

# PARTNERS' DAY

2021-2022

CORPORATE SPONSORED SENIOR PROJECTS PROGRAM  
& SENIOR DESIGN SHOWCASE

UC SANTA CRUZ





# INTRODUCTION

This publication highlights the 11th year of the **Corporate Sponsored Senior Projects Program (CSSPP)** at Baskin Engineering, UC Santa Cruz.

CSSPP ([csspp.soe.ucsc.edu](http://csspp.soe.ucsc.edu)) provides students with a unique opportunity to work on real-world engineering projects during their undergraduate education. Throughout the academic year, students interact with teammates and hold frequent meetings with their sponsors, getting feedback on the solutions they have developed and guidance on the work in progress. By working with mentors at corporate partner companies, students learn important skills, take on interesting challenges, and begin to understand what it means to be a professional engineer.

We appreciate our corporate sponsors for supporting CSSPP, mentoring our students, and providing them with challenging projects to work on. We also appreciate our students, who have worked hard and have enriched our lives through their energy, intellect, and determination. This year has featured significant disruptions, as both students and sponsors have had to continue to interact in a distributed environment. Some students worked remotely while others were able to come to campus creating a hybrid team environment. All of our students had to be tremendously resourceful to find ways to work together productively and advance their projects.

This publication also includes this year's Senior Design Program Projects from student teams in the Computer Science & Engineering and Electrical & Computer Engineering departments who worked on faculty/student initiated projects. As with our CSSPP projects, students working in our senior design program had to be agile and creative in pursuing their projects to completion in the face of limited access to critical resources and to one another.

We appreciate the flexibility and creativity of our corporate partners, our faculty mentors, and our students as they have worked through this challenging time, and acknowledge that with industry evolving in response to employees' growing adoption of remote and hybrid work, the experience our seniors have had this year will likely prepare them well for what is on the horizon professionally.



**Alexander L. Wolf**  
Dean  
Baskin Engineering

UC SANTA CRUZ

 **Baskin  
Engineering**

## ACKNOWLEDGMENTS

We would like to acknowledge and thank the faculty, teaching assistants, and staff who have been so instrumental in the Corporate Sponsored Senior Projects Program:

### SENIOR DESIGN FACULTY

#### CORPORATE SPONSORED SENIOR PROJECTS PROGRAM 2021-22

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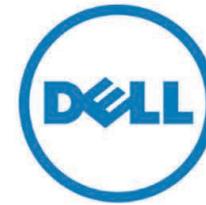
Production Assistant, Baskin Engineering Copy Center

## SPONSORS

Special thanks to our sponsors for your generous support of our Corporate Sponsored Senior Projects Program. Your time, experience, and financial support were beneficial to our students and the success of their Senior Design Projects.

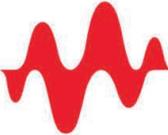
CLOUD BRIGADE 

  
databricks



  
UNIVERSAL AUDIO

  
FOREVER OCEANS

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**UC Santa Cruz Alumni  
Association**

**UC Santa Cruz  
BUSINESS & ADMINISTRATIVE SERVICES**

## Abstract

The team at Cloud Brigade wanted to find a way to clarify how employees spent their time at work. Their solution was to develop an application (Priorly) that would help employees track their time online. Priorly displays how an employee is spending their time in an easily understandable manner. This approach allows users to identify potentially hidden obstacles in their workflow that can drastically reduce productivity.

## Approach

### • Data Collection

We used APIs to gather data from several services including: Google Calendar, Gmail, Zoom, and the user's browser. This data provided us with a basis for understanding a user's online activity. We then consolidated this data into a JSON file using a nesting method.

### • Data Storage

AWS S3 buckets were used to store the JSON data from the collection APIs. After reconciliation, this data was then loaded into the application and AWS DynamoDB.

### • Reconciliation

Our reconciliation engine allows the user to view a table containing their tracked data and categorize it.

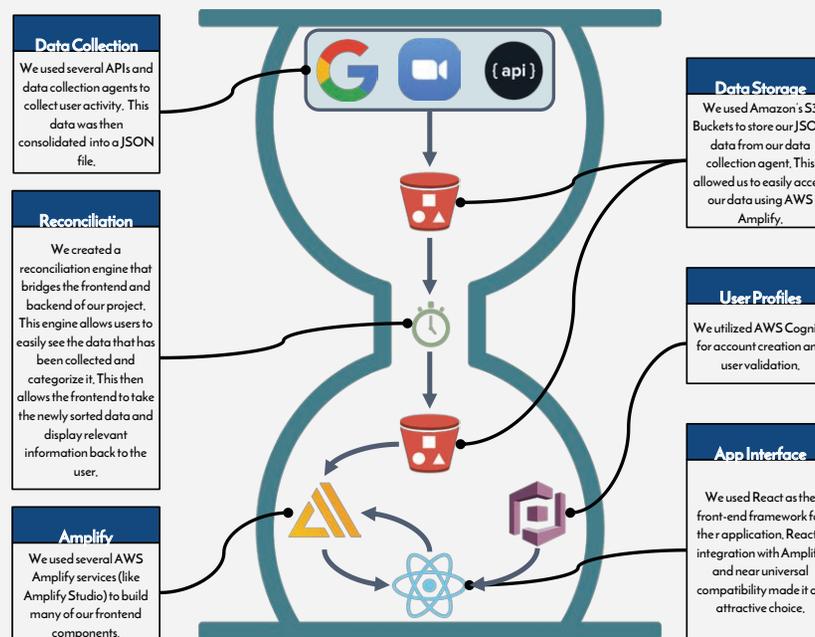
### • Visualization

We used a React charting library along with AWS Amplify Studio to allow the user to easily visualize their time.

## Overview

According to several studies, the average employee is only productive 60% of the time, and the temptation of social media and other internet-based services are mostly to blame. The team at Cloud Brigade asked us to build an application to solve this problem. This application would display how much time was spent on certain tasks in a visual manner. Both managers and employees would be able to see where their time was spent. Priorly enables employees to easily monitor their own activity and for employers to better separate between tasks that are billable and those that are not.

## Architecture



**Data Collection**  
We used several APIs and data collection agents to collect user activity. This data was then consolidated into a JSON file.

**Reconciliation**  
We created a reconciliation engine that bridges the frontend and backend of our project. This engine allows users to easily see the data that has been collected and categorize it. This then allows the frontend to take the newly sorted data and display relevant information back to the user.

**Amplify**  
We used several AWS Amplify services (like Amplify Studio) to build many of our frontend components.

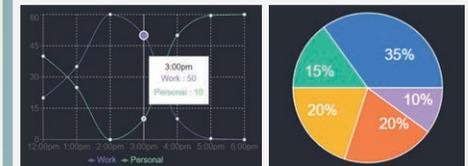
**Data Storage**  
We used Amazon's S3 Buckets to store our JSON data from our data collection agent. This allowed us to easily access our data using AWS Amplify.

**User Profiles**  
We utilized AWS Cognito for account creation and user validation.

**App Interface**  
We used React as the front-end framework for the application. React's integration with Amplify and near universal compatibility made it an attractive choice.

## Features

- User authentication and profile management
- Tracking of participant's digital activities (such as browser usage, Google Calendar, Gmail, and Zoom)
- Categorization of digital activities by user
- Visualization of digital workload analytics with charts and graphs
- Asynchronous data updates every hour



## Results

We found that making our application a reality was more challenging than we had initially anticipated. Throughout the project, our team faced many hurdles. Luckily with the help of our sponsor, Chris Miller, and our TA, Golam Mukhtadir, we were able to persevere through them and complete the project.

In the end, we created an application that retrieves data from several different APIs and allows users to categorize this information. After this, the data will be visually displayed on the dashboard using a variety of graphs. This satisfies our initial goal of creating a productivity application that helps track where employees spend their time.

## Acknowledgments

Cloud Brigade  
Chris Miller

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Richard Jullig, Golam Mukhtadir

# Incident Response Orchestration Framework

Angel Martinez, Connor Stewart, Krishna Pandian,  
Prasana Guthy, Richard Choe



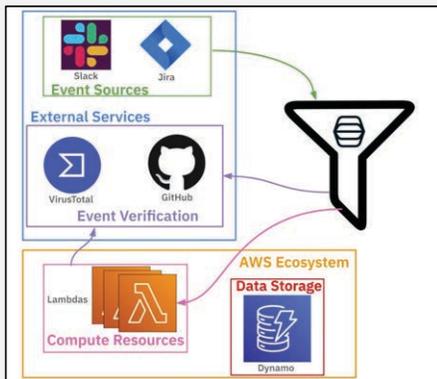
## Abstract

For our project, we created a framework to automate preliminary inspection of incoming security issues in a timely manner. This is extremely relevant to security response teams. The framework's most important features are its extensibility and scalability.

## Approach

Our solution was to create a **Security Orchestration Automation and Response (SOAR)** Framework that focuses on Incident Response (IR). Some benefits of SOAR includes:

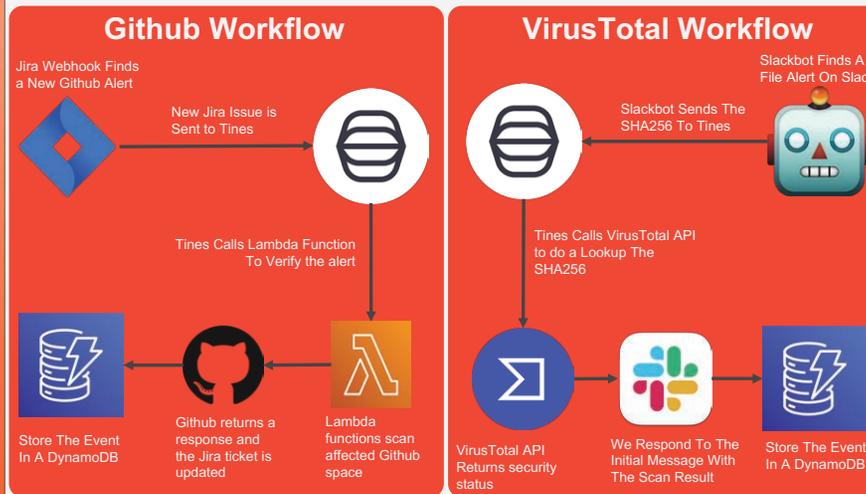
- Standardized response times
- Automatic Event Verification
- Triage and Escalation



## Overview

At Databricks, security is an important challenge. At companies with small security teams, handling the large number of security risks can be overwhelming. As a result, security teams may start missing requests, fail to identify false positives, and make mistakes. The project goal is to create a tool that will reduce the workload on security engineers with automation, while scaling to the large quantity of requests at a company like Databricks.

## Workflow Execution



### Goal

Whenever a new Jira issue is created regarding a leaked DAPI, check inside the repository to verify if a token has been leaked and update the JIRA issue with the result.

### Goal

Whenever receiving a slack alert regarding a completed file scan, verify the malicious nature of a file using the SHA256 and respond to the initial slack message sent.

## Glossary

- Lambda** - AWS product used to host serverless functions
- DynamoDB** - AWS NoSQL database for logging
- Tines** - An automation tool that orchestrates workflows
- SHA256** - Security Hash for a unique file identifier
- DAPI** - Databricks API token

## Results

- Developed infrastructure for code base to be maintained as an open source project
- Created shared software modules between workflows
- Successfully implemented 2 workflows using the framework

## Future Prospects

The framework is designed to be extended to other workflows easily. Some workflows that can be implemented in the future include:

- Forensics on suspicious VMs for bitcoin mining
- Finding AWS resources that have been made public without review

## Acknowledgments

Sponsors: Anthony Felts, Arpita Biswas  
TA: Aidan Smith, Golam Muktadir  
Professor: Richard Jullig

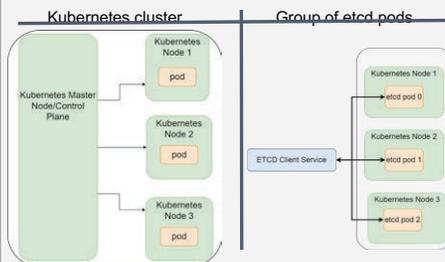


## Abstract

The Resilient Kubernetes project works to enhance the protection of data within Kubernetes - a Linux container management software - for Dell. Kubernetes is a part of Dell's Infrastructure Solution Group which provides remote computer infrastructure resources to various corporations that would like to use a remote IT solution. We enhance this data protection by making etcd - a key-value store used by Kubernetes to hold essential cluster data - more resilient.

## Approach

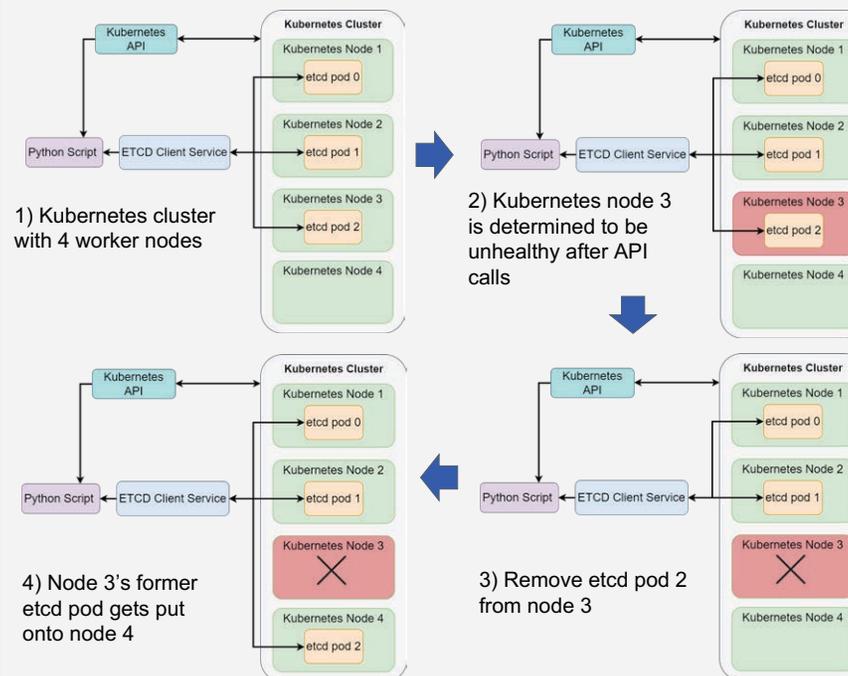
- Kubernetes is a cluster of servers (nodes in Kubernetes) where one server is the master node and acts as the control plane for the cluster, and the rest of the servers are worker nodes that rely on the master for scheduling and resource allocation.
- Etcd works as a group of pods (in Kubernetes we refer to containers as pods) that runs on a Kubernetes cluster. Etcd works on the Raft algorithm and as such has a leader-follower consensus protocol.
- We wrote a protocol that communicates with the etcd and Kubernetes client APIs to get both Raft metrics, and Kubernetes cluster metrics to determine if a particular node is unhealthy, or if a pod is unhealthy or unstable.



## Overview

When we determine that a **node is unhealthy** - meaning its memory/CPU usage is too high, or it has a bad connection to the network - or a **pod is unhealthy** - meaning it is unresponsive when we try to communicate with it - or the **etcd group is unstable** - meaning there are some disk issues or problems choosing a leader - we take the steps to do a migration. A **migration** involves the process taking an etcd pod that is running on a particular Kubernetes node, removing it from that node, and then finding a better node in the cluster to then place the pod onto. If the whole group is unstable we migrate all the pods.

## Migration



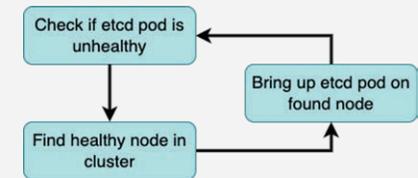
## Acknowledgments

We would like to thank Shefali Gautam, George Mathew, and Chegu Vinod from Dell for all their help and support during the project. Furthermore, we would like to thank our TAs Aidan Smith and Golam Muktadir, and our Professor, Richard Jullig.

## Key Ideas

**Why do we care if a pod or a node is unstable/unhealthy?** - Valuable client data can be lost if there are too many etcd pods that are unhealthy, or running on unhealthy nodes. Thus there is a minimum number of pods we need to be healthy at all times. The migration we perform avoids scenarios where client data is lost by placing pods onto the nodes that are believed to be the most healthy.

**How do we determine where to place the new pod?** - The Kubernetes cluster is split into several racks of servers, and we further partition these clusters into several domains. These partitions are used to ensure the etcd pods are spread evenly among the cluster.



Protocol Execution Flowchart

## Results

Our solution was to create a protocol that migrates etcd pods when unhealthy. This protocol is robust and complete for the issue we were presented to solve, and we decided to write it as a python application.

## Conclusion

We had fun learning about Kubernetes, etcd, Raft, and Linux and we are satisfied with the protocol we developed even though there was a bit of a steep learning curve initially.

# DDI Smart Diagnostics

Matthew Zurlin, Arthur Weimholt,  
Ruiyang Liu, Brandon Kwe

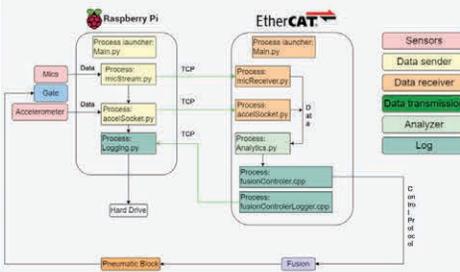
## Abstract

DDI Smart Diagnostics is a solution to underutilization of the lifespan of wafer manufacturing vacuum gates. Detecting the level of degradation of vacuum gates would allow semiconductor manufacturers to schedule maintenance before gate failure, which would expand the lifespan of each gate and thus reduce the cost of production.

## Approach

By monitoring the gate with microphones and an accelerometer as it runs, we collected data in order to see how these audio frequencies and accelerometer data changes over time in a high temperature environment.

Processes on the EtherCAT control the gate, record its operating status, and transfer status data back to the Raspberry Pi for Logging. Then, we accelerate wear by adding heat, to force gate failure.

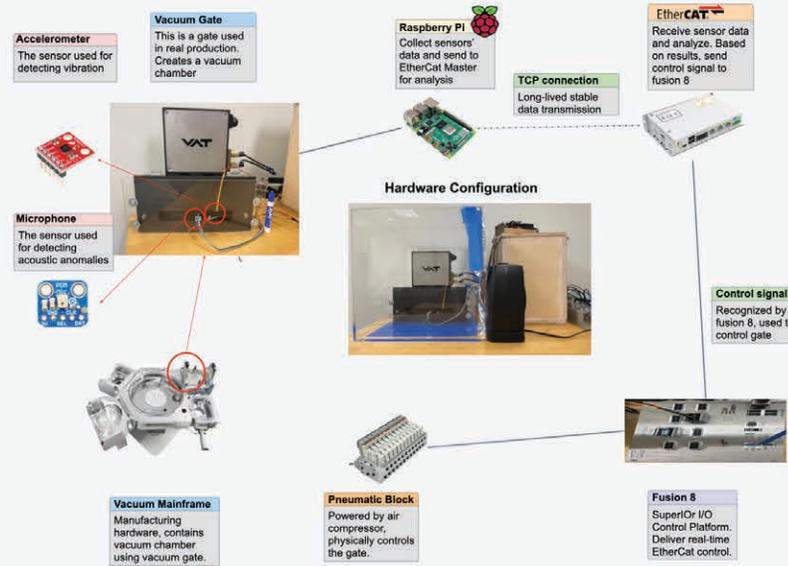


## Overview

During semiconductor manufacturing, one of the major points of failure is vacuum gate degradation which leads to wafer contamination. The current solution is to preemptively change the gate before it fails, which needlessly increases the downtime of the whole system. In order to increase its efficiency, the team developed a system to detect the onset of deterioration of the gate vacuum seal.

This involved data collection via microphones and accelerometers, persistent storage of this data, signal processing, and analysis of the data for the detection of signatures indicating normal operations and identifying transitions to degraded material states.

## Workflow



## Acknowledgments

**DDI Sponsors:**  
Nir Merry (President, CEO)  
Rick Casler (VP Engineering)  
Gary Daniel (Engineering Fellow)  
David Dodd (Director of Software)

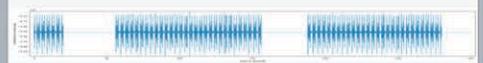
**UCSC Faculties:**  
Richard Jullig (Professor)  
Golam Md Muktaadir (TA)

## Results

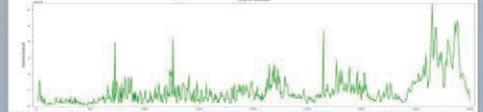
Sensor's picked up loud periodic air compressor sounds:



The air compressor sounds had to be removed to leave a clean signal:



With a cleaned signal, fast Fourier transforms were performed, delivering data in the frequency domain:



Over time and with the addition of heat certain frequency profiles shifted into higher ranges, indicating a change indicative of wear. This can be seen in a plot overlay:



The red overlay is one week after the green plot.

## Conclusion

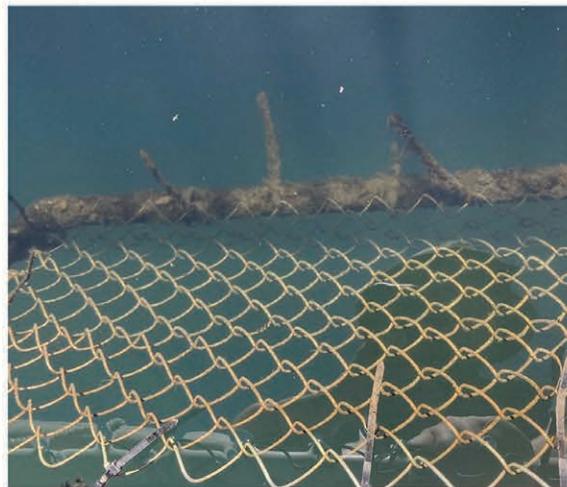
As of now, our frequency comparisons over time show changes, this implies a timeline that should show the point of vacuum gate failure. With further testing, exact failure characteristics can be determined. Then signals can be analyzed for those failure characteristics, and the system can be serviced at the more efficient time.

# Anti-Biofoul Remotely Operated Vehicle (ROV)

Matthew Bennett (RE), DJ Gihring (RE), Cameron Law (EE), Wren Sakai (RE)

## Abstract

Forever Oceans is a mariculture company that aims to sustainably grow fish. They operate offshore netpens to avoid harming more fragile coastal ecosystems and to take advantage of the ocean currents ability to disperse waste. However, this system has significantly increased maintenance costs to operate the netpens. Our project aimed to create an ROV to support netpen maintenance while meeting the company's sustainability goals.



### Biofoul Problem

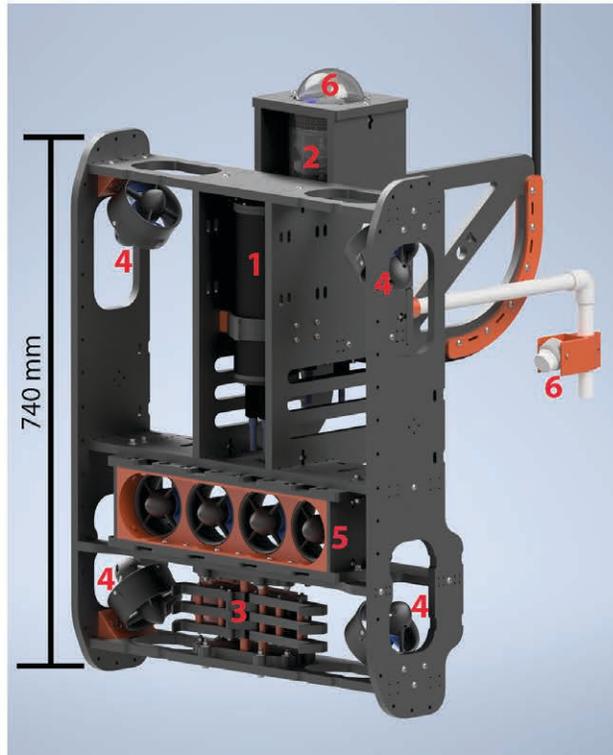
Anti-biofouling is a particularly challenging problem for open ocean mariculture. Anti-biofouling is the act of removing marine algae growth from the netpen structures that contain fish. Algae buildup can damage hardware and expose fish to deadly parasites and pathogens.

In near-shore fish farms, anti-biofouling is commonly performed with divers or even ROVs, but such methods are not optimized or viable for open-ocean operations.

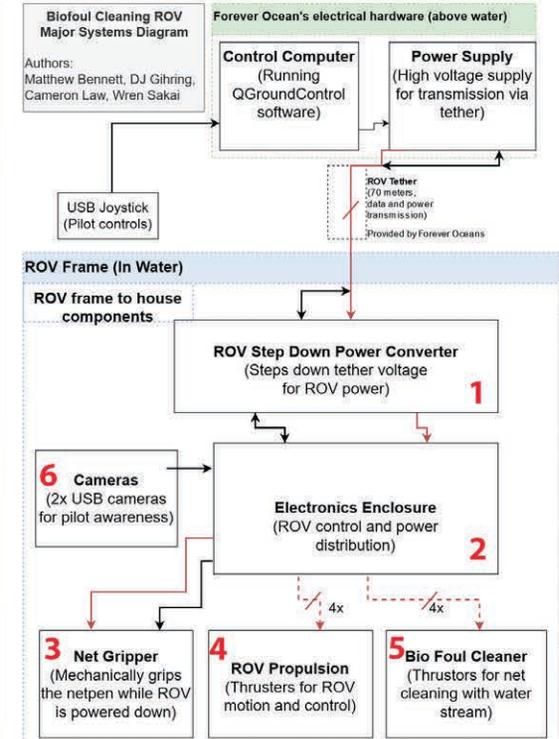
### Design Goals

- Horizontal and Vertical net traversal speed of .2 m/s
- Transportable by a single person and must weigh under 23 kg
- Must be operational below 30 meters below the surface of the ocean
- Must complete all tasks while powered by net micro-grid
- Must be operational for over 7 days without intervention
- Must cling to the netpen while ROV is in low power mode
- Must clean biofouling off of the netpen
- Must be pilotable by a single operator
- Must provide multiple camera perspectives
- Must be operable over the internet

## Our Design

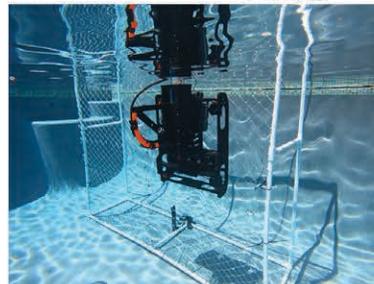


3D Render of ROV



Block Diagram of each System Component

## Testing



ROV during pool testing. Completing a movement test along simulated net pen.

## Results

- Max Cleaning Bank Suction Force: 190N
- Average Strafe Velocity, Vertical: 0.26m/s
- Average Strafe Velocity, Horizontal: 0.30 m/s
- Max Current, Strafe with Suction: 3.3A
- Max Current, Stationary with Suction: 2.9A
- Max Power Consumption, Stationary with Suction: 1160W
- Max Power Consumption, Strafe with Suction: 1320W

The ROV met all basic and movement requirements. Preliminary cleaning tests are positive. Further testing in real world by client needed to ensure efficacy of cleaning bank.

# OpenTAP Data Visualizer

Artyom Martirosyan, Sidhant Bahl, Mason Rylander,  
Ryan Lee, Sriram Ramesh

## Abstract

Our visualization tool improves upon existing solutions by:

- Removing the requirement of storing large log files locally.
- Allowing comparisons between hundreds of different test runs, instead of just two.
- Allowing visualizations of log data greater than 10MB.

## Approach

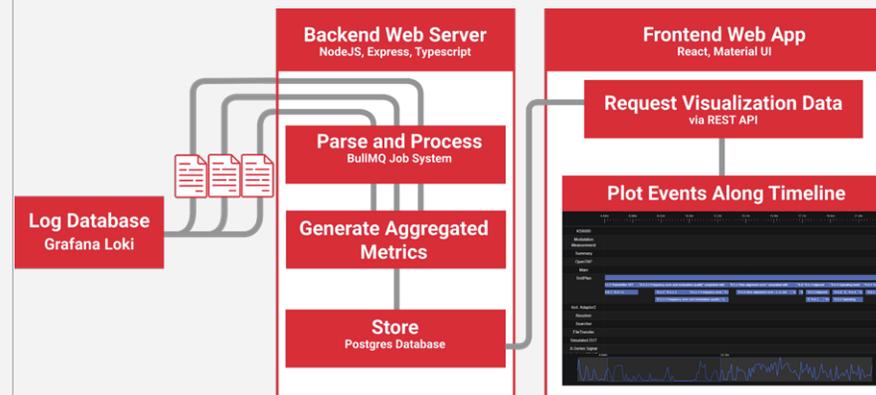
- **Create a web-based tool**
  - Allows the user to view tests from any device, and reducing storage requirements.
- **Focus on performance**
  - Minimize the amount of data handled by the app at any given point in time.
  - Stream events to the frontend as the user explores different areas of the timeline.
  - Preprocess log files, to reduce response time.
- **Visualization of the Data**
  - Create a custom timeline chart, for maximum control.
  - Show minimum and maximum durations as whisker marks to represent aggregate statistics.

## Overview

Keysight is a leading provider in test automation for developing, manufacturing, and designing new hardware. OpenTAP is one of their latest projects - an open source test automation framework. Companies utilize OpenTAP to run hundreds of automated tests on their hardware, which can produce gigabytes of log file data. Interpreting such a large amount of data is a problem for these companies, and that's where our project comes in. Our goal is to analyze the output of their automated tests, and visualize the events in an intuitive and digestible way.



## Architecture



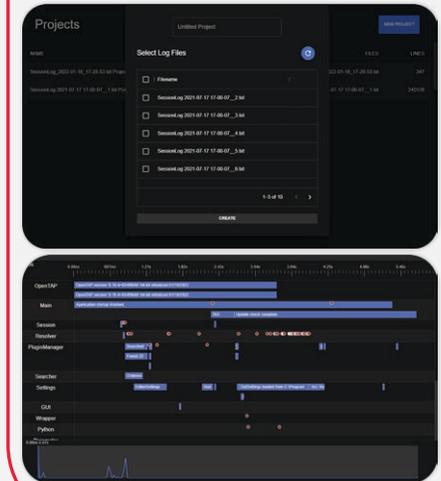
## Acknowledgments

**Keysight Technologies**  
Brennen Drenzo, Ivan Diep, Jeff Dralla

**UCSC**  
Richard Jullig, Golam Muktedir

## Results

Users can visualize, analyze, and compare OpenTAP log files in a web application, thus avoiding the need to download software. We can handle log files containing hundreds of thousands of events.



## Conclusion

The data visualizer provides OpenTAP users with a data visualization application that requires no downloads and can be accessed through mobile devices, thus allowing them to view tests fast and conveniently.

## OVERVIEW

Universal Audio wanted to bring music and social media together. They love the idea of using the connection of the internet to create music. Our team set out to create an app that could accomplish just that. That app is called Modio. Modio will allow musicians, from anywhere in the world, with any instrument or just their voice, to make songs together. We want this app to be an outlet and tool for casual musicians to be able to record, post, and collaborate on musical tracks.

## KEY FEATURES

### 1. UPLOAD NEW TRACK



The user can:

- Pick up any instrument or prime their voice
- Record a track of themselves
- Give the song a title and cover
- Post their new song

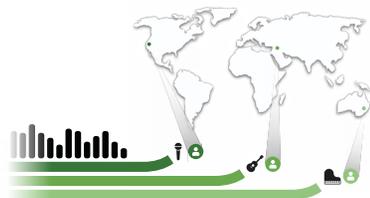
### 2. OVERLAY TRACKS



The user can:

- Find a track they want to add to
- Record themselves over that track
- Give the song a title and cover
- Post their new modified song

These two key functionalities allow users of Modio to create songs and tracks with large ensembles of instruments and voices.

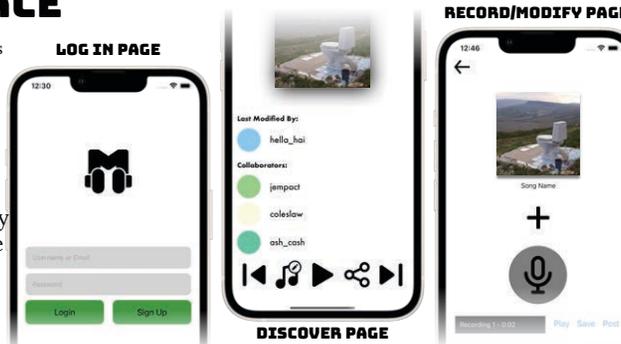


## INTERFACE

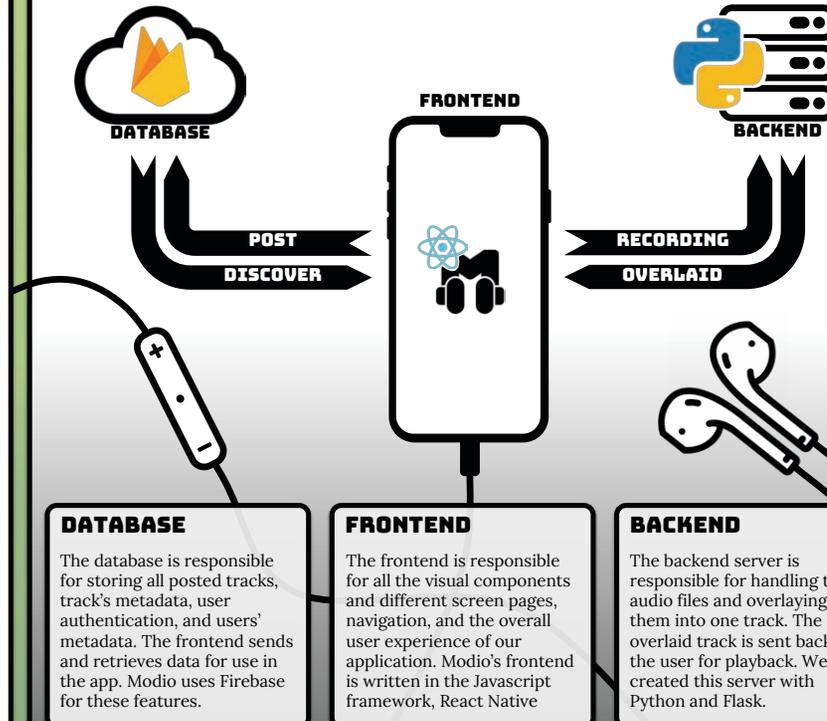
Modio's user interface is

**SIMPLE, EASY, and QUICK.**

This allows musicians with any level of knowledge to use the app without any difficulty.



## ARCHITECTURE



## RESULTS

### Current:

We succeeded in creating a way to enable the collaboration of music creation through a social media application. Our current build of the app supports user authentication, audio recording and uploading, and audio over laying.

### Future:

We had a lot more ambitions and ideas for features that we were not able to implement. There were many challenges that slowed us down, but we will continue to add features such as friends, sharing, and a profile page.

## CONCLUSION

In conclusion, creating a mobile application which manipulated audio files proved to be a challenging project.

Our team was able to overcome many of these challenges through the help of our TA and sponsors. The team was able to demonstrate resourcefulness and creativity during the design process of our application.

Modio is a reflection of our interests in mobile development as well as our background as creative artists. We aim to continue building this application and hope that it can one day grow into a popular tool that musicians can use to create and share music content.

- The Modio Team

## ACKNOWLEDGEMENTS

### A special thanks to:

<b>Universal Audio</b>	<b>UC Santa Cruz</b>
Beau Silver	Richard Jullig
Jean Laroche	Golam Muktedir
Allan Timms	Frank Howley
	Patrick Mantley

## Abstract

UCSC students, faculty, and staff need volunteers for many campus events, and alumni are continuously looking for ways to continue their relationship with their alma mater. The UCSC Alumni Association has to find volunteers through staff-driven and labor-intensive means. We provide a solution to these issues with Tassel, a robust microvolunteering platform to connect the UCSC community.

## Approach

- **Website** - built with React and the Material UI component library
- **Server** - built with Node.js and Express.js
- **Database** - built with PostgreSQL hosted on Amazon Web Services
- **Functions** - enables our real-time notifications, hosted on Firebase
- **Deployment** - used Heroku

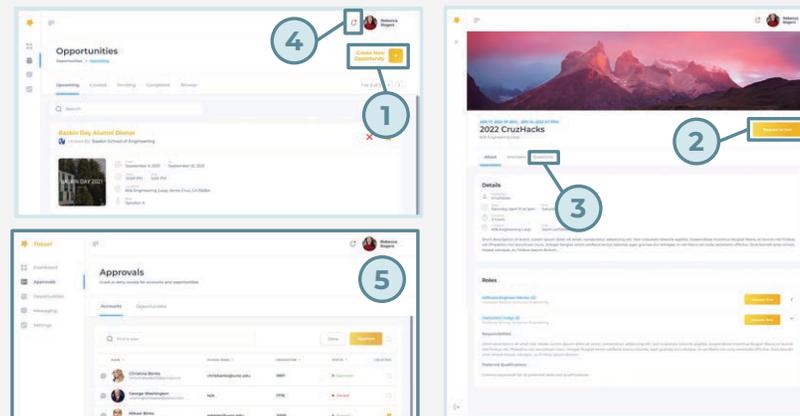
## Acknowledgements

Special thanks to Michael Riepe, Jorge Henriquez, the UCSC Alumni Council, Professor Jullig, and Aidan Smith

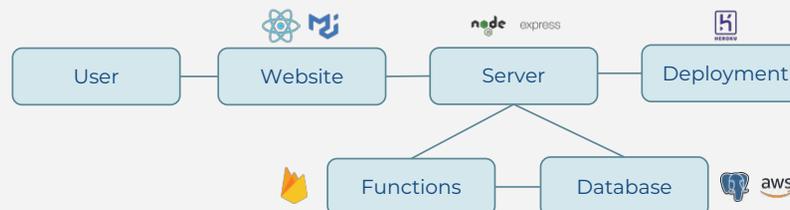
## Overview

The Tassel web app provides an easy way for users to post volunteering opportunities, find qualified volunteers, and join opportunities. We also provide a system that is secure, lightweight, and scalable through our admin accounts, smooth user experience, recommendation engine, data analytics, and use of cloud storage.

## How Tassel Works



## Architecture



## Key Features

1. **Create opportunities** - post your opportunity and have qualified volunteers recommended to you
2. **Join opportunities** - join roles that suit your interests and skills
3. **Forums** - ask questions and chat with other volunteers
4. **Notifications** - get reliable updates and opportunity reminders
5. **Admin accounts** - approve users and opportunities, as well as view data analytics for the website

## Results

We reached out to alumni and students to run focus groups and beta testing. They were satisfied with our current prototype and future goals. We are on track to being approved by the University Relations department and published on the ucsc.edu domain.

## Conclusion

We hope to do more market research and build off of our prototype in order to be the official volunteering platform for UC Santa Cruz.

## Abstract

The integration of a third-party auditing tool allows for the Business and Administrative Services (BAS) division of UCSC to more effectively and intelligently monitor campus purchases. A rethinking of card purchase policies is relevant to minimize campus spending and maximize returns. We analyzed years of transaction data to reform the policies and give BAS a better understanding of where transactions occurred.

## Approach

### Full-Stack Web Application

- 1. Database** - compile two years of transaction data into a database
- 2. Website** - using React and NextJS, create an interface to view and filter transactions
- 3. Server** - using Django and Python, create functions to run on our data
- 4. Analysis** - run functions and analyze what policies are outdated

### Third-Party Auditing Tool

- 1. Transition** - transfer and test our functions on the tool's website
- 2. Flagging** - sample five years of data and flag transactions that violate multiple policies
- 3. Reports** - prepare tool for ongoing scheduled reports

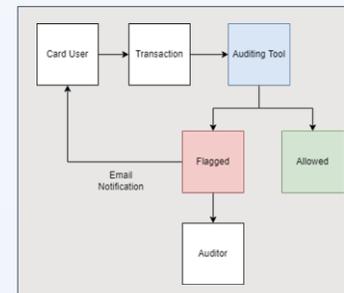
## Overview

In recent years, UCSC has seen successful increases in the usage of campus-wide credit cards including their procurement (Pro) and corporate travel and entertainment (CTE) cards. Millions of dollars are now going through these cards monthly, and UCSC now generates increased revenue from the rebate system. Before this project, all transactions were manually checked by dedicated staff and was time and resource-consuming. Policies are potentially out-dated and being violated consistently. The UCSC BAS department lacks a high level auditing tool to adjust policies in fitting the current usage of cards. This project enables BAS to visualize the status of their existing policies, potentially adjust and create policies, as well as help set up the auditing tool for any future usage.

## Architecture



With our website, users are able to upload transaction data and filter the data on the frontend using React. In our backend, many rules are run on the transactions with Django and Python. The backend communicates with the database we created to store and retrieve transactions.



Third party auditing tool process:

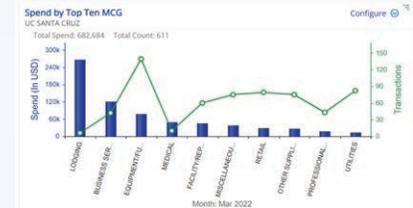
1. The card user makes a transaction
2. The auditing tool utilizes rules we created to determine if the transaction should be flagged
3. If flagged, an email is sent to the card user and an auditor is notified to check the transaction

## Acknowledgements

We would like to thank Biju Kamaleswaran, Marcia Bock, and Ed Moran of UCSC's Business and Administrative Services for their immense amount of help and collaboration. We would also like to thank our professor Richard Jullig, and our TA Golam Mukhtadir for guiding us along the way.

## Transaction Analysis

Analyses are being done through monitoring the spending trends as well as marking potential violations and finding patterns among transactions.



## Results

Here is a comprehensive histogram showing violations against some policies including:

- Forbidden Amazon purchases
- Blocked Merchant categories
- Transactions over personal limits



## Conclusion

Using the auditing tool we integrated, UCSC BAS will have scheduled, automated policy checks on previous, current, and future transactions. UCSC BAS will continue to reform policies based on our findings.

**We are very pleased to include posters for the Senior Design Projects that were done without industry sponsors.** Some of these projects were instigated and/or sponsored by research at Baskin Engineering while others were created by students with the assistance of faculty mentors and TAs.



## Problem

Braking too hard on a wheeled vehicle can cause the wheels to lock up and the vehicle to slide. This is especially worse for bicycles, as locking the front wheel results in much more severe loss of control than it does in vehicles with four wheels as four wheeled vehicles can't fall over.



An example of bicycles locking their wheels while braking around a sharp turn. Image Credit: Suburban Assault, Skid Marks | Suburban Assault.

## Solution

We want to create a system to detect wheel slipping and automatically release the brakes, just like what is already standard in the motor vehicle industry, but for consumer bicycles.

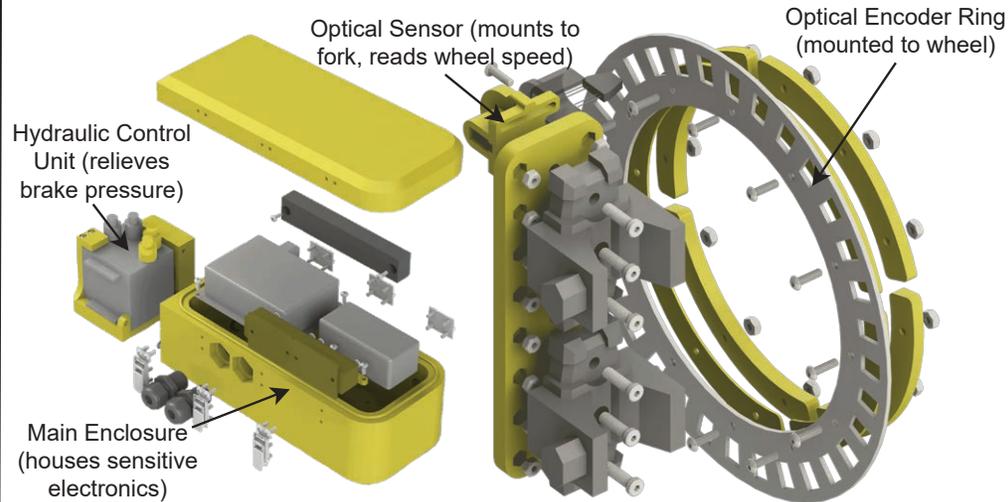
## Approach

Our system is designed to be:

- Completely fail-safe, will return to normal braking behavior if any failure occurs
- Affordable for the average consumer
- Effective at reducing time spent in wheel lock
- Adaptable to install on most bicycles
- Weatherproof
- Easy to install for any user

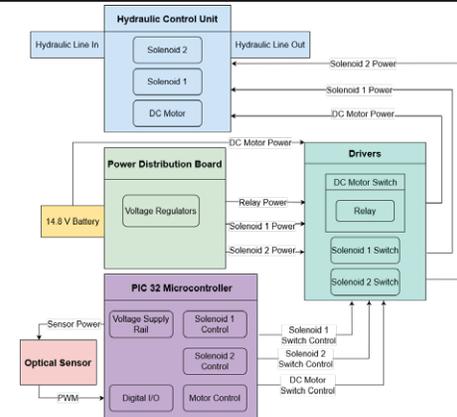
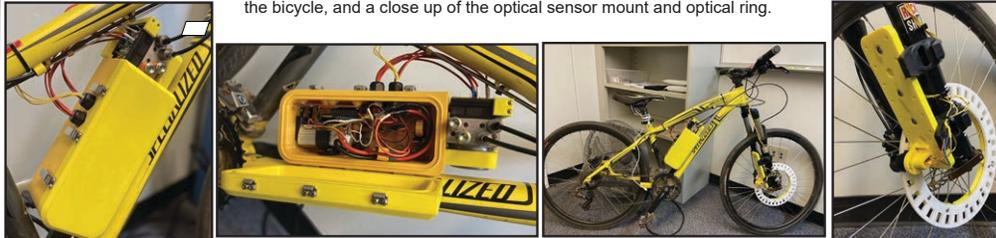
# Anti-Lock Brakes For Bikes

By Jakob Stafford (Electrical Engineering), Uriel Antonio (Robotics Engineering), Patrick Allen (Electrical Engineering), and Daniel Walton (Robotics Engineering)



Above: Exploded views of the CAD models for our ABS system, including the Main Enclosure, Hydraulic Control Unit, Optical Ring, and Optical Sensor.

Below, from left to right: Real world pictures of the main enclosure when closed and open, an overall image of the system mounted to the bicycle, and a close up of the optical sensor mount and optical ring.



The block diagram depicting all of the major subsystems of our ABS and how they interact

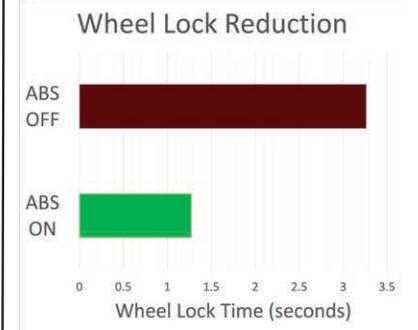
## Components

- Powered using a LiPo battery
- The brakes are actuated using a salvaged motorcycle ABS Hydraulic Control Unit
- Uses custom motor and solenoid switching electronics to drive the HCU
- Reads wheel speed using an optical encoder ring mounted to spokes and optical sensor mounted to fork
- Microcontroller calculates wheel acceleration and analyzes acceleration to detect slip events
- When a slip is detected, the microcontroller sends control signals to the switching electronics to drive the HCU and relieve the brakes



## Results

The final cost per unit is \$323.28. The only specialized tool required to install is a bicycle brake bleed kit and is easily installed by the average consumer. Unfortunately, due to internal wearing issues with the HCU, we were not able to meet our braking distance reduction goals, but we were able to successfully reduce lock time by over 60% which greatly improves controllability of the bicycle during lock events.



## Conclusion

We were able to meet our main goal of reducing wheel lock time, but unfortunately not braking distance due to time constraints. Despite this, our system demonstrates that consumer bicycle ABS is feasible both from a price and ease of use perspective. That being said, there are still areas on which to improve. A purpose designed and manufactured HCU would be able to produce much better results as it could be designed with pedestrian bicycle hydraulic pressures in mind. The existing hardware could also be used to prevent front flipping with the addition of a gyro sensor and more programming to detect flips.

# Automated Pet Door

"One size to fit all"

Project by: Nelson Norman, Huabo Min, Yue Chen  
 Robotics Engineering Major    Electrical Engineering Major    Electrical Engineering Major



## The Problem

Current available automated pet doors require constant battery replacements for their collars and are not available for larger dog breeds.



## Approach

- The footprint of the door is 20.5" wide by 30.75" tall with an opening of 14" x 24" to accommodate extra large pets.
- By using passive RFID tags on the collar and an electrical outlet as the power source for the door we have eliminated the need for batteries.
- The panel will automatically slide open when collar tag is present within 2 feet from the tag reader located on the front of the door.
- Phone can remotely operate the pet door through a Wi-Fi connection.
- Door notifications available to users through the App.

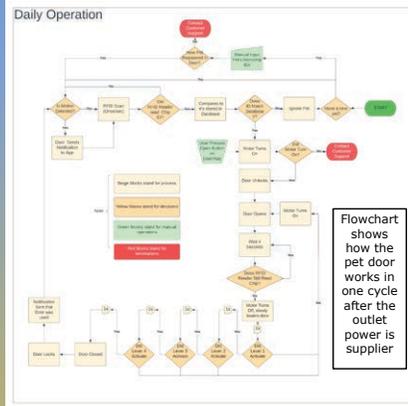
Development Board Choice  
 Arducam ESP32s UNO PSRAM

- Feature:
- Bluetooth 4.2
  - WiFi 802.11b/g/n/e/i
  - Low-power modes
  - SPI, I2C, URAT, GPIO, ADC, DAC communication protocol



Contact us for more information

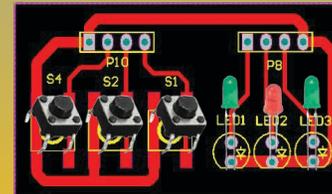
## Our Product



Door opened by a motor and cable pull system with switches for height detection



RFID tag sensing ensures your pet is away from the door before closing



I/O Panel is mounted on the inside frame of pet for user to control the state of pet door. There are three switches and three LEDs.

- Reset Switch
- Open Switch
- Power Switch
- Power LED
- Error LED
- Timer on/off LED

## Features



Remotely operate your pet door with our app



Get notifications through the app when the door is used or motion is detected to keep safe



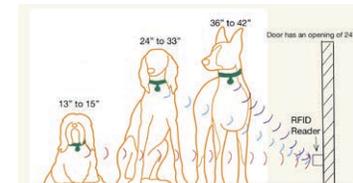
Safety features, such as automatic reopening if obstruction detected, will keep your pets from harm



Our battery free collar tag will only grant your furry family access to the house or yard

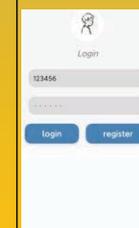


Pet door is easy to use and install in a door or wall



Great choice for multi-sized dog families!

## Phone App



- Login Page
  - Register your account
  - Login
- Main page
  - daily operation timer
  - open door button
- Notification page
  - Errors
  - Motion Sensed
  - Door used
- Pet registration page
  - pet's name
  - tag number

Baskin School of Engineering Capstone Project  
**Automatic Sail Adjustment**

Michael Justin, *Robotics Engineering*  
Bailen Lawson, *Bioengineering*



### Data Collection

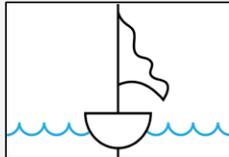
Data on wind speed, wind direction, boom angle, and heel angle were collected in the following three states:

#### Properly Trimmed



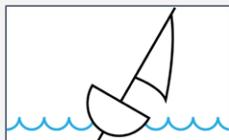
When properly trimmed, the boat is lightly heeled with a full sail.

#### Under-Trimmed



When under-trimmed, the mainsheet is too slack, and the sail begins to flog.

#### Over-Trimmed



When over-trimmed, the mainsheet is pulled in too far. The boat slows and heels excessively.

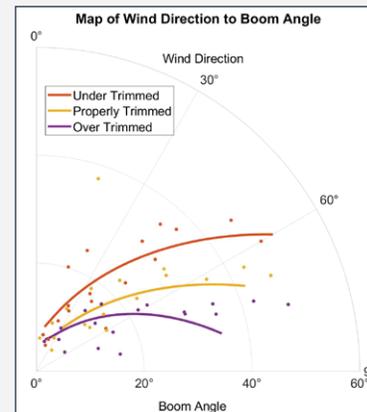
The data characterize an acceptable range of trim, so the final user receives a system that minimizes power consumption by only intervening when necessary.

### An Unfulfilled Need

Small, affordable autopilot systems which steer a boat on a fixed compass course are commonplace on sailboats of all sizes, but wind shifts require a person to manually haul in or let out lines to keep sailing the same course. There are currently no affordable solutions for automatic sail adjustment. Our project aims to develop an easy-to-install system that can work in tandem with an autopilot to provide truly automated sailing to cruising sailors.



Clockwise from upper left: boom angle sensor at gooseneck fitting, masthead anemometer, the sailboat used in this project.



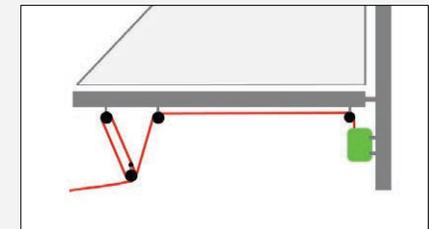
Plot of data collected on the water. The area between the red and purple best-fit curves corresponds to 'acceptable' states of trim.

### Results

- We developed a system capable of sensing whether a sailboat's mainsheet should be hauled in, held fast, or let out to achieve proper trim.
- The data we collected defines how the system should behave on upwind headings in light winds.
- The system is able to collect the data necessary to similarly characterize all headings and all reasonable wind conditions.

### Next Steps

- Collect additional data to generate boom angle maps for all headings and conditions.
- Explore sail flogging as an indicator of an under-trimmed sail
- Implement an actuator to adjust the boom according to the map.



Mockup of an actuator using a double-ended mainsheet to control boom angle. The mainsheet can be adjusted manually from the left, or automatically by the actuator on the right.

### Acknowledgements

We would like to express our gratitude to those who gave us advice and assistance throughout the project.

#### Thank you:

Stephen Peterson	<i>Professor</i>
Tela Favalaro	<i>Professor</i>
Sushmita Joardar	<i>TA</i>
Azzam Qureshi	<i>TA</i>
Rusty Kingon	<i>Stakeholder</i>
Gary Coonce	<i>Stakeholder</i>

# BSOE Management System

Edwin Kam, Gefei Lu, Shiyuan Huang, Qiance Yu

## Abstract

Currently, BSOE does not have an automated management system to track its assets. They rely on humans entering asset information into an excel spreadsheet. Our goal is to transfer our current asset information to an automated tracking system to reduce human errors and increase efficiency.

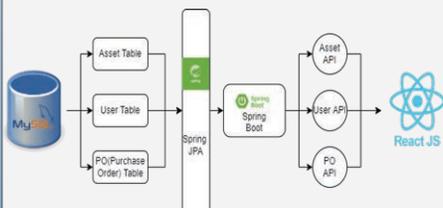
## Approach

**Security:** Database is hosted on the BSOE server. Campus VPN is needed in order to connect to the data.

**App Server:** Using Java Springboot to create the API endpoints and JPA to query and transform data to Java objects.

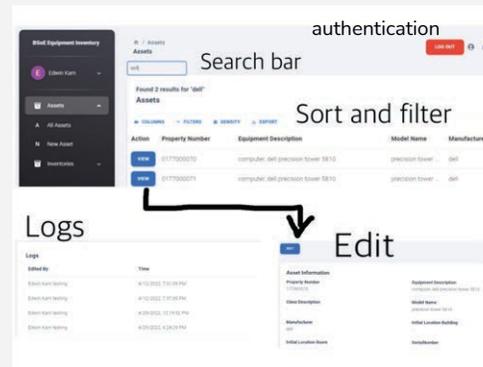
**Web Server:** Node.js is common and reliable. We also choose to use React as the frontend framework because the MUI library provides a variety of components that we can fit right into the web application.

## Architecture



## Overview

The BSOE management system provides an easy way for BSOE facilities to keep track of the BSOE's assets. The app can store the serial number, property numbers, custodians, locations and images of the assets.



**Edit history:** the system keep tracks of all of the activities of each asset such as previous locations, who made the changes..

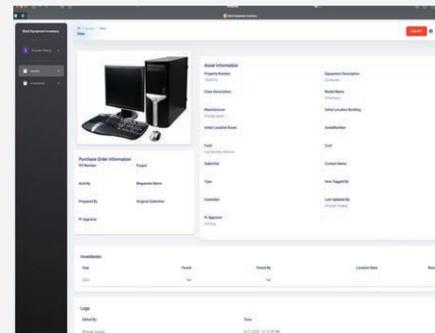
**Report:** Generates inventory report every two years by given property numbers required by UCSC.

**Sort and Filter:** Assets can be searched, sorted and filtered by various fields such as property numbers, PO numbers, etc

**Authentication:** The admin of the app has the authority to give edit permission to different users.

**Asset's attachments:** Different from the old spreadsheet, we can now store images or file attachments along with the assets

**Purchase Order Information:** Assets page will also include purchase order information which will offer users and manager more information about transaction of assets.



## Technologies

**For backend:**

**Springboot** contains a lot of models that help our team code much more efficiently. In this way, our team could focus on the system design.

**For frontend:**

**React** has the property of modular structure, which means that React's code is much easier to maintain. Moreover, React is compatible with most Backend Frameworks.

## Result

We have already migrated the old data from the spreadsheet to our new database. Once we finish implementing the key feature and testings, BSOE will start using this app.

## Conclusion

We hope to continue adding more features and making this app become a general BSOE tracking system of everything, such as packages, safety certificates.

## Acknowledgments

Sponsor: Russell Evans (Baskin Engineering Laboratory Services Manager)  
Professor: Richard Jullig.

## BACKGROUND

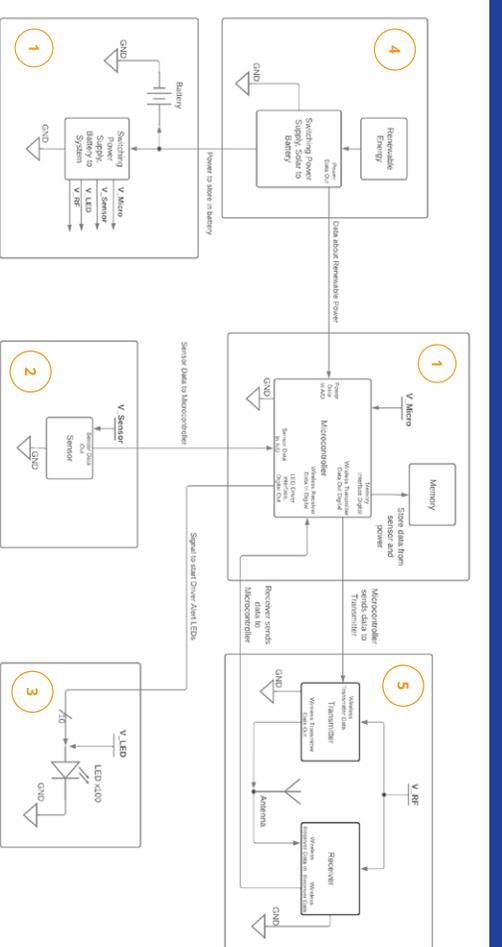
Empire Grade in Bonny Doon is a popular location for mountain biking enthusiasts. Unfortunately, there are many dangerous areas on this road due to numerous blind corners and the lack of a dedicated bike lane or adequate shoulder for bicyclists to ride.

## SOLUTION

Our project aims to prevent accidents on Empire Grade by alerting drivers of bicyclists ahead of them that they are unable to see due to blind corners.



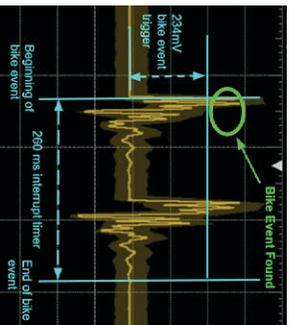
Proposed system setup on Empire Grade.



## OUR DESIGN

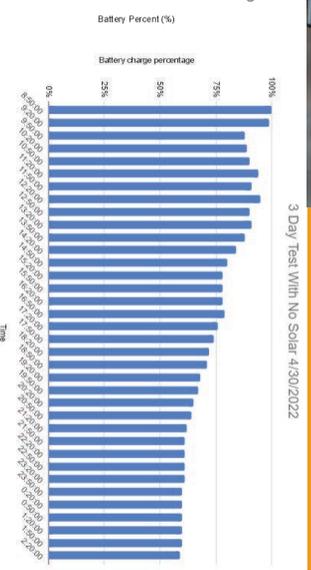
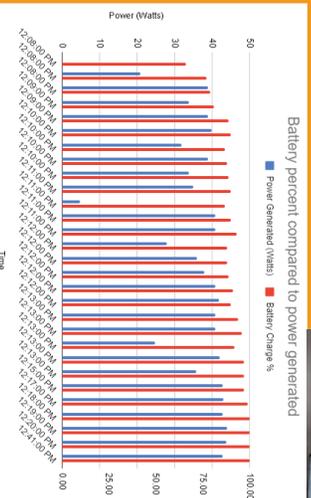
1. PCB Housing
  - a. Microcontroller
  - b. System Integration
  - c. System Power
  - d. Pressure Sensor
2. Pneumatic Tubes
3. Driver Alert LEDs
4. Solar Panel
5. Radio Frequency (RF) Functionality

## RESULTS/CONCLUSION



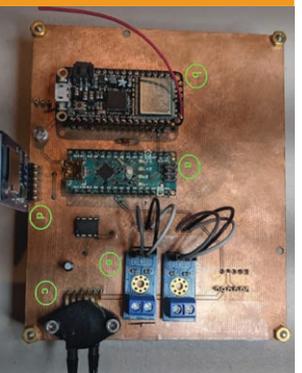
## System Power

Battery is capable of recharging efficiently with solar energy and operating the system for 3 days without any daylight.



## Method of Bike Detection

Waveform taken from the pressure sensor shows the method of bike detection with a 234-488 mV pressure threshold and an interrupt timer that takes an average of 5 data points over 260 ms.



## System Integration Board

The system integration board incorporates (a) the microcontroller, (b) the RF module, (c) the pressure sensor, (d) the SD card, and (e) voltage and current sensors for the solar panel.

# Airship Drone for Remote Lake Sampling

Water is a resource essential to the existence of life on Earth. With the increased production of plastics, greenhouse gases and other pollutants, this resource is under threat and needs to be regularly monitored to ensure the health of our planet.

## How are water resources monitored?

Currently it falls to Hydrologists to travel to and check up on bodies of water by collecting vital water samples and sensor readings. This can be time consuming for Hydrologists, particularly if it takes a multi-day backpacking trip to reach the body of water in question. Additionally, some bodies of water may not even be accessible on foot necessitating the need for a new water monitoring method.



## The UAV Vehicle Team

University of California, Santa Cruz  
Class of 2022

Duseok Choi, Jonathan Hartley,  
Jason May, and Richard Owens



## Next Steps

- Summary of what needs to be done to realize the original goal or improve on it.
- Further testing of flight stability under varying conditions
- Energy consumption optimization for longer flight distances and hover times
- Lightening the airframe by replacing parts with carbon fiber
- Implementation of landing standoffs
- Helium Envelope Balonet (Pressure Control)

## How does it work?

Normally, our hybrid airship drone will be heavier than air, relying on VTOL thrusters and aerodynamic lift generated by wings to achieve flight. However, once the drone deploys its sensor, a flotation device on the sensor will "offload" the weight of the sensor such that the drone becomes lighter than air enabling it to hover without expending additional energy.

### Main Components:

- PU coated Nylon Envelope contains 384 ft<sup>3</sup> of Helium (generates ~25 lbs of lift)
- 2x VTOL thrusters
- Wings optimized for low speed and high lift
- Inverted "V" tail
- Gondola containing all onboard electronics
- Sensor payload, a multiparameter water quality probe
- Winch for deploying sensor payload
- Overall dimensions - 15'L x 7'W x 8'H

## Reaching the Unreachable

In order to address this need, our team set out to develop a drone capable of autonomously monitoring remote bodies of water, enabling Hydrologists to reach those remote locations and save time in the process. This drone would be equipped with a hydrological sensor payload and utilize a hybrid airship design for greater endurance than the typical drone.

## The Outcome

The team is in the midst of testing our prototype airship, thus there are no formal test results to publish here. However, feel free to ask the team members about how testing is going as we'd be delighted to discuss that with you!

Background image sourced from NoCoastBestCoast.com;  
Vehicle model image is of the v2-0 prototype.

# LML Marine Debris Map Data Visualization

Bridget Chew, Kaitlyn Liao, Noah Cantwell, Spencer Fulgham, Vinh Le, Zachary Miller



## Abstract

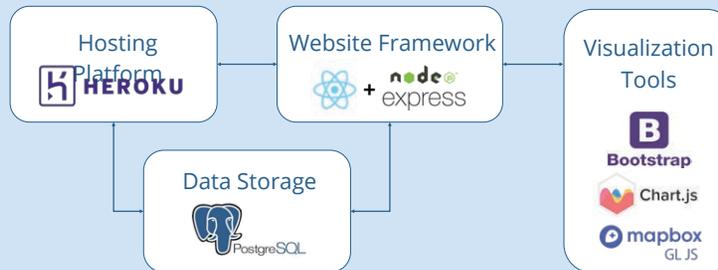
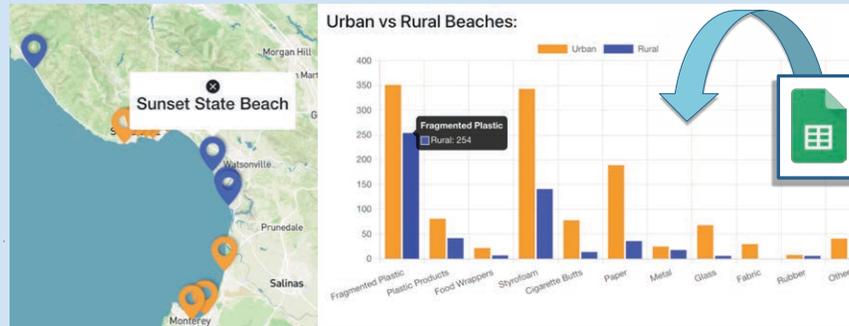
The Marine Debris Data Tool is a web application developed to visualize the data on debris found at select beaches in the counties of Santa Cruz and Monterey. This tool's features include data filtering, map markers, interactive data visualization, spreadsheet uploads, and admin security. This allows both the Long Marine Lab and the public to look at this data in more intuitive and flexible ways than previously possible!

## Approach

- **Website Framework:** React.js is the skeleton of our website. Node Express allows us to achieve fast querying of information from our database.
- **Database:** PostgreSQL holds admin login information and uploaded debris data for safe storage.
- **Visualization Tools:** Mapbox displays the locations of the 12 beaches. Chart.js takes the data for each beach and displays it for users on various graphs.
- **Hosting Platform:** Heroku hosts the website for all to see and share.

## Overview

UCSC Long Marine Lab (LML) contributes to scientific research and marine conservation by collecting data on ocean and beach pollution. The extensive marine debris data collected by LML using the NOAA protocol is gathered in spreadsheets, which is not a format accessible to the public. To remedy this, our website formats the data for visualization and analysis via maps and graphs. Hence, making the data available to be used as a tool to educate the public on ocean care and inform our behavior at the beach.

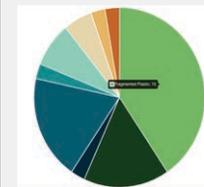
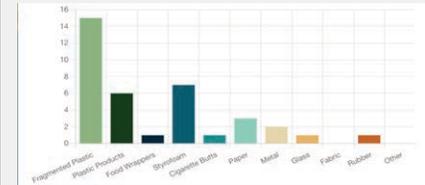


## Acknowledgments

We would like to thank Dr. Robin Dunkin, Juliana Limon, and Maia Smith of the UCSC Long Marine Lab for their great feedback and collaboration. We would also like to thank Professor Jullig and our TA Aidan Smith for their continuous support throughout our project.

## Key Features & Results

### Types Of Debris Data



Bar chart showing total units of each type of trash.  
Pie chart showing proportional value of each type of trash.

### Temporal Data

Line graph to show total trash over time



Bar graph to show seasonal data



### Login Page

#### Upload CSV Data

Choose File

A way for admin to manage and update data

## Abstract

As the UCSC Hybrid Systems Laboratory dives deeper into the world of self-driving vehicle research, they need a platform to test their autonomous algorithms that can easily be installed on one of their existing campus vehicles. Our system, once installed, will allow a vehicle to be controllable by-wire without disabling the vehicle's existing controls. Our redundant emergency stops and capability for manual override makes our system safe and transparent to use.

## Overview

The system on a bench provides a visualization for our system's capabilities and functionality. The user may select an input device (such as a joystick) on the mode selection panel. The user may then use the input device to control the vehicle's steering angle, brakes, and acceleration. The user may also control peripherals such as the lights and horn.

## Approach

Our system's microcontroller processes commands from the user using a custom packet format. The microcontroller controls the actuators and peripherals using contention circuitry and relays. Our system's finite state machine constantly monitors for errors and changes in input.

### Steering <sup>1</sup>

A rotary actuator runs a feedback loop to mechanically control the steering column. When implemented on a vehicle, the motor will also be able to act as powered steering when our system is off.

### Braking <sup>2</sup>

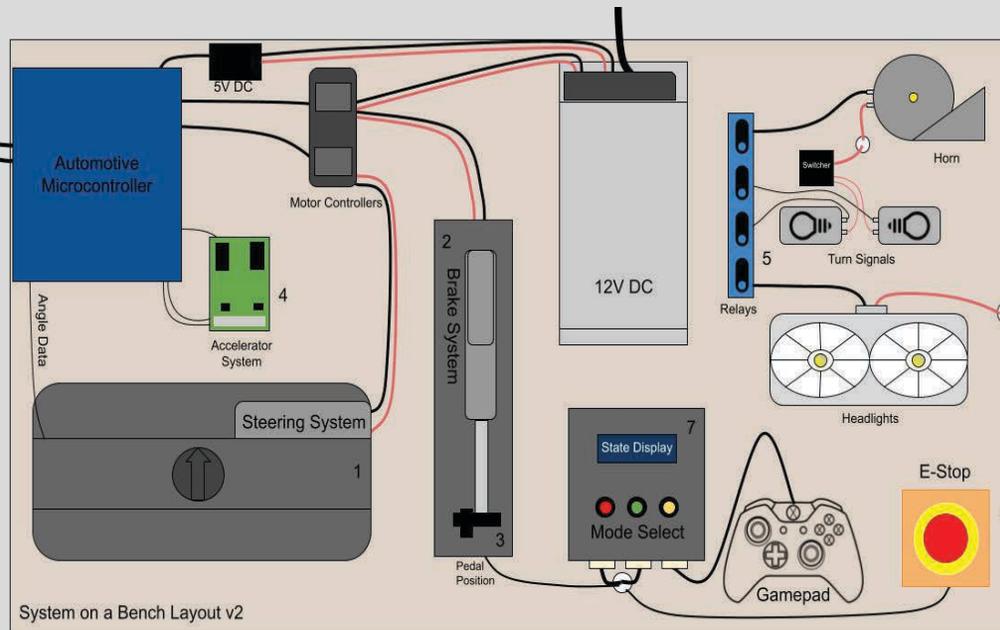
A linear actuator runs a feedback loop to mechanically depress the vehicle's brake pedal. A pedal position sensor allows the user to manually override the system by pressing on the pedal.

### Manual Override <sup>3</sup>

According to UC regulation, our system can be disengaged by pressing the brake pedal or any of the E-Stop buttons.

### Acceleration <sup>4</sup>

Our system outputs a signal that mimics that from a traditional accelerator pedal. If the system is active, a contention circuit sends the correct signal to the vehicle.



### Peripherals <sup>5</sup>

An array of relays lets the user to control the horn, turn signals, and headlights.

### Emergency Stops <sup>6</sup>

E-Stops inside and outside the vehicle ensure that autonomous algorithms can be safely disengaged and our system can bring the vehicle to a halt.

### User Interface <sup>7</sup>

The user can interface with our system using an autonomous controller/laptop. Our mode selector allows the user to choose to drive using a joystick instead.

## Conclusions

Our team successfully demonstrated digital control of a simulated vehicle. We believe our system has the potential to become the foundation of future research by enabling teams to safely test their algorithms on existing vehicles.

## Acknowledgements

We would like to thank our sponsors at UCSC's Hybrid Systems Laboratory, as well as Dr. Steve McGuire and Dr. Gabriel Elkaim.



life.augmented





## Abstract

MyPantry serves as a means to destigmatize the use of pantries. It builds a community around pantry users and organizers while serving as a tool to provide pantry information as efficiently as possible.

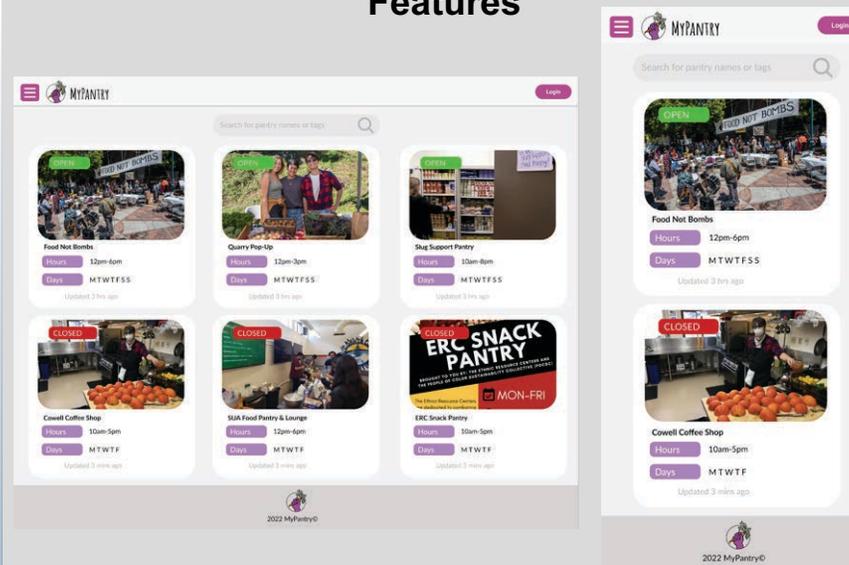
## Approach

- Initial plan was to have pantry organizers and volunteers to manage their respective pantry pages; however pantries are extremely understaffed and the organizers were not willing to have volunteers do more than their present workload.
- Our solution to this problem is to crowdsource current information such as pantry inventory through pantry users. Users would provide tags to describe their experience with a specific pantry such as a popular stock item.
- Students are often moving around between their classes and jobs with little time to spare. As a result, we aim to be as efficient as possible by providing only necessary information upon loadup such as opening hours.

## Overview

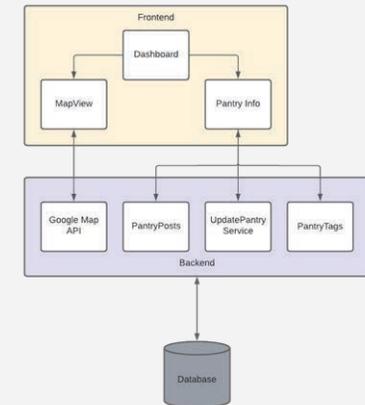
Currently, there is no stable medium to serve as a hub between food pantries and their users. MyPantry's goal is to build relationships between pantries and their current and potential users by providing accessible updates and information, bridging the gap between available food assistance and qualified users.

## Features



- A tagging system used to categorize pantries with popular stock items.
- A posting forum that allows pantry users and organizers to communicate and foster a community.
- An interactive and simple UI designed for efficiency and upgradability.

## Architecture



## Conclusion

MyPantry is built to be scalable (easy to increase scope of operations) and extendable (easy to add features). Future goals of the web application include fine tuning the tagging system by adding a ranking algorithm, and implementing a feed filtering system to display user preferred information.

## Acknowledgments

Many thanks to the IDEASS team:  
Kai O' Brian, Grisha Khachatryan and  
Tamara Ball  
As well as our great teaching staff:  
Richard Jullig and Aidan Smith

### Overview

Homeowners cannot easily control their power consumption on a device-by-device basis. PLUX provides them a way to monitor their power usage as well as the ability to manually or automatically power on or off those devices remotely.

For example, someone who is upset about how high their electricity bills have been, knows that all the devices they have plugged in draws power constantly. To help manage their electricity usage, they would like a way to monitor/control their power usage.



Functional Prototype



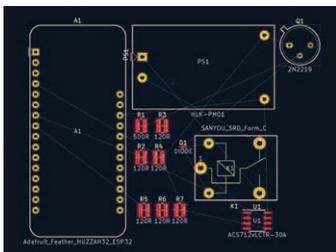
Aesthetic Prototype

### Goals

- Cheaper or as expensive as existing smart plugs
- Allow connected devices to be turned on or off remotely
- Display data analytics (average/peak power, graphs/histograms, online cost comparison)
- Easy to replace or repair

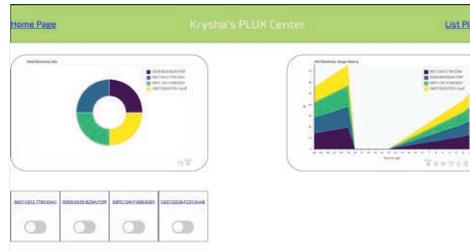
### Design For Manufacture/Assembly

- Custom PCB design allows components to be easily assembled
- Case is comprised of two components with no screws
- Widely available components allow scalable production
- Small number of components allows users to build their own plug



PCB schematic based on circuit.

### Website

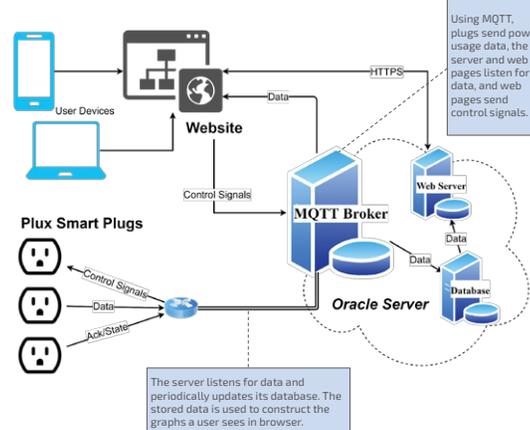


The dashboard allows users to view an overview of power usage of all devices they are monitoring and turn devices on or off.



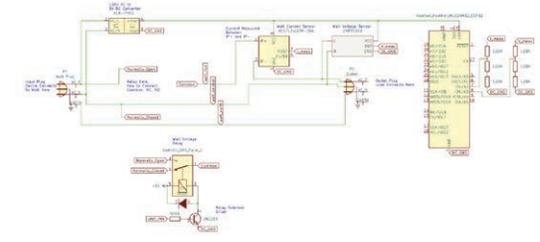
A graph that shows data sent by the plugs in real time.

### Data Flow

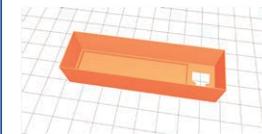


### Hardware Design

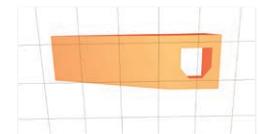
Component	Function
ACS712-30A bi-directional current sensor	Measures instantaneous current through load
240V/15A AC/DC relay	Turns a connected device on or off
ESP32 240hz dual-core microcontroller	Handles power calculation and MQTT data transmission
6x 120Ω resistors	For 5V-3.3V logic level conversion into ESP32 pins
HLK PM01 AC-DC 5V converter	Power supply for circuit (no external batteries needed)
2N2222 NPN transistor	Toggles relay according to GPIO pin



Internal circuit schematic for a PLUX unit.



3D model for circuit case.



3D model for circuit lid.

### Contact

James Quiaoit: [jquiaoit@ucsc.edu](mailto:jquiaoit@ucsc.edu)

### Acknowledgements

We would like to thank Jason May for lending us his 20A wire for prototyping, as well as Professor Stephen Petersen reviewing our circuit schematic.

## The Problem

Constrained work environments in information heavy fields can lead to frequently tab flipping and loss of notifications and critical information.

## Recommended for...



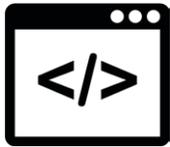
Researchers



Developers



Students



SW Only

Recommended for users who want to transform their existing workspace easily with Bluefoot's software capabilities



Smart Desk

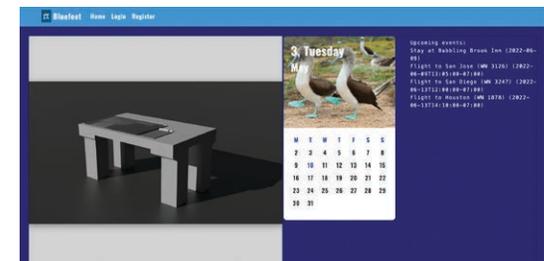
Best suited for users looking for an all-in-one setup equipped with an onboard display and control panel

## Our Solution

Embedded monitor & Raspberry Pi in a sleek and compartmentable desk providing 50%-100% more screen space while offering built-in, customizable productivity features.

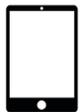


## User Workflow



Availability

## Hardware



Rasp. Pi LCD

- Provide a control panel for different modes and settings
- Acts as the initial access point for pairing device
- Touchscreen for accessibility



Rasp. Pi

- Provides file interaction via buttons
- Auto-brightness configuration
- Runs web-application



MySQL

- Build web-application suite
- Integrate Google, Spotify, and Discord tokens
- Create pathway to database for storing and accessing user info



Flask

- Manage client username and password
- Save registration information
- Authenticate user login

## Software

## Functional Prototype



## Contact Us

For more information, contact Lance Chong-Kit at [lichongki@ucsc.edu](mailto:lichongki@ucsc.edu)



## 1 Introduction

Wildfires pose an ever-increasing threat to commercial forests (Fig. 1). Existing wildfire prevention options for these forests are both expensive and unreliable. Firenode provides an affordable, effective, and long-lasting solution to wildfire prevention. It is designed to be easily deployed by timber companies to safeguard assets, nearby communities, and other stakeholders in the commercial forest industry.

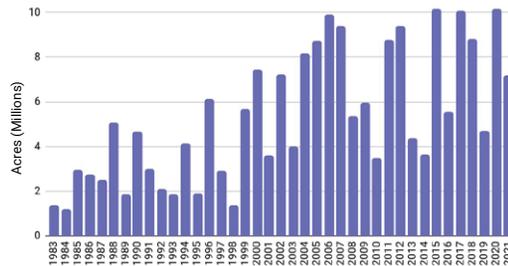


Figure 1: Acres burned by wildfires per year (U.S.)

## Target Users



### Tim Timber:

Mr. Timber is the owner of a large timber company. The Firenode early wildfire detection system can help him reduce economic loss caused by forest fires.



### Florence Firefighter:

Florence is a firefighter chief. Her crew will be responsible for responding to fires. Firenode can help her team respond to wildfires more effectively.



### Danny Driver:

Danny is the head driver at a timber company. Firenode provides Danny the early warning he needs to move expensive equipment out of the path of a wildfire.

## 2 Power Management

To reduce power consumption, battery-operated nodes run on duty cycles. The router node oscillates between low power sleep mode and active mode (listening/receiving messages) at a constant frequency. The detection node wakes up after a timer expires and performs a sensor reading. If a fire is detected, this is communicated to the sink node. Afterwards, the node returns to sleep.

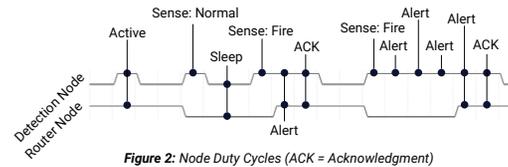


Figure 2: Node Duty Cycles (ACK = Acknowledgment)

## 3 Simulation

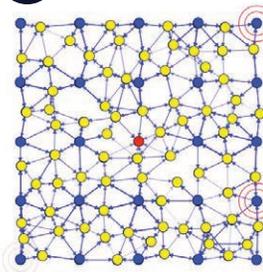


Figure 3: Cooja Simulation of Firenode network with 97 nodes exhibiting 100% connectivity

Simulation was done using the Cooja network simulator (Fig. 3). The purpose was to simulate Firenode's ability to handle complex network scenarios and perform crucial tests that could not be achieved physically. Each node is represented with colored dots: yellow for detection nodes, blue for router nodes, and red for the sink node.

## 4 Design

Node enclosures are designed to be assembled without tools or fasteners. Batteries are easily accessible. An elastic belt is used to mount the enclosure to the tree without impeding growth.



Figure 4: Detection node enclosure

## Prototype

The enclosure is 3D printed in polyactic acid (PLA) plastic. The detection node enclosure (Fig. 5) has a roofed, exposed sensor bay while the router node (Fig. 6) is completely sealed. Both designs have protected openings for external antenna.

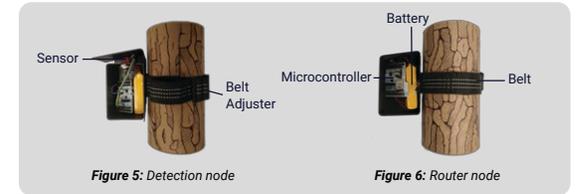


Figure 5: Detection node

Figure 6: Router node

## 5 Web Application

The web application allows for visualization of the sensor network (Fig. 7). It provides an interface through which nodes can be added, edited, or removed from the system and displays fire detection warnings in real time.

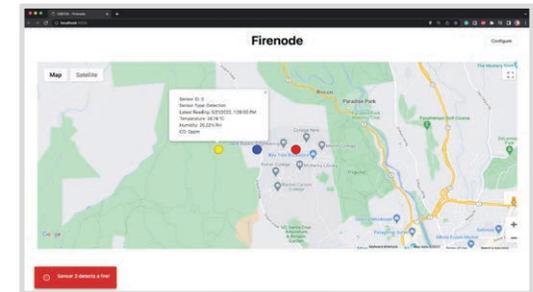


Figure 7: The Firenode web application

## References

"Wildfires and acres," National Interagency Fire Center. [Online]. Available: <https://www.nifc.gov/fire-information/statistics/wildfires>. [Accessed: 20-May-2022].



## Project Overview

**Need:** Too many bikes that are securely locked are still stolen and are not able to be recovered.

**Goal:** Reduce the number of securely locked bikes that are stolen and never recovered.

**Design Objectives:**

- Bike lock that is equally resistant to theft as other bike locks on the market.
- Incorporates a system that allows the lock to be easily located.
- Includes electronics that do not require frequent charging.
- Notifies the user of the status of their bike lock.

**Target Market:**



Steven Brown

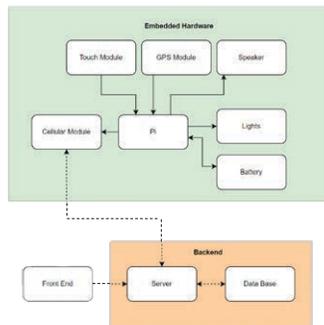
Student who needs their bike to commute between school and work and cannot afford it to be stolen.



Patty Smith

Police officer that wants to increase the amount of reported bike thefts that result in a successful recovery.

## Project Architecture

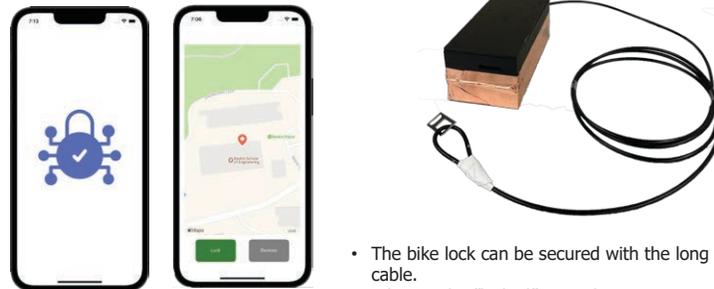


Overview of embedded hardware and its connection to the mobile application

## Aesthetic Rendering Cyber Cycle Lock



## Functional Prototype



- App implemented with React Native and Expo
- App displays the lock's tampered status and GPS location

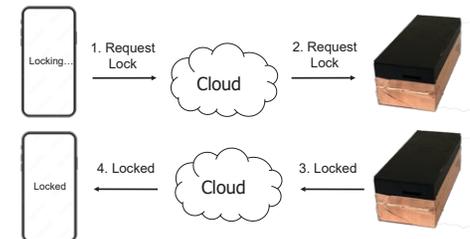
- The bike lock can be secured with the long cable.
- When in the "locked" state the copper tape will detect tampering and change of location.
- Tampering in the locked state will trigger an alarm and flashing LEDs.

## Summary of Features

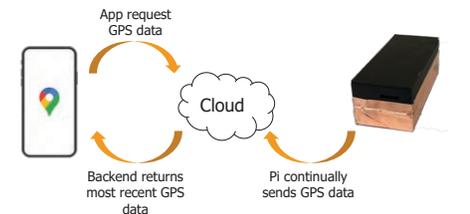
Feature Types	Features	Prototype Functionality
<b>App and Lock connectivity</b>	Cellular Connectivity	Simulated in Prototype
	Bluetooth Connectivity	Documented in Design Document
<b>App Features</b>	Lock and Unlock Functionality	Fully functional in Prototype
	GPS Location Polling	Fully functional in Prototype
	GPS Location Alert Notifications	Fully functional in Prototype
	Tampering Alert Notifications	Fully functional in Prototype
<b>Lock Features</b>	Lock and Unlock Remotely	Fully functional in Prototype
	Audio and LED Output	Fully functional in Prototype

## Backend Design

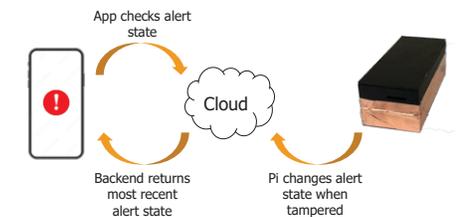
### Locking and Unlocking:



### GPS Feature:



### Notification Feature:



## Acknowledgements

We would like to thank Professor Harrison for guiding us through this project.

## Background

Blinds can be difficult to reach and open or close. So, we want to automate the process of opening/closing with an add-on.

### Objectives

- Cost effective - < \$20, available in any home improvement store
- Easy to Install: < 10 minutes, able to do without any tools.
- Range of remote - 10 meters, within anywhere in a house
- Range of curtain - 0 to 180 degrees, with precision up to 15 degrees

## Target Users



Worker who spends much of time in his room.  
Likes gaming in the dark



Senior who spends lots of time inside, but likes warmth from the sun. Struggles to work blinds rod.



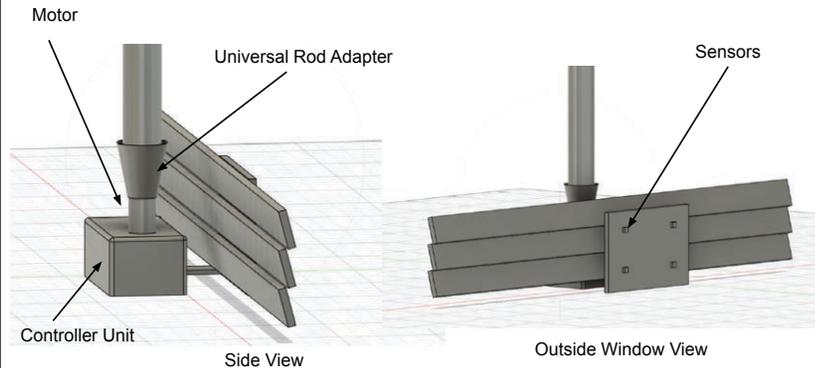
Influencer who wants to get the best possible natural lighting for her videos. Also enjoys doing yoga in her room.

## Contact Info

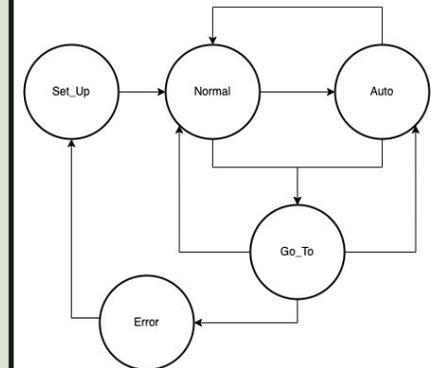
Luke Jeffrey: [ljeffrey@ucsc.edu](mailto:ljeffrey@ucsc.edu)



## Final Design Rendering

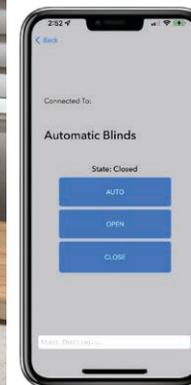
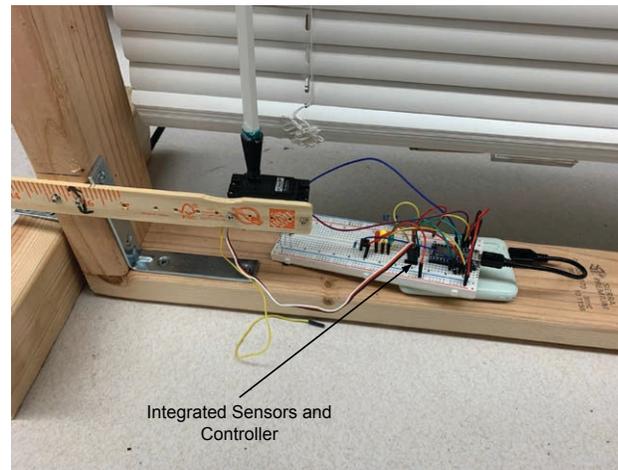


## State Machine



- Set\_up: Initial state to control openness level of blinds
- Normal: Wait for user input, i.e. button press or app message
- Auto: Waits for sensor input
- Go\_to: Controls moving of motor
- Error: Problem rotating motor, needs to be reset from setup phase

## Functional Prototype



Mobile Application User Interface

## Future Plans

- Multiple blinds support
- Easier installation
- Bluetooth authentication
- Auto mode customization
- Multiple levels of openness



Anthony White, Calvin Stickler, Connor Stewart, Maxwell Voorhes, Robert Witt, Sophia Dela Pena, Terrence Ng, Thomas Zhan

### Design Statement

#### Problem:

The frequent spread of COVID-19 has required people to maintain a distance of six feet from each other, which can be hard to enforce throughout the day.

#### Solution:

To create a device which will actively monitor the user's personal six foot radius and alert them if they are no longer socially distancing.

### Design Objectives



**Accurate**  
Within 1 foot



**Lightweight**  
30 - 80 grams



**Durable**  
Withstand small drops



**Rechargeable**  
Battery is rechargeable

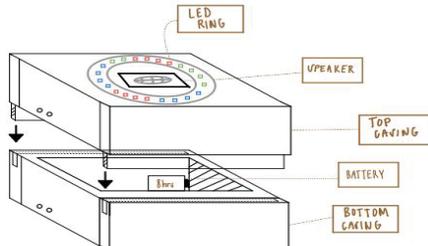
### Potential Users

- CEO of tech company that wants to promote social distancing within the workplace
- Person with COVID-19 who still wants to go about their daily life with caution
- Visually impaired person who can't see if they're properly social distancing



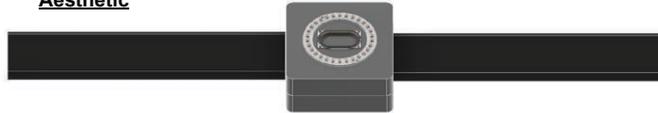
### Design Features

- Haptic components are easily accessible for replacement
- Open/close mechanism for casing requires no additional tools
- Device lasts eight hours on a full charge

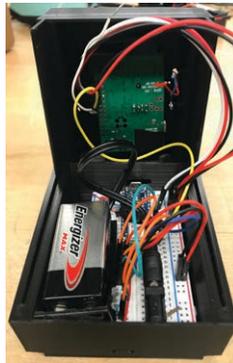


### Prototypes

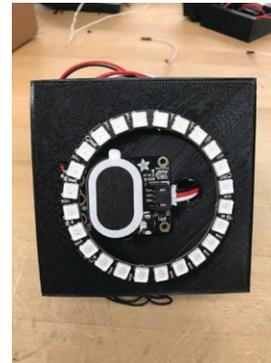
#### Aesthetic



#### Functional

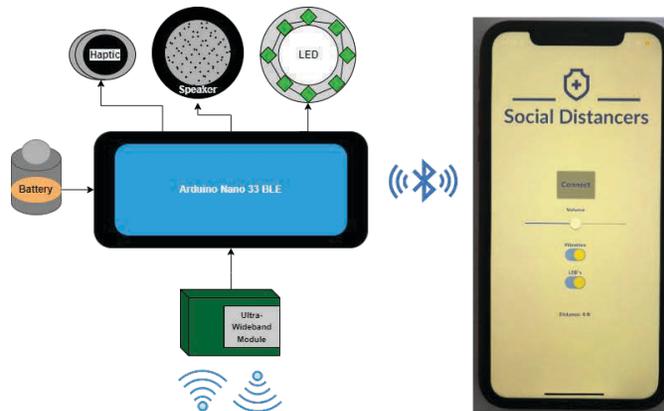


Internal Components

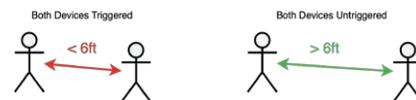


External Components

### Internal Component Schematic



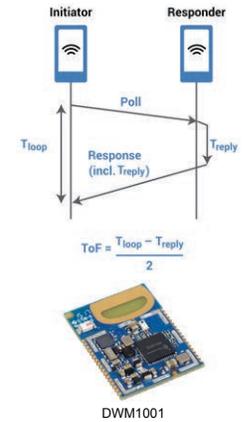
### Usage Demonstration



Contact Info: SocialDistancerDevice@gmail.com

### Distance Detection

- The initiator and responder both take timestamps as they send and receive Ultra-Wideband messages
- These timestamps are used to calculate Time of Flight (ToF)
- The ToF along with the speed of light is used to calculate distance
- Each device alternates from being the initiator and the receiver so they each get a distance reading
- Distance Detection is executed by the DWM1001 Ultra-Wideband module



### Design Overview

- The DWM1001 Ultra-Wideband Module (UWB) measures and calculates the distance
- The Arduino Nano microcontroller obtains the distance from the UWB and calibrates it to get a more accurate distance reading
- The Nano then communicates with our React Native Application via Bluetooth Low-Energy (BLE) to send the app its detected distance
- The Nano then receives information from the app to acknowledge that its signal has been received, as well as to take in any feedback changes that the user desires
- The Nano then triggers the vibration motors, LED ring, and speakers if the distance detected is less than six feet



Arduino Nano BLE 33



Speaker



LED Ring



Vibration Motor

### Mobile App

- Simplistic design offers a streamlined and guess-free experience without the need for a tutorial or instructions
- Features include volume level control, silent mode, the ability to toggle the LEDs, and real-time distance readings



Built with React Native



Communication via Bluetooth



# TR.A.V.I.S. Television Remote and Voice Interpretation System

Ann Sophie Abrahamsson, Nathan Banner, Lillian Gwendolyn, Katy Johnson,  
Aidan Martens, Heath Robinson, Kanybek Tashtankulov



- Simplified TV remote to make channel surfing more accessible.
- Uses voice recognition software to listen and respond to the user's commands if buttons are out of reach.

### What is TRAVIS?

#### Simple Design

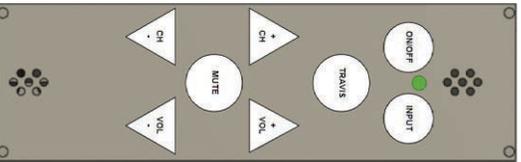
- 8 large, easy-to-press buttons.
- TRAVIS button toggles voice activated software on and off.
- LED lights up when listening.
- Simplified, ergonomic design.
- Button layout matches your remote.

#### Easy Setup

- TRAVIS asks for TV manufacturer when first powered on.
- Model remembered thereafter.
- Ideal for those not tech savvy or frustrated with modern remotes.

#### Commands Available

- "TRAVIS, initialize"
- "TRAVIS, turn power on/off"
- "TRAVIS, change input/source..."
- "TRAVIS, change channel (to)..."
- "TRAVIS, channel up/down"
- "TRAVIS, mute"
- "TRAVIS, turn volume up/down"
- "TRAVIS, assign..."



- ★ Every button bigger than a quarter!
- ★ Microphone and speaker placed like a phone!

### 3D Printed Design

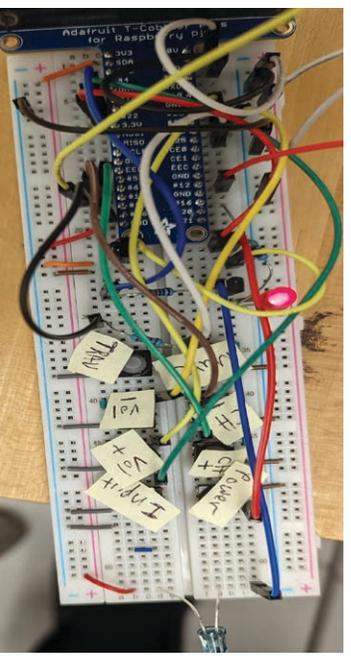
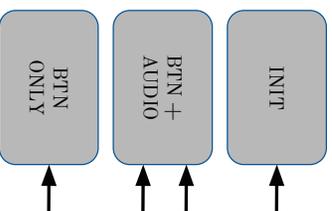


- Key Features
  - Removable battery door for replacing 9V battery.
  - Simple to manufacture design, needs only screws.



### What Makes TRAVIS Tick?

- Runs on a Raspberry Pi Zero 2 W - small form factor and high power gives quick audio feedback.
- Google speech processing available with wifi connection.
- CMUSphinx speech processing available for offline use.
- Runs speech through REGEX to determine command.
- Successful command sent through LIRC to pass signals to TV.



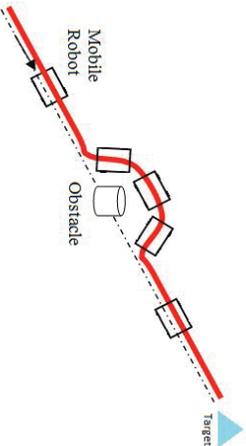
### Acknowledgements

- ❖ Thank you to Dr. David C. Harrison for valuable guidance and feedback, as well as finding us a TV to work with.

# Smart Dog Rover

## Introduction

Senior citizens and people with mobility issues are limited in the range of loads that they can perform. Our project can increase targeted people's ability to carry heavy loads and independence of allowing them to perform more loadings.



### Object Avoidance

- Object avoidance is implemented and functional.
- The rover is capable of determining whether there are obstacles in its way and avoid it while continuing to track the object it is supposed to track.
- Two Infrared sensors detect car side distance and a Ultrasonic Sensor detect the distance in front.

Contributes to



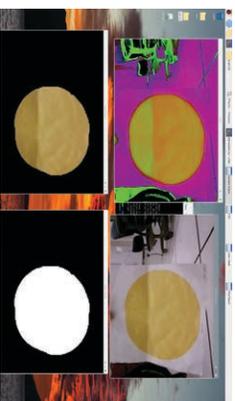
### Infrared Sensor

- IR Infrared Obstacle Avoidance Sensor Module can be widely used in robot obstacle avoidance.
- Detect Distance: 20-30 centimeters.



### Ultrasonic Sensor

- Ultrasonic sensor is used to detect the distance between obstacle and smart rover dog.
- Detect distance: ~ 2 meters.



### Object detection

Top right: Camera output  
Top left: HSV  
Bottom right: color mask  
Bottom left: Final result

### PI Camera—Object detection and tracking algorithm

- Tracking yellow ball
- Using OpenCV library
- Define the lower and upper boundaries of the "yellow" ball in the HSV color space
- Resize the frame, blur it, and convert it to the HSV color space.
- construct a mask for the color "yellow"
- Keep the yellow ball in the middle of the window

Functionalities



Functionalities

- **Raspberry Pi**  
• Control all the sensors and camera.



### Arduino MEGA

- Control all the motors and batteries.



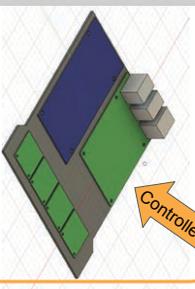
Controllers

### Manufacturing and maintenance

- Utilizes modularity to streamline the manufacturing process.
- Twin hull design simplifies maintenance and weather resistance.



Controller Placement



### Our Functional Prototype

#### Main Feature

- 20 bit bearing capacity
- 5 hours power supply
- Track and follow a yellow dot
- Standby when in range
- Obstacle avoidance
- Bluetooth function the LED light

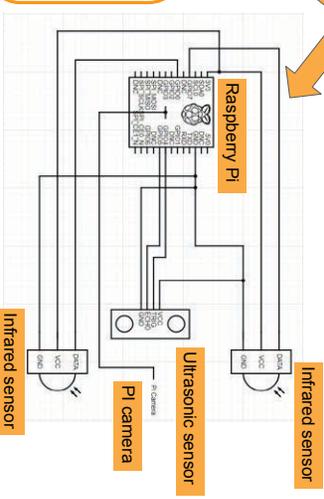
### PI Hardware Schematic

Raspberry Pi connection with Ultrasonic sensor, Infrared sensors and Pi Camera

### Bluetooth



- Bluetooth functionality is not fully implemented.
- Currently, manually control via bluetooth is still lacking.



**Acknowledgements:** We would like to thank Professor Harrison ,CSE 123 classmates and BELS team support and knowledge throughout the design process.



# Remote Wildfire Detection System

Izak Oien, Joshua McIntire, Prajit Saravanan, Zack Halverson

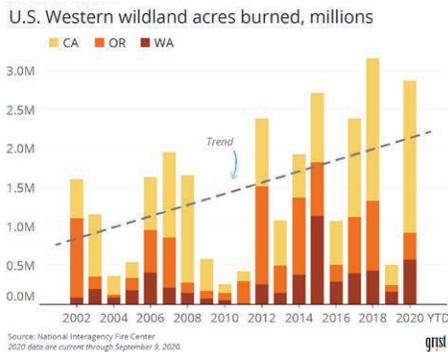
Senior Design Project: Electrical and Computer Engineering/ Robotics Engineering



## Overview

With many of the most destructive wildfires starting deep in the forest, a system is needed to be able to detect the presence of fires in remote areas and report them. Our system is able to operate for extended periods in remote locations with minimal infrastructure. It monitors environmental conditions through the use of various sensors and transmits this information and any detected fires to first responders.

### Problem Statement



In the western portion of the United States, wildfires burn millions of acres each year, leading to lost forests, towns, and lives. With the increasing threat and destruction, there needs to be a system for early detection and prevention which current solutions are not able to adequately accomplish. The likelihood of a wildfire is usually based on environmental conditions including temperature, humidity, and soil moisture. Therefore the system needs to be able to sense this information, operate in remote locations, and communicate with first responders who are away from the source.

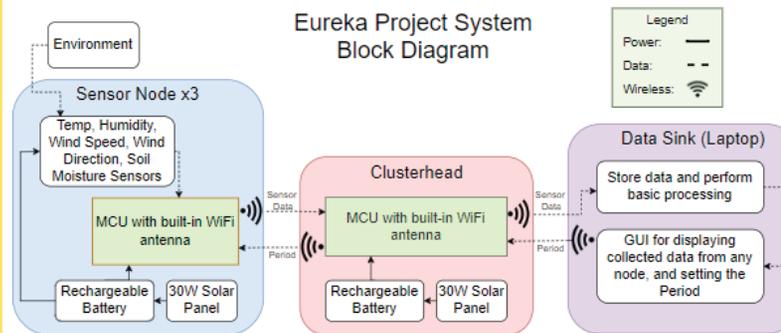
### Acknowledgements

Our team would like to thank Graduate Student Andrea David and Professor Katia Obraczka who entrusted us with their project and provided us with the knowledge and resources necessary for completion, and Professor Tela Favaloro and Professor Stephen Petersen for their guidance.

### EUREKA Project

The system is comprised of three major subsystems: sensor node, clusterhead and datasink

- **Sensor Node:** There are three sensor nodes, each equipped with a sensor suite, an MCU, a solar power system and an antenna. The nodes are mounted onto a pole and held in weather proofed housing.
- **Clusterhead:** There is a single clusterhead which aggregates data from all sensor nodes and sends it wirelessly to the datasink. The clusterhead housing is identical to that of the sensor nodes.
- **Datasink:** The datasink is a webserver, hosting all data gathered at the clusterhead and displaying this sensor data in a user friendly GUI. The user has the option to change the system's duty cycle from the datasink.

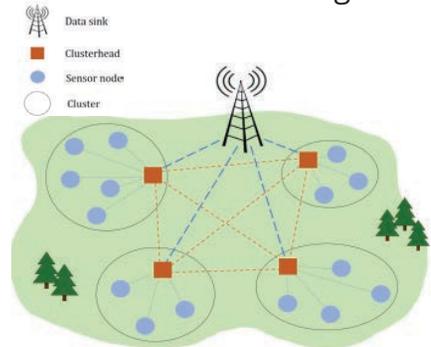


The EUREKA system is powered using easy to set up solar panels that are effective in keeping the system operating in remote locations. The system wirelessly communicates with the data sink, providing completely remote operation.

### Results and Conclusion

The EUREKA wildfire solution is a successful prototype for the EUREKA IoT remote monitoring system. The system is able to function for a week without a solar source in the field, detect extreme temperatures and alert the user of a potential fire. The data sink keeps a log of all sensed information in cloud storage, allowing for researchers to perform analysis on the data and develop fire prevention strategies.

### Future of the Design



The future system will continue to use three hierarchical levels and the scale will be increased with the Clusterhead collecting sensed data transmitted by 5 or more Sensor Nodes and the Data Sink receiving data from multiple Clusterheads. The Data Sink will be able to identify areas of high fire risk.

# Slugcharge: Renewable Charging Station

## Empowering the homeless community



Dept. of Electrical and Computer Engineering

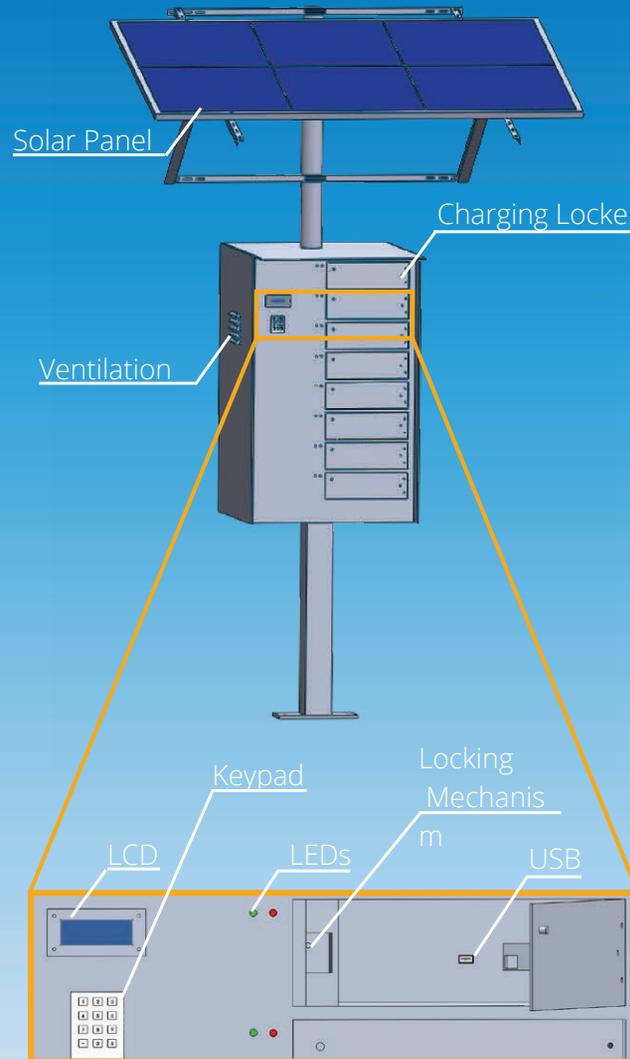
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### Problem

Santa Cruz County has the highest homeless population per-capita in the state of California, with approximately 2,200 unsheltered. These individuals don't have access to a reliable free power source to charge their phones and electronic devices, leaving them unable to communicate with loved ones and assistance programs. This project aims to develop an easily accessible station for those experiencing homelessness to charge their phones.

### Features

- Fast Charging: Charge phones up to 2.4A.
- Stand-Alone: Completely off-grid, powered by 100% renewable energy allowing for access at any location.
- Durable Design: Weather resistant to ensure longevity of the station.
- User Friendly: Easy to operate.
- Storage Security: Lockers are password protected and designed with security in mind.



### How it Works

The entire system is powered by a single 335W monocrystalline solar panel. System control is performed using an ATmega2560, and users are able to interact with the station through a 16x2 LCD and 3x4 keypad. Designed with eight individual lockers, users are able to choose their own locker with a personalized password. Each locker has two LEDs to display occupancy status for users.

### Conclusions

Each subsystem was tested and verified. These are the major results:

- Power System: Simulated using real solar irradiance data that showed the design can operate in conditions year-round.
- Embedded System: Tested system functionality through user interaction.
- System Integration: A prototype of a single locker was constructed that validated the compatibility of the mechanical and embedded subsystems.

# Linear Transponder: EXTENDING LONG DISTANCE HF RADIO COMMUNICATIONS

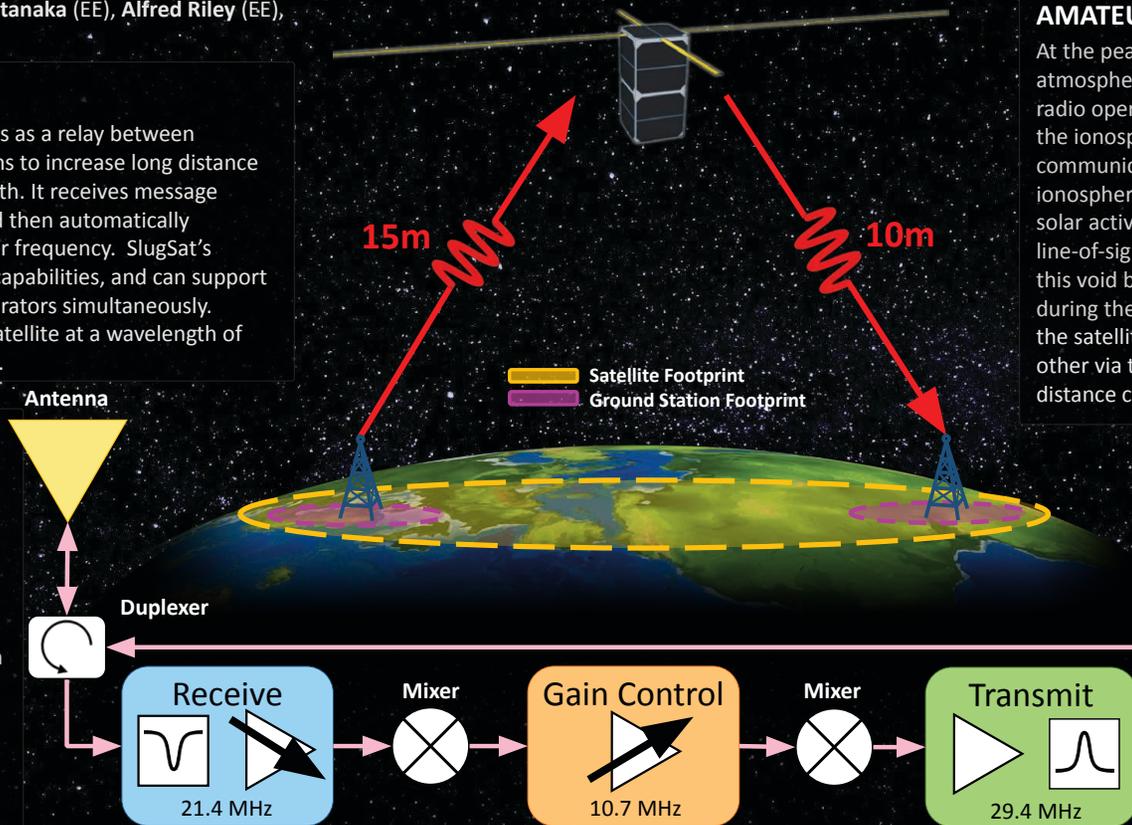
**Team Members:** Colin Hatanaka (EE), Alfred Riley (EE), and Joseph Kneeland (EE)

## WHAT DOES IT DO?

The linear transponder serves as a relay between amateur radio ground stations to increase long distance communication range on Earth. It receives message signals on one frequency and then automatically re-transmits them on another frequency. SlugSat's transponder has full duplex capabilities, and can support up to 10 single-sideband operators simultaneously. Signals are received by the satellite at a wavelength of 15m and transmitted at 10m.

## ANTENNA

- The HF Duplexer allows our system to utilize one antenna for receiving and transmitting RF signals.
- The duplexer is a lumped element filter and impedance transformation network comprised of third and fourth order inverse chebyshev topology filters.
- The current design (Duplexer Rev 0.3) meets the majority of the revised design parameters, but requires additional fine tuning.



Signals are received at 21.4MHz, mixed to 10.7MHz for power stabilization, then mixed back up to 29.4MHz for transmission.

## GAIN CONTROL STAGE

- Automatic gain control stabilizes signal power via active adjustment of system loop gain.
- A variable gain amplifier and attenuator are controlled via a MCU with feedback from an RSSI detector.
- This keeps signals below power levels harmful to the system over a range of possible Rx powers.
- Our team fully defined by the automatic gain control algorithm with script to accommodate future updates to component parameters. This remains to be implemented in code.
- The RSSI detector stage was entirely redesigned by our team to improve detection range and accuracy.

## AMATEUR RADIO

At the peak of the 11-year solar cycle, Earth's atmosphere becomes electrically charged. Amateur radio operators can then bounce HF radio waves off of the ionosphere, allowing ground stations to have a larger communication range, or footprint. Unfortunately, the ionosphere cannot reflect HF radio waves during low solar activity, limiting stations' footprints to their line-of-sight above Earth's horizon. Our satellite will fill this void by facilitating long-distance communications during these conditions. Any two ground stations inside the satellite's footprint can communicate with each other via the linear transponder, thus providing the long distance communication link.

## TRANSMITTING STAGE

- The transmitting stage amplifies the signal to a high enough power level to be received on Earth.
- In order for the signal to be coherent, the amplification is required to introduce significant gain with a linear input to output power relationship.
- The resultant gain of the amplifier has increased by a factor of 10 to meet requirements.
- The 1-dB compression point of the amplifier increased by a factor of 3.3 to meet requirements.
- The amplifier will require additional fine tuning in future revisions.



### Problem

Home cooking is abandoned by more people because of the convenience of pre-made meals and food delivery services. To bring people back to a healthier option for food, we "smartified" an existing range hood to reduce users' workload and time spent cooking.

### Approach

Our team uses sensors and a microprocessor to automate range hood ventilation and lighting to reduce interaction for a cooking session. This range hood integrates different kitchen tools to reduce user's workload and combines with safety features to prevent potential fire hazards. To reduce frequency of cleaning, it also includes gesture control and other features.

### Overview

- The Smart Range Hood GUI is interactable with a hand gesture sensor. A sequence of hand gestures can enable different functions for a simplified cooking experience. These functions include the following:
- **Autonomous Ventilation:** Fully automatic on/off and fan speed adjustment
- **Autonomous Lighting:** Auto-on when approaching the range hood in the dark
- **Integrated Cooking Timer:** Touchless cooking timer for any cooking scenarios
- **Boiling Water Alarm:** Allow effective usage of wait time for water to boil
- **Screen Mirroring:** Cast recipes and cooking videos on a large screen
- **Unattended Stove Detection:** Prevent fire hazards caused by an unattended stove
- **Check Filter Reminder:** Prevent greasy kitchen caused by dirty grease filters
- **Gesture Control:** Easier and cleaner interaction with the range hood

### Results

The system updates in an average of 0.514 seconds and have been stably running for over two days.

Autonomous ventilation achieves auto on/off and fan speed adjustment with an average response time of 8 seconds. Autonomous lighting has successfully turned on and off based on ambient light intensity and contains feedback rejections. Integrated cooking timer feature achieves  $\pm 1$  second accuracy over 10 minutes. Check filter reminder feature successfully records 20 minutes of ventilation activities. Boiling water alarm feature successfully detects boiling water between volume ranges of 200 mL to 4000 mL.

Unattended stove detection safety feature is still in progress to be implemented in the meantime because the infrared radiation from the hot stove surface causes false positive readings of human presence on the PIR sensor.

### Conclusion

The Smart Range Hood was able to automate range hood ventilation and lighting, integrate existing kitchen tools such as kitchen timer and thermometer, provide safety features such as filter change reminder and reduce the frequency of cleaning with touchless gesture control.

Annotated Functional Prototype

**PIR (Passive Infrared) Sensor:** Detect motion in the kitchen to determine human presence

**Gesture Sensor:** Detect hand gestures as user inputs to navigate the GUI

**Photosensing Circuit:** Detect ambient light intensity to turn on/off the light

**Raspberry Pi:** Processes all sensor readings and provides video and audio output



**Ultrasonic Sensor:** Detect cookware presence and an alternative way to detect stove state

**Thermal Camera:** Monitor stove temperature to determine stove state

**Relay Control Board (Hidden):** Controls ventilation and light signals of the range hood



## Abstract

SproutLabs utilizes a device called a Sprouty to collect soil, climate, water, and weather data. This data is stored in a cloud database and can be accessed and used through a web application. The Sprouty can help from potted plants to large scale farms.

## Glossary

- Sprouty**  Hardware device used to collect field environment data
- Firebase**  A place to store the data collected
- Google Cloud**  Web host that allows all our information to stay online
- Node**  A singular device to a user account
- Valve**  Automated water dispenser to plant
- API Gateway**  A connector between the front end and back end, approving connections between
- OSO**  Authorization package for Golang Applications

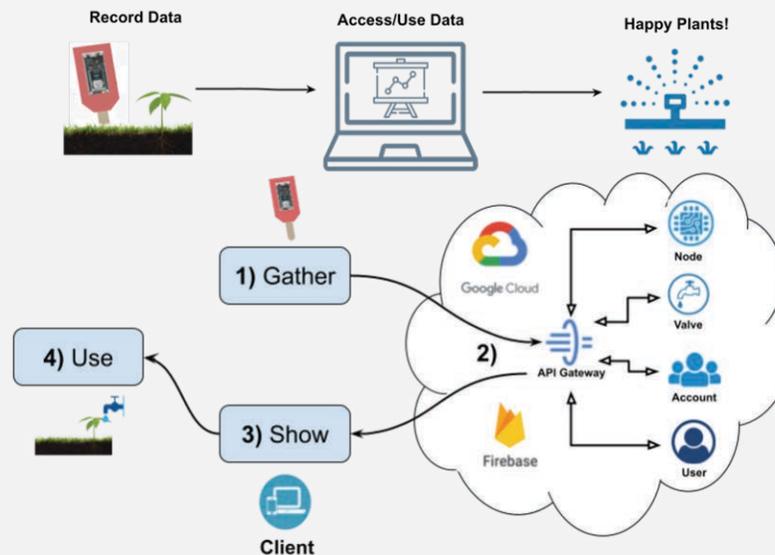
## Acknowledgments

SproutLabs:  
**Yuan Lin** and **Babandeep Singh**  
And to our teaching staff:  
**Professor Richard Jullig, Aidan Smith,**  
and **Patrick Mantey.**

## Overview

Water usage and conservation is a pressing issue in society. SproutLabs addresses this issue with the Sprouty device, and guarantees plant health while promoting water conservation. We created a more reliable backend and added safeguards for users' private data. In addition, we improved the Sprouty device by incorporating a new sleep schedule to increase the battery life and a log function to track the information.

## Architecture



## Conclusion

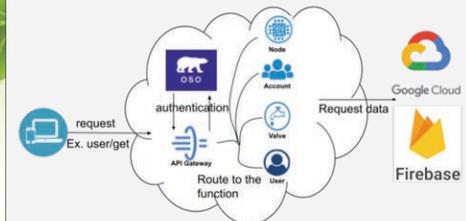
Not only did we make the backend more robust by creating new tests, but we also worked on restricting account access to only specific users. With this new backend and enhanced hardware, SproutLabs is now ready to develop a web app so customers can see and use the data for optimal irrigation decisions.

## Approach

- 1) The Sprouty device gathers field data.
- 2) Data is gathered through the API Gateway and is stored in Firestore. It is then shared with the Node, Valve, Account, and User functions.
- 3) Each user can manage Node data through the web application.
- 4) Data in the cloud is processed to optimize the watering schedule. The server then irrigates at optimal times through the Valve.

## Results

- Thoroughly tested backend through unit testing, API testing, end to end testing.
- Golang and OSO used to create authentication and authorization roles to limit the access and operation permissions of different users and set access restrictions for different types of data.



- Hardware facilities achieve shorter response times and can effectively reduce the consumption of equipment power



## CONTACT US

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