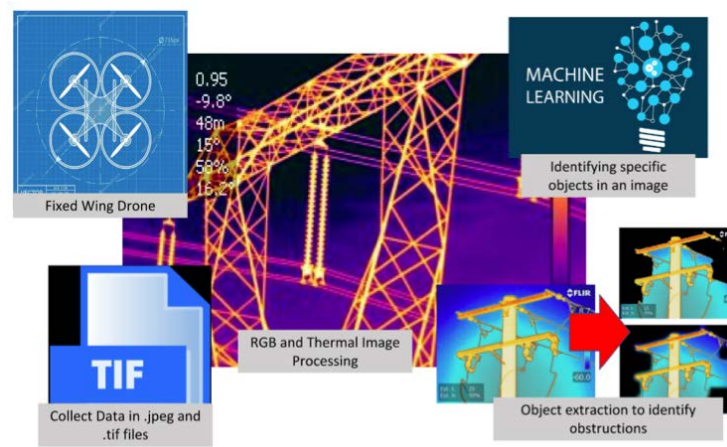


Fig. 1. TLD Overview Diagram representing the primary elements of the automated transmission line inspection solution we have proposed.

References

[1] Fatal Occupational Injuries in 2015 [PowerPoint Presentation]. Available: <https://www.bls.gov/iif/oshwc/foi/cfch0014.pdf>

3 PHASE INVERTER AND FILTER FOR HIGH TEMPERATURE APPLICATION

Alexander Regal¹, Alejandro Gonzalez¹, Jayraj Bavda¹, Eduardo Hernandez¹, and Thuan Pham¹

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Project Summary

This project consisted of designing and improving the efficiency of 3-phase inverter and filter at extreme high temperatures. The temperature range was up to 25-150⁰ C. A simulation was generated for the inverter using PSIM software. A DC input of 24[V] was used as a source and a 3-phase motor was used as a load. The design plan consisted of using a DC source followed by a filter, which was needed to filter out harmonics. The filter was tested on a hot-plate with temperature ranging from 25-150°C. The filter was then connected to a microcontroller which controlled the inverter switches. A 3-phase motor was used as a load.

Problem and Need

An inverter is a device which is used to convert DC (direct current) to AC (alternating current). Inverters are used in field engineering and many petrochemical projects as well. Sometimes these inverters can be exposed to extreme high temperature conditions such as oil drilling or electric cars. This causes the inverter to lose efficiency or stop functioning as the parts degrade with increase in temperature. The focus of this project was to investigate the effects of high temperature on the equipment. The increasing temperature created unwanted harmonics which hindered the performance of the inverter. Due to unwanted harmonics the cutoff frequency of the filter changed because the capacitors and inductors lose their characteristics as temperature increases. The frequency values changed exponentially as temperature changes.

Significance

Extreme temperature power electronics have become possible with the recent availability of silicon carbide MOSFET. This material, compared with other wide-bandgap semiconductors, can operate at temperatures above 500 °C, while silicon is limited to 150–200 °C. Lots of work is still needed to design and build a stable power system that is able to operate in harsh environmental conditions (high temperature and deep thermal cycling). In addition to drilling, motors in electric vehicle may need to operate at temperatures close to 150 degrees Celsius. With the advent of electric cars, stable power electronic systems that can function at high temperatures are a necessity. For our project, we believe that it will benefit any applications of power electronics at high temperature

Goal

Simulations were done using PSIM, a engineering design software, to generate models of the functionality of the embedded inverter and the filter that was designed. During the simulation process we experienced some issues simulating the thermal module for the capacitor and inductor along with choosing the correct values for them. The filter was designed with the purpose of mitigating the harmonics coming from the load when exposed to high temperatures. Proper filter materials and components were chosen to withstand the high temperatures we dealt with. Next the microcontroller was programmed and calibrated with the three-phase motor using code composer and control suite to run at ten-thousand kilohertz. In the second phase, the Spring semester of 2018, we tested the filter after connecting it to the microcontroller on a hot plate to test whether the harmonics where mitigated at high temperatures.

Customer/User Analysis

Our project was intended to be used in the power electronic field, such as oil drilling operations for petrochemical companies and electric automobiles. The voltage quantities used in the research were reduced to ensure safe work practices. To test the circuit components at varying temperatures, a hot plate was used to heat up the circuit to mimic the effect of ambient temperatures in oil drilling operations. Some experience requirements include basic knowledge of DSP and AC motor calibration as well as power electronics and signal processing.

Deliverables

The deliverable was to model and simulate a 3-phase inverter that can function between 25–200 °C. The materials for the filter were selected that can handle high temperature. The testing of the inverter circuit was done on a hot plate from 25–200 °C.

Terminal Objective

Target objectives included: the design and simulation of a 3-phase DC-AC inverter in PSIM which enabled variations of speed and temperature; the research of materials and specifications for the design of a suitable 2nd order low-pass filter for the 3-phase inverter; understanding the different voltage/current/temperature sensing options for the system; and identifying the best way to connect all sub-modules together for the system with a thermal plate.

Overview Diagram



Fig. 1. Circuit Diagram of Filter and 3-Phase Inverter

References (if applicable)

- [1] N. Mohan, T. Undeland, W. Robbins, "Power Electronics: Converters, Applications, and Design," Wiley, 3rd Edition, pp. 200--245, October 10th, 2002.
- [2] D. Hart, "Power Electronics," McGraw-Hill, 1st Edition, pp. 331--382, 2011.
- [3] M. Rashid, "Power Electronics: Devices, Circuits, and Applications," Pearson, 4th Edition, pp. 306--464, 2014.

ACOUSTIC LARVICIDE WITH AN AUTONOMOUS LARVASONIC BOAT

Toluwaleke Ayannusi¹, Zulkifl Gire¹, Duy Le¹, and Ryan C. Norwood¹

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Project Summary

The purpose of this study is to create an autonomous boat that can navigate bodies of water and exterminate mosquito larvae using acoustic larvicide. New Mountain Innovations™ developed a Larvasonic© transducer that kills mosquito larvae by generating sound waves ranging between 18 - 30 kHz, the resonant frequency range for mosquito larvae, that rupture their dorsal tracheal trunks. This results in either instant death, or deformations after hatching. The Larvasonic device is mounted beneath a boat, equipped with two one-directional motors, to create a user-friendly method of controlling the boat and exterminating larvae.

The boat is able to localize itself within the boundaries of a generated map, avoid obstacles, and follow a path using sensors such as Lidar and GPS. The sensor data is processed using ROS (Robotics Operating Software), passed into a ground control software to define a set of GPS waypoints for the boat to follow, and sent to a Pixhawk 2 flight controller to steer the boat. The boat can also be operated via remote control and switched into autonomous mode once the user has approached the intended path.

Problem and Need

Although the Larvasonic© device eliminates mosquitoes, it requires someone to operate it. New Mountain Innovations™ is working together with Dr. Aaron Becker, the team sponsor, to create an autonomous boat for the Larvasonic© by developing an algorithm to detect boundaries and avoid obstacles. This provides an easy and efficient way to control the mosquito population.

Significance

This project intends to provide an alternative, user-friendly solution for mosquito control. Governments, private entities, and any consumers who are constantly trying to reduce the mosquito population would be able to use the Larvasonic© boat. In this particular case, the Harris County Mosquito Control Department would be able to use this device locally as an alternative to pesticides.

Goal

To create a user-friendly boat that can autonomously navigate a body of water, by using sensors to map its surroundings and localize itself within that map, and exterminate mosquito larvae using the Larvasonic© transducer.

Customer/User Analysis

The Larvasonic© boat can be maintained and operated by anybody who has basic knowledge using a remotely operated vehicle. The user would ideally need background in pesticide control to know where to operate the boat and maximize the effectiveness of acoustic larvicide.

Deliverables

The Larvasonic© Device, powered by its own proprietary battery, emits auditory frequencies between 18-30 [kHz] to eliminate mosquito larvae. The boat's main interpreter between every other device is the Pixhawk 2. It is powered by a separate 12 [V] LiPo battery, and controls the boat by utilizing the built-in gyroscope and various sensors. The Pixhawk 2 then communicates with two ESCs, which regulate the voltages and currents of each motor. The Pixhawk 2 uses a GPS to obtain its current location and set its target location. A Scansse Lidar sensor is also used to detect boundaries and obstacles within 40 meters of the boat. The boat is also equipped with a remote control in case of malfunctions in the autonomous mode. This remote control communicates with the Pixhawk 2 through an X4R telemetry device. Finally, relay switches will be connected to each battery to enable remote powering on/off of the system.

Terminal Objective

To develop a boat that can autonomously follow a user-defined path, detect boundaries, and avoid obstacles by using a Lidar sensor and GPS system.

Overview Diagram

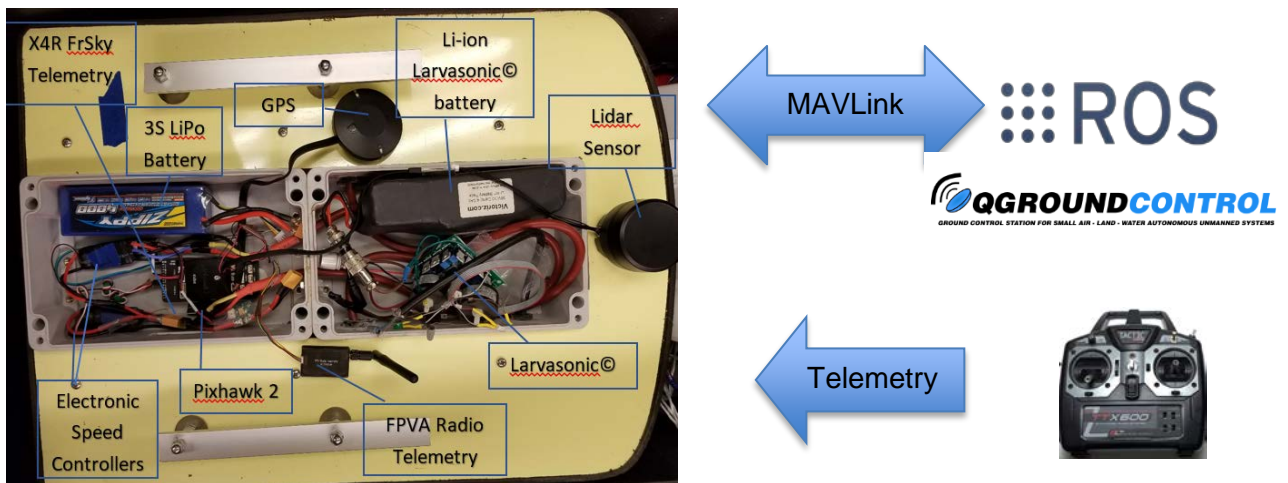


Figure 1. The boat and its components (left) can communicate sensor data to ROS via MAVLink, process the data with a ground control software, and communicate with the Pixhawk 2 to steer the boat. The boat can also be remote controlled via telemetry.

References

- [1] "Larvasonic Products." New Mountain Innovations, www.newmountain.com/acoustic-larvacide/.
- [2] "ROS." ROS · PX4 Developer Guide, dev.px4.io/en/ros/.

PHYSIOSHOE

E. Stinemetz¹, H. Sajedi¹, K. Mandiga¹, J. Tran¹
¹Department of Electrical and Computer Engineering
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Project Summary

For our senior design project, we are creating a shoe that performs gait analysis at the feet of a patient and provides critical data for physical therapists. We apply our knowledge in electrical engineering to help geriatric patients in physical therapy. We have contacted Physical Therapists and electronics professionals that we believe can better assist us moving in the right direction. With this project we expect to develop a cheaper solution to gait analysis that can be used in the health care community.

The PhysioShoe will be a cost effective, portable, and easy to use gait analysis system that offers real-time data capturing. This tool will be mainly used by physical therapists to help their patients get rehabilitated. We will be analyzing the basic parameters of the foot used in gait analysis such as pressure contour, step length, and foot angle. Our team is a group of experienced individuals who are highly motivated to create PhysioShoe to help the people of our community.

Problem and Need

The problem that we are trying to address is that currently gait analysis is costly and is proprietary, so access to such technologies are very limited. Many physical therapists cannot afford such high tech equipment, so there is a need to have an inexpensive alternative that would be more widely available. We want to bring costs low and modern technology to the current practice of physical therapists. Currently, many physical therapists are using old methods or old technologies to perform gait analysis and we would provide a more efficient way to complete the process or at least provide extra context to help them tailor their therapy sessions.

Significance

Healthcare professionals, mainly physical therapists using outdated practices or that don't have access to current gait analysis equipment would benefit directly from our project. Most practices today use decade old technology or simply don't require such large and complex systems. So, we want to provide the option of using inexpensive yet simple to use modern technology.

Goal

Gait analysis is for measuring body mechanics used in clinical evaluation of movement disorders. Today there are some clinics that service the middle to low-income population, but these clinics are not able to take advantage of modern options for their analysis. In other clinics, gait analysis is very expensive and the setup is complicated. These clinics have various methods of gait analysis, including placing electrodes on the body and cameras in the lab that monitor patients closely. Additionally, devices on the current market are proprietary. Our project offers more affordable gait analysis and real-time data for better examination. This product is intended to perform basic analysis that shows a pressure contour of the foot and calculates parameters including step length, stride length, cadence, speed, and foot angle.

Customer/User Analysis

Our intended customers are physical therapists and they will be using this project as an aide for their examinations. Typically work in hospital or clinical settings where a room is required for examinations. There are many types of gait data that may make the scope of our project overwhelming so we narrowed it down to the most necessary and feasible tasks to complete. They will attach a insole-like pressure sensor into a shoe that will be worn by the patient. A separate device will be strapped around the patient's

ankle that will gather data. Data will transmit wirelessly to a smartphone where it will be viewed and analyzed.

Deliverables

Our final deliverable is a small box containing the essential electronic components. The box will strap around a patient's ankle and will face toward the opposite leg that it's placed on. In the overview diagram below we lay it all out. Inside is a microcontroller, battery, Bluetooth, and gyroscope. Our insole is a pressure sensor with pressure points laid out in a grid and will be placed inside a shoe.

Terminal Objective

Our approach was to get a working prototype as fast as possible and then improve the system from there. Therefore, for the fall semester, we obtained our first prototype. This shoe prototype displayed a pressure contour and the foot angle based on measurements from the sensors and sent data to a computer via Bluetooth. We refine the prototype by adding a distance sensor and finish designing the power circuit with accompany with a chargeable battery. We then focused on integrating the final code and developing a phone application.

Overview Diagram



Fig 1. The black box houses all the internal electronic components used to gather and process data. The pressure sensor insole is composed of a fabric material and lined with conductive wiring to create variable resistive points at each intersection.

PROJECT STRIDE – SELF-SUSTAINING POSITION TRACKING FOOTWEAR

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Project Summary

Project Stride aims to provide a means for caretakers to have peace of mind while offering users freedom in the form of a location reporting shoe that is completely sustained on the excess kinetic energy a human generates by walking. Our smart shoe is an innovative solution to an ongoing problem of people going missing and the costs involved in finding them. A person suffering from memory loss or a child gone missing can induce stress on to loved ones who are working their hardest to find these individuals.

Our device functions by using the voltage generating properties of piezoceramics and converting this energy to usable energy to the low powered electronic components placed inside our shoe. The microcontroller would record and transmit GPS locations with the user's mobile phone through an android application and Bluetooth. This device will obtain the GPS values and allows users to view the route on Google maps using an android application. The shoe contains every module needed for location tracking, data transmission, and energy generation and storage.

Problem and Need

The current problem that exists in part of society are missing persons, from children to elders. Missing persons cause distress for multiple parties, the person lost as well as the party searching for said person. Each year billions of dollars are used in search of lost individuals such as Alzheimer patients and children. At least 450,000 annual accounts of missing children have been reported [1] and over 2.5 million total cases of Alzheimer patients being lost have been reported [2] as well. The solution that needs to exist is a device that can function without special upkeep, with the ability to track the position of the wearer and report their location to a caretaker.

Significance

Project Stride strives to create an intuitive low power system that users of all age ranges can use. By utilizing the kinetic energy leftover from walking, we can assure that the energy needed to power the microcontroller never runs out, with the only limit to connectivity the battery life of their caretaker's phone. Those with elderly or young dependents can rest assure that the unobtrusive system wouldn't be left behind like a phone or accessory as using our product is as reflexive to use as putting on your shoes.

Goal

Project Stride strives to aid caretakers of individuals who suffer memory issues or are easily lost. Project Stride is a self-sufficient low maintenance device, able to transmit user locations to the caretaker. This is achievable by placing energy harvesting materials within the insole of the shoe, a shoe was chosen as there is vast amounts of kinetic energy to harvest as well as the point that many users are assumed to wear shoes when walking in public.

Customer/User Analysis

Two user profiles exist when using the product, the immediate user that wears the shoes and the caretaker that receives all necessary information transmitted by the wearer. Each shoe contains a microcontroller that is attached to wireless transmission device (Bluetooth/FM Transmitter) that will send information from the connect GPS module to an Android device, that will then decipher that information to show where the user. For the setup, the wearer will only need to wear their shoes that will automatically connect to their phone and alert the second user profile, the caretaker with all necessary information.

Deliverables

Project Stride aims to deliver a shoe that can convert kinetic energy to electrical energy by using the voltage generating properties of the piezoceramics. This shoe will be self-sufficient and will house low powered electronic modules that can track user's locations and relay this information to loved ones. Our project can be broken down into two main components, the hardware of the self-sustaining shoe and the software location tracking system.

The hardware component of this project's overall goal is being able to power a microcontroller through moderate user activity. This power must be able to sustain itself within 1 hour of sustained walking and must be rated at a minimum of 380 milliwatts to power all modules in the design. The hardware components will fit within a 2-centimeter-thick sole that is of comfortable wear. This is an additional specification as our shoe should be comfortable for the user.

The software side of the project must prove that it is able to send notifications of the user's location to the caretaker. This notification can either be in the form of an SMS or in-app notification but must notify the caretaker of the user's coordinates from a 10-meter distance away for the proof of concept. The GPS will obtain location readings every 60 seconds and store them in the microcontroller. It will send out the location via Bluetooth when the caretaker requests the location.

Terminal Objective

The primary goal for this project is to construct a shoe with the ability to generate and harvest electrical energy by converting kinetic energy from the movement of walking. This energy harvested will be used to power a microcontroller that can relay the location of the user to an android application of either a caretaker or a loved one.

Overview Diagram

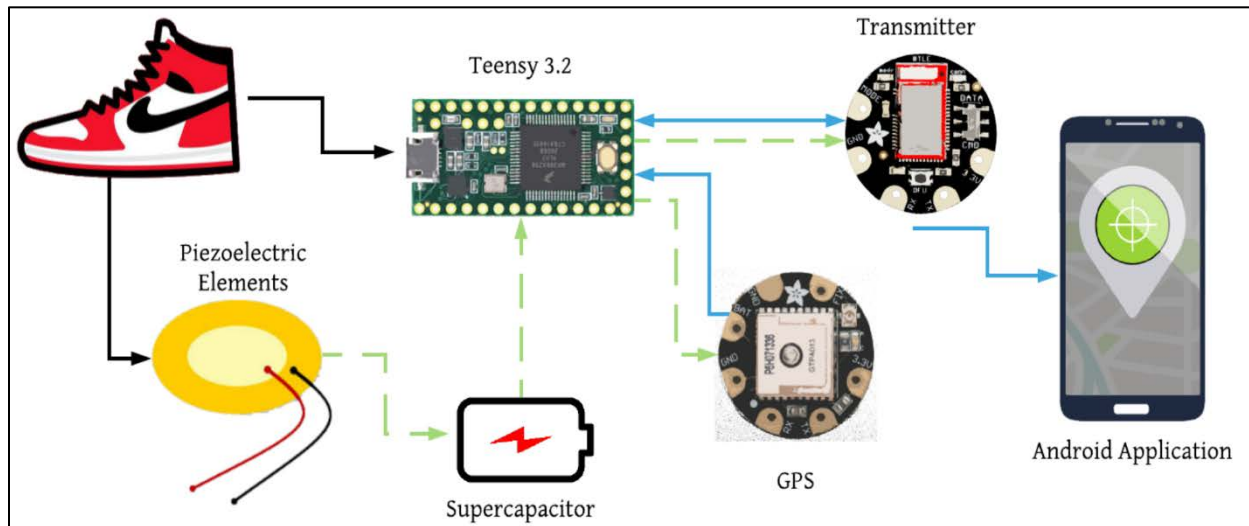


Fig. 1. The overview diagram for this project featuring the low powered system with all the modules and the communication functionalities. The arrows with a solid line indicate the flow of information and the dashed line indicate the flow of energy.

References

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- [2] "Latest Alzheimer's Facts and Figures." Latest Facts & Figures Report | Alzheimer's Association, 29 Mar. 2016, www.alz.org/facts/.

AUTONOMOUS ROBOT DISCOVERY AND RETRIEVAL OF RESOURCE FOR NASA SWARMATHON 2018

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Project Summary

In the NASA Swarmathon competition, a group of robots, called Swarmies, searches for and collects April tagged cubes in a set space. The project started with NASA's base code to program the Swarmies and identified many methods that would allow them to gain an informational advantage. This project implemented the sharing of information so that data collected from other Swarmies can be utilized. The pickup rate of the April tag cubes was also improved by modifying the base code from the problems encountered by adding a pause clock cycle. Finally, a breadth-first search algorithm is used in order to advance through the arena so that any empty area would not be visited again.

Problem and Need

In the future exploration of Mars, the Moon, and other extraplanetary surfaces, the discovery and allocation of resources is crucial. One viable solution is using a swarm of robots to gather resources such as ice, minerals, and other materials. To make this solution a reality, algorithms must be developed for robots working as a swarm.

Significance

This project is significant for entities such as NASA that are looking for viable resource allocation schemes. This work is also useful for any companies that needs to search an area, such as for disaster relief, because the main component of this project is developing an algorithm that can efficiently search an area.

Goal

The goal of this project is to deliver an algorithm that will allow the swarm robots to use the full range of motion possible, utilizing their grippers to grab, carry and drop resources into the collection zone. The swarm robots will be able to use the search algorithm to detect the resources and collect them, with a goal to collect 90% of the resources that is laid within an area. Customer/User Analysis.

The end user for this project needs a minor background in programming, knowledge of ROS/C++/Python is a plus. The underlying algorithm for the search and pickup processes is completed, however the Swarmies need to be calibrated for each new environment. The types of people that can effectively use the Swarmies is anyone with a technical background, ranging from engineers to IT technicians.

Deliverables

In the Swarmathon competition, no hardware was modified, and all work was done on the software side. As such, this project's final deliverable is the search and pickup algorithm that was developed.

The algorithm is a search pattern that utilizes a swarm of identical robots to operate autonomously to search/map an area and recover specified resources in it. The objects that they recover can be modified, with additional programming, to fit a large range of situations.

Terminal Objective

By the end of this project, the object is to develop a comprehensive view of the Robotic Operating System (ROS) and a better understanding of the integration of the behavior of the Swarmies with the functionality associated with each module.

Overview Diagram

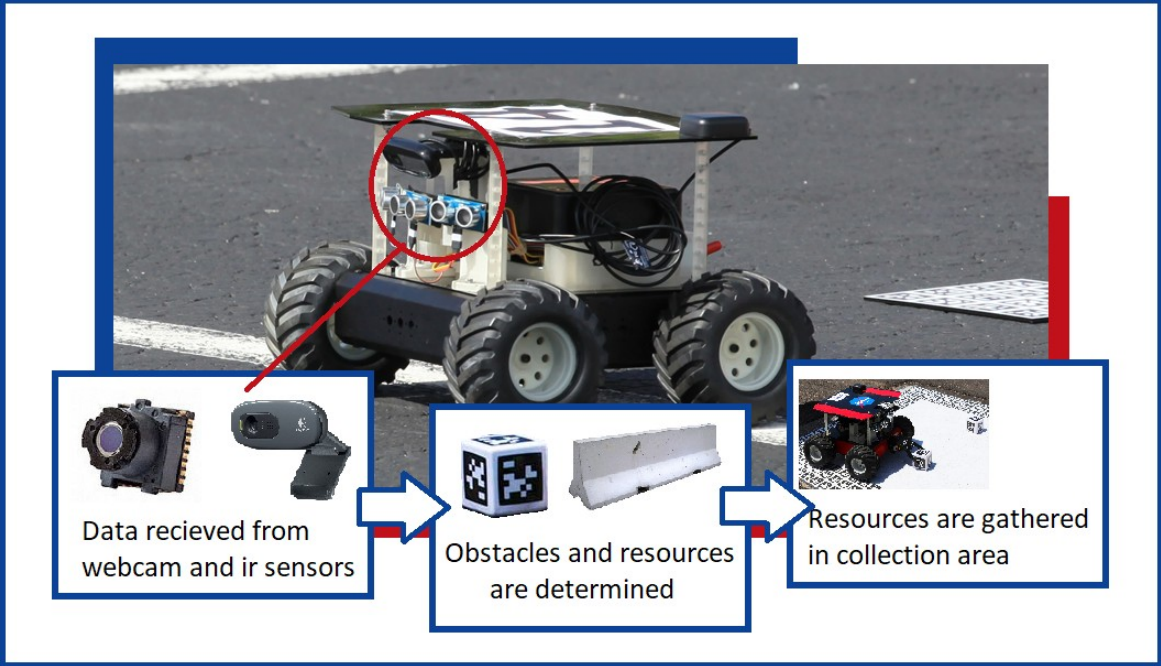


Fig. 1. Swarmie robot uses external signals such as camera and sonar to detect the environment. Internal signals such as GPS and odometer will use data to correlate what action to take whether it be search, pick up resources, etc.

DEEP SPACE MULTI-CUBESAT TELECOMMUNICATION

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Project Summary

With NASA's focus on Mars exploration, there have been concerns about the use of Cube Satellite, or CubeSat, technology. CubeSats are an inexpensive, lightweight, and powerful technology; however, they have never been used in deep space telecommunication and have a limited lifespan. Both, are problems hindering NASA's mission to further explore Mars using the CubeSat technology.

Our team is determined to improve the performance of the CubeSat's current systems by implementing a redundancy system that allows the satellite to power back on without external efforts as well as creating an inexpensive & self-sustaining telecommunication system to communicate from Mars (deep space) to Earth Mission Control. For the purposes of this project, a self-sustaining system will be defined as a system capable of identifying its power needs and running protocols to attain a minimum three-year lifespan. This telecommunication system will be modeled using three CubeSat systems: Alpha-Master, Beta-Master, and Beta, as well as one additional telecommunication system to function as mission control.

Due to constraints, our product will be a small-scale prototype meant to provide a foundation for future CubeSat applications. The prototype will provide system power and telecommunication standards and applications that can be translated to a full-scale product.

Problem and Need

Problem:

A sustainable CubeSat system to establish and maintain telecommunications from Mars to Earth does not currently exist.

Need:

An inexpensive and self-sustaining telecommunication system to communicate from Mars to Earth Mission Control during a Mars orbiting mission.

Significance

The self-sustaining CubeSat system will serve as a powerful and cheap alternative for Mars exploration and deep-space communication, and therefore has a direct relevance to NASA as well as to all other space agencies interested in deep space telecommunication network systems.

Goal

Design and establish a telecommunication system to communicate between CubeSats with redundancy protocols while attaining a three-year power lifespan.

Customer/User Analysis

Our CubeSat system is intended to be used and monitored by a team of engineers from either NASA or one of the contracted industry partners. These engineers will need to have expertise in satellite operations, control systems, deep space telecommunication, redundancy protocol, and power systems.

Deliverables

A CubeSat telecommunication and power system prototype comprising of four CubeSats: Alpha-Master, Beta-Master, Beta, and Earth Mission Control. This system will be self-sustaining, adhering to the three-year life span requirement, as well as have redundancy protocols to extend longevity of the system as a whole.

Terminal Objective

Design and establish a telecommunication system to communicate between CubeSats with redundancy protocols while attaining a three-year power lifespan.

Overview Diagram

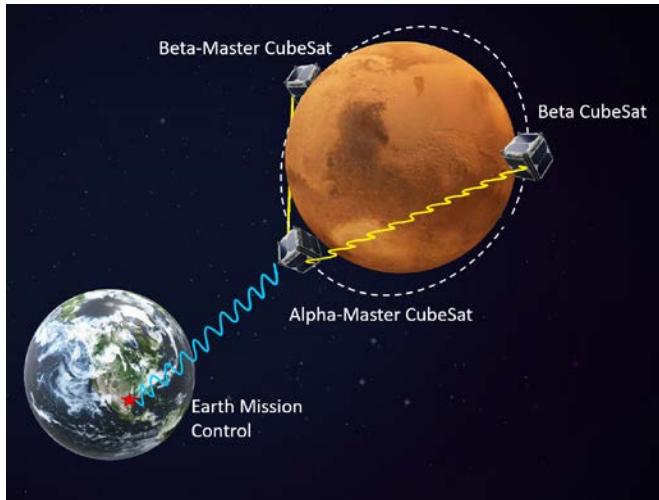


Figure 1 An overview of the telecommunication system concept in which the Betas communicate with the Alpha-Master, which then in turn relays the information to Earth Mission Control.

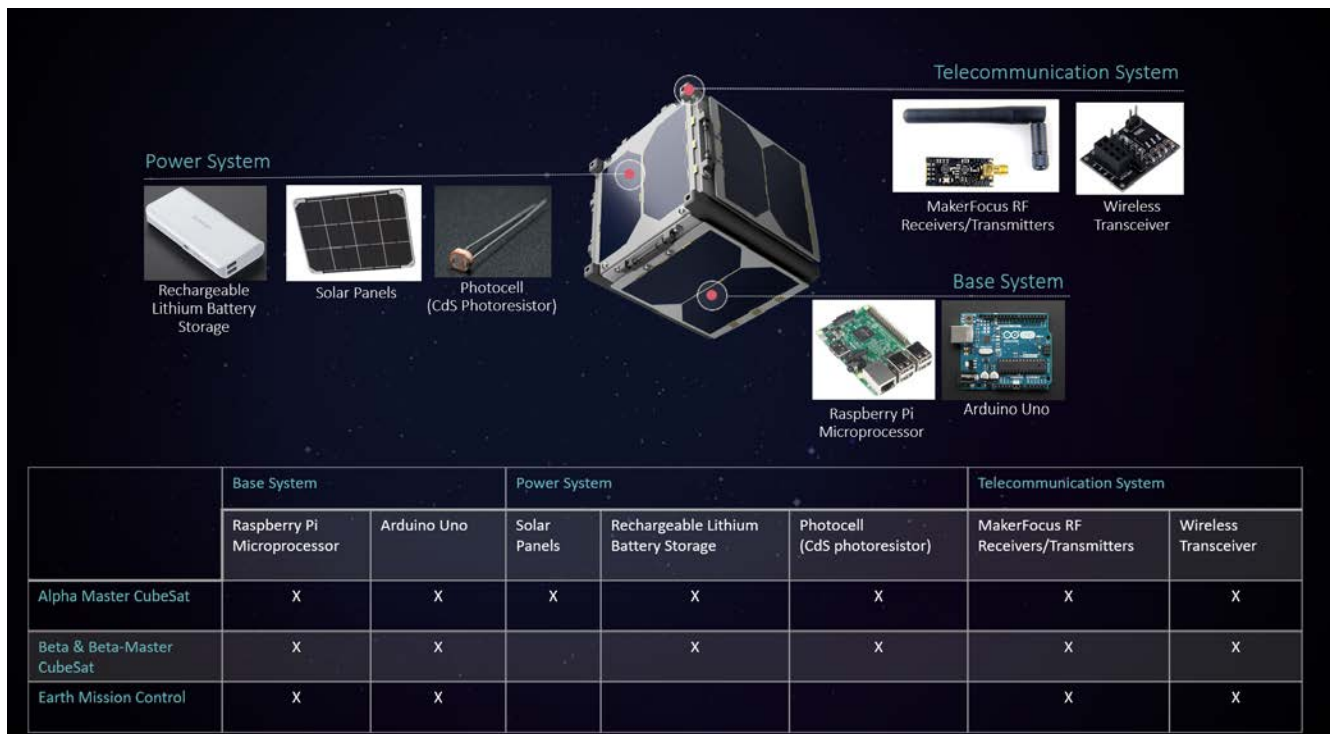


Figure 2 The overview diagram of the components making up the CubeSat system.

MARS ROTARY ROVER

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Project Summary

The objective and purpose of this project is directed towards increasing the success and longevity of the Mars Rover on future NASA Missions to Mars. The intent of this objective is to build a Rover with greater mechanical functionality and adaptability to the challenges of operating in the Mars environment. The primary areas of development focus are with respect to LiDAR sensor data acquisition, modular chassis reorientation, and independent motor control.

The LiDAR-based Obstacle Detection System implements a modified LiDAR sensor to conduct 3-D mapping and coverage in the airless environment of Mars. The function of this sub-system is to retrieve and interpolate sensor values in order to successfully maneuver the rover within its immediate surroundings and to circumvent obstacles on its path. This sensor has been physically modified to acquire data in the 3-D plane. We have accomplished data acquisition through a Raspberry Pi 3 in conjunction with appropriate LiDAR Sensor ROS packages.

This realized model employs a reorientation mechanism by utilizing motors at the axles to better maneuver over elevated obstacles, and benefits from a greater degree of articulation over irregular surfaces. These auxiliary motors are attached at three terminating points on the chassis to appropriately reconfigure the Mars Rover in a rollover situation. The Rover can currently communicate through a phone application by employing a Bluetooth module to remotely accomplish forward or reverse motion.

Problem and Need

The current Rover designs are slow, not adaptive to the environment, and cannot reorient themselves. In order to rectify this, hardware and software mechanisms are needed that will allow for faster near bound obstacle detection to improve maneuverability and self-reorientation

Significance

NASA is currently implementing a four-phase plan to Mars, with the goal of landing humans on Mars by 2030. The work that we are doing, as a team, is significant and relevant to the Rovers and Landers which are a major component of this new mission. This next generation of Rovers will be responsible for more than just acting as a mobile science laboratory; they will also serve as scouts and conduct mapping functions on Mars in preparation for the incoming astronauts.

Goal

The overarching goal of this project is to build a robust Mars Rover that is capable of tackling the rough terrain of the Mars environment and can reliably circumnavigate obstacles in its path.

Customer/User Analysis

The intended end user(s) for the Mars Rotary Rover would encompass members of the Mars 2020 Rover Team as part of the planned launch of the Mars Exploration Program.

Deliverables

The final deliverable for this project is an operable Mars Rover that is capable of functioning autonomously and able to reconfigure itself from a rollover situation through the use of independent ancillary motors fixed to three points on the chassis.

Terminal Objective

The Rover should be able to traverse a path around simulated obstacles such as crevasses and outcroppings without user intervention, and appropriately reconfigure itself from a rollover situation.

Overview Diagram

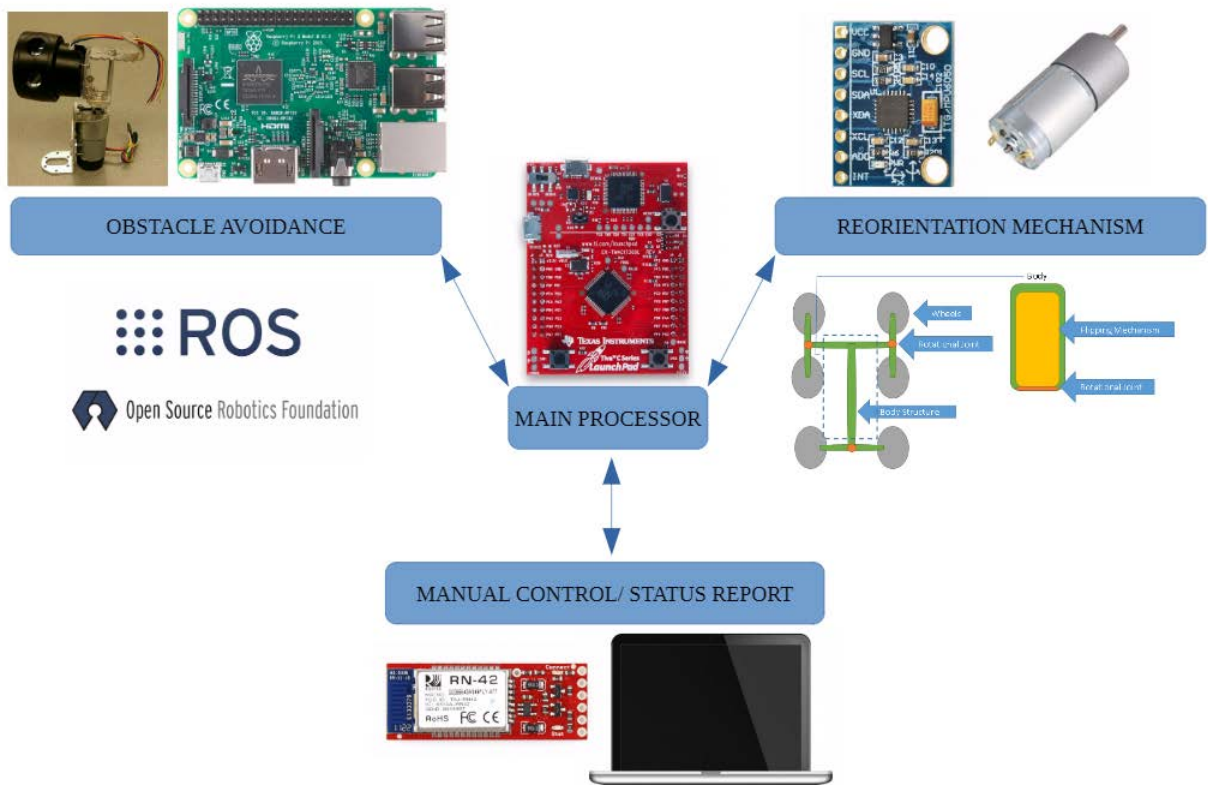


Fig. 1. Overview diagram for the final Mars Rover prototype including the various sub-systems

FACE AND SPEECH TRANSCRIBER WITH RECOGNITION (FASTR)

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Project Summary

FASTR is a personal mobile device that performs real-time face and speech recognition to identify and store important information about persons of interest that the user of the device interacts with. FASTR takes pictures and parses speech to create profiles on people that it manages to identify. If the device recognizes somebody who already has a profile, it will output the profile's information to the user instead of creating a new one.

Problem and Need

The world is growing more interconnected, more populated, and people are living ever longer. Those three trends both together and individually ensure that there are more people to remember and more to remember about them. Remembering names and other details is difficult, especially in an environment where one must interact with and remember the names and needs of many people or if there is memory disease at play.

The customer satisfaction in many business situations can be improved if the business person is able to directly refer to someone by name. However, in many businesses, the staff may have only met the client once—when they checked in. If the staff can recall the name of the client, the client will feel more appreciated and likely to reuse or recommend the business. This is true for other service industries, restaurants especially. Additionally, the quality of life for those suffering from memory diseases or the natural degradation of memory would also be improved by being able to function in a more self-sufficient manner.

Our project aims to assist business persons and scientists in networking and forming connections with people during conferences or other workplace interactions as well as improve the quality of life for those suffering with memory disease.

Significance

Remembering someone's name can have an immediate and positive effect going into a conversation; on the same note, forgetting a name when the other party expected you to know it can set talks off to an awkward start. Furthermore, remembering other details such as their occupation can give clues as to the person's purpose, allowing for easier and smoother interaction. By improving the consistency of the recollection of important information, FASTR will have a direct impact on improving results in these situations.

Goal

The desired results of the semester project are to create a personal wearable device that, combined with a software suite, is able to collect and provide data over individuals of interest to provide users aid and relief with the task of recollection of those individuals of interest's names and information.

Customer/User Analysis

We believe that our primary user base will be those people in the business and hospitality industry. Each of these fields requires a lot of interpersonal interactions, which could be aided by the usage of FASTR. Our device will aim to eliminate the instances in which the user forgets the name of a client or patron

whom they've previously encountered; this will allow them to better serve their customers and provide a truly personal experience.

Another important area that we feel our project is relevant to is for those with memory issues or related disabilities. FASTR could serve as a tool for them to help cope with an inconsistent or failing memory. The goal would be that by prompting names and other key points of information, FASTR could serve as a memory jog that would allow them to recall other related information and function with more independence.

The technical expertise needed to use FASTR is low. All the user needs to be able to do is get the appropriate applications installed on a PC and connect the wearable device via Bluetooth. The users don't even need to be able to install the applications themselves, they just need access to someone with the basic computer skills to do it for them. After that they just need to be able to run the program.

Deliverables

The final deliverable for FASTR consists of two major components which form an integrated system: a wearable device, and a computer application. The wearable device is an embedded system with a camera, microphone, headphones, and wireless communication with which it transmits and receives images and audio. The application, running on a computer, receives images and audio from the wearable via wireless. It then performs facial recognition and natural language processing to identify people after which it provides feedback to the device/user.

Terminal Objective

Our terminal objective is to create a device that will offload the burden of remembering people from the user of the device.

Overview Diagram

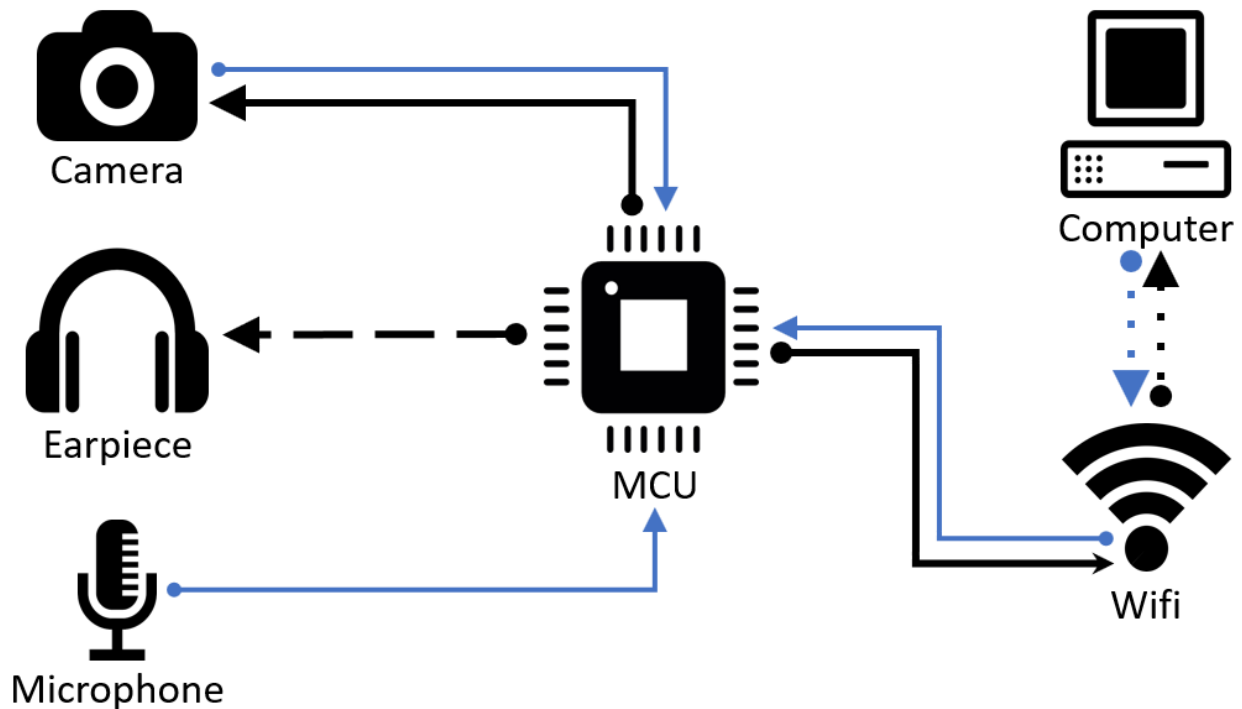


Fig. 1. This hardware diagram outlines the peripheral connections and data flow of FASTR. The blue lines indicate inbound data (from the MCU's perspective) and the black signify outbound data.

PIECE OF MIND – A REMOTE EEG MONITORING SYSTEM

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Project Summary

The prevalent role that electroencephalography (EEG) plays in characterizing, diagnosing, and studying neurological disorders is consistent by the medical and academic communities alike, owing to its accurate real-time monitoring of brain activity and relative low-cost. Other industries have leveraged the Internet of Things (IOT) technology to meet growing demands by which a lateral distribution of smart devices/sensors are enabled to report more data to an end-user than previously possible. This project employs a combination of these two ideas to obtain a telemetric medicine model in which a custom-built “smart headset” detects the wearer’s EEG signal and wirelessly uploads the data to central repository. This system’s Arduino-powered gateway enables the use of remote EEG monitoring. The simple design of the headset does not require the need of a trained technician or neurologist to apply gel electrodes, and the wireless technology allows data to be transmitted if the gateway is connected to an internet network.

Problem and Need

Over 12% of total global deaths are attributed to neurological disorders and are projected to increase over the next 10 years [1]. Current challenges surround brain injuries like concussions, carrying symptoms that are very subtle and can be misdiagnosed with today’s subjective question test [2]. Moreover, neurological disorders and injuries can require a time-intensive monitoring schedule needed to gather sufficient data. In neurological healthcare and academics, electroencephalography has been used to address financial concerns of cerebral monitoring as it is among the lower-cost neurological tests that monitors the electrical activity of the brain. Specifically, its measured voltage differences have been noted to be an accurate diagnosis or classification tool for some neurological disorders, like epilepsy; and, it may soon be an important role for detection the early stages of others. The need to leverage the power of IOT to continuously monitor EEG data from a low-cost EEG headset is pervasive in the solution’s ability to deliver more sets of data at a lower cost.

Significance

It should be noted that this project does not attempt to diagnose any neurological disorders or injuries. However, the low-cost, telemetric monitoring system detailed in this project can be used as a proof-of-concept by the medical and academic communities alike. It can be furthered to study the system’s efficacy for diagnosing specific neurological disorders. Else, the platform can be combined with other state of the art tools or software (e.g. machine learning) to develop new diagnosis protocols.

Goal

The overall goal of the project was to leverage IOT technology in combination with a custom built, low-cost “smart headset” to enable a wireless telemetric EEG system capable of continuously monitoring a patient’s signals from the comfort of his or her own home.

Customer/User Analysis

The end user primarily envisioned was determined to be a neurologist using the platform as a cost-effective solution to collect large amounts of reliable data remotely. The headset was designed using ergonomically fitting casings, elastic headband material, and non-intrusive electrodes to optimize comfort while EEG testing is in progress. The wireless capability was implemented so the wearer could, in theory, allow data to be collected from comfort of one’s work or while using the device for a sleep study at home.

Deliverables

The center of our system features an adjustable “smart-headset” capable of detecting a single channel EEG from its electrode and reference node. On either side of the headset is a 3-D casing, each of which hold the band to the adjusted size. One casing contains a printed circuit board (PCB) used to detect the signal, reduce the noise, and converting the amplified output to a digital encoding that is then sent via Bluetooth to the Arduino-controlled Gateway. The gateway is coded with a graphical user interface (GUI), allowing the user to connect to the network of their choice and entering the corresponding password. The gateway also communicates with wearer about battery time remaining and connectivity issues. While no issues arise, the gateway continuously forwards the data to a centralized website. The repository accepts the data transmitted data over Wi-Fi and calls upon embedded MATLAB scripts to display the EEG to the end-user.

Terminal Objective

To achieve the project's goal of remote EEG monitoring, the system needed to be broken down and built to satisfy its subcomponents requisites. A circuit was first tested to satisfy each of the signal detection, noise reduction, and amplification specifications. Bluetooth and Wi-Fi testing were performed to ensure there was no loss of data occurring on either the receiving or sending end for the Arduino module.

Overview Diagram

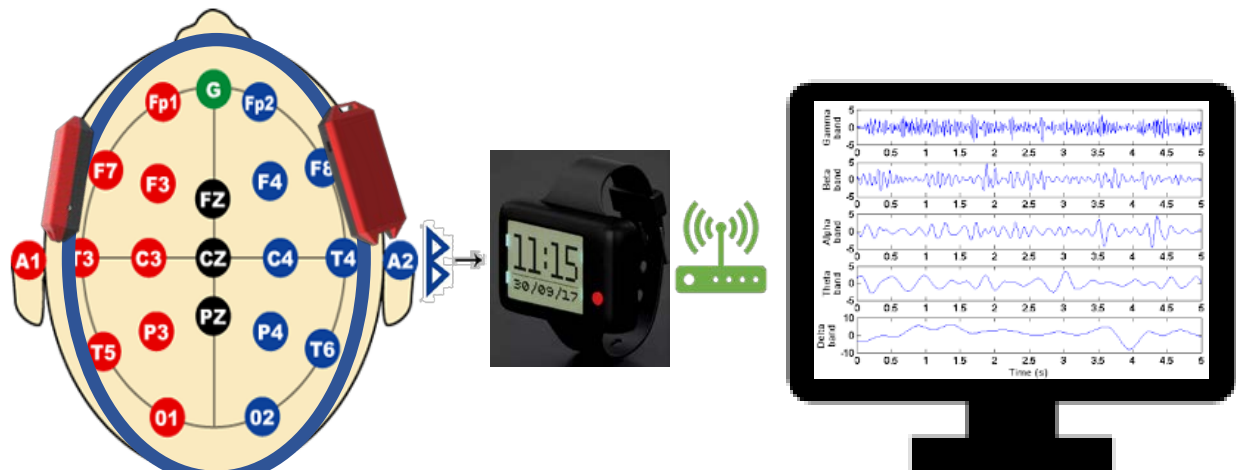


Fig. 1. An adjustable smart headset, outlined in blue, detects a wearer's EEG from an electrode located in range from Fp1 to Fp2 and a reference node located at A2. The PCB, enclosed in the 3-D printed casing on the right side of wearer's head, encodes a clean amplified signal outputted from its circuit via a 10-bit analog-to digital converter. The headset uses its HC-05 Bluetooth 2.0 module, also enclosed in its casing, to send the converted digital data to the Arduino-powered watch, containing the receiving Bluetooth module. The watch forwards the signal over the user-designated wireless network to a centralized data repository site. On the website, an embedded MATLAB is embedded to continuously store the streaming data and allows the end-user to visualize general EEG patterns and waveforms.

References

- [1] World Health Organization. “Neurological Disorders Public Health Challenges,” pp. 33-35, 2015.
- [2] Mez J. et al. “Clinicopathological Evaluation of Chronic Traumatic Encephalopathy in Players of American Football,” *JAMA*, 2017.

THE LONG-RANGE ASSET TRACKER PROJECT

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Project Summary

This project is aimed at large industries that require their asset to be transferred from one area to the next in varying conditions. The device will not require users to have extensive technology knowledge other than understanding how to use a computer. At the end of the year, the device is to be able to periodically read data from its sensors and relay information back to headquarters wirelessly over long ranges with low power consumption and an extended up-time of around 1 month. Throughout the project, we've used technologies such as modern BUS protocols largely used with arrays of sensors with a main processor and touching on how to design a PCB with commonly used software in the industry while being able to meet deadlines.

Problem and Need

The problem that we are trying to solve is that companies that operate in rural, large worksites such as oil fields may find it difficult and expensive to track their equipment, especially when no cellular signal is available. An inexpensive device is needed to help the aforementioned companies track its assets to ensure a safe environment for the workers and minimize accidents or faults in the equipment.

Significance

Oil companies, coal companies, and park rangers are examples of who may want to implement this device to their process in order to enhance the safety of the workers and cut down on labor costs.

Goal

The goal of this project is to lower the cost of tracking assets and enhancing workers' safety for companies that operate in large worksites.

Customer/User Analysis

Our product is focused in industries that require assets to be transferred in large worksites. Industries such as oil and gas will be a large part of the customer base. Users are expected to range from the average person and experienced engineers. Products used out in the field would only require users to know how to turn the device on/off. Other users will be those that are based in the offices being notified of different data logs being sent back and forth from the field and should be able to interpret them.

Deliverables

The final deliverable is for the device to periodically take temperature, accelerations, and GPS readings whilst being able to send alerts that certain thresholds have been exceeded and that action must be taken. Whilst performing all of these readings, the device will be able to keep an up-time of around 1 month on a single battery. Power consumption is at a minimal due to its ability to enter a low current sleep mode, as with its sensors.

Terminal Objective

Our terminal objective is to learn about the industry standards in device communications such as I2C and SPI. Other industry standards that we learn are how to design PCBs with commonly used programs such

as eagle. This project also gives us the opportunity to get an understanding on how to approach project deadlines and objectives.

Overview Diagram

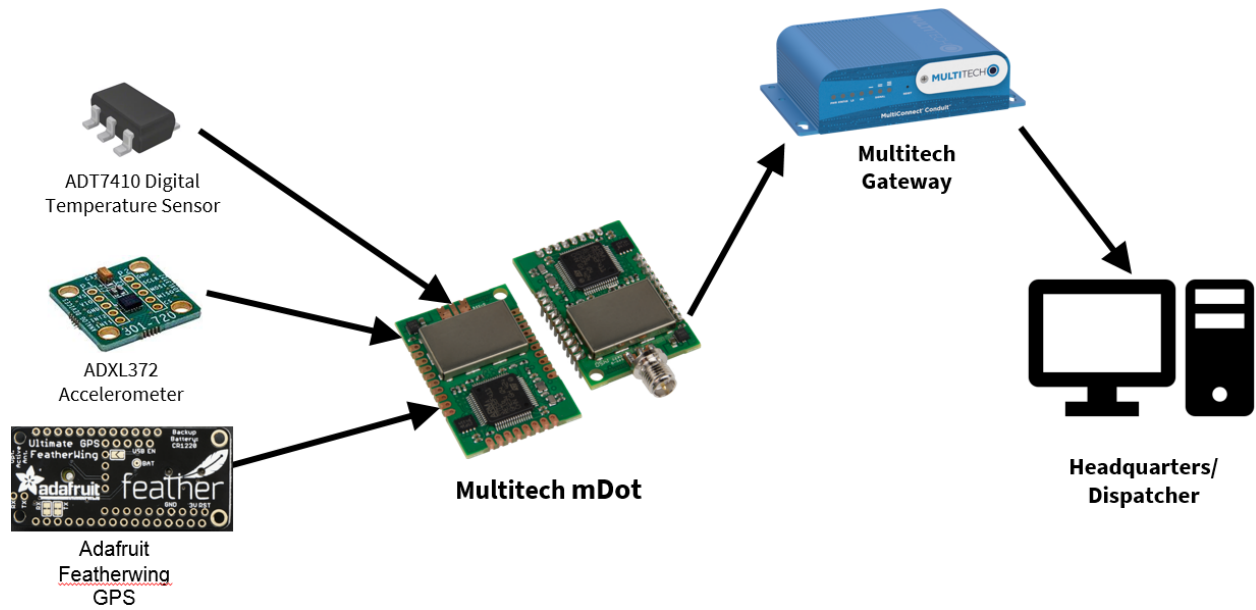


Fig. 1. Overview diagram of the project, showing that the Multitech mDot takes measurements using three digital sensors (GPS, temperature, and acceleration) and send it to a gateway, which connects the headquarters or dispatcher from the company.