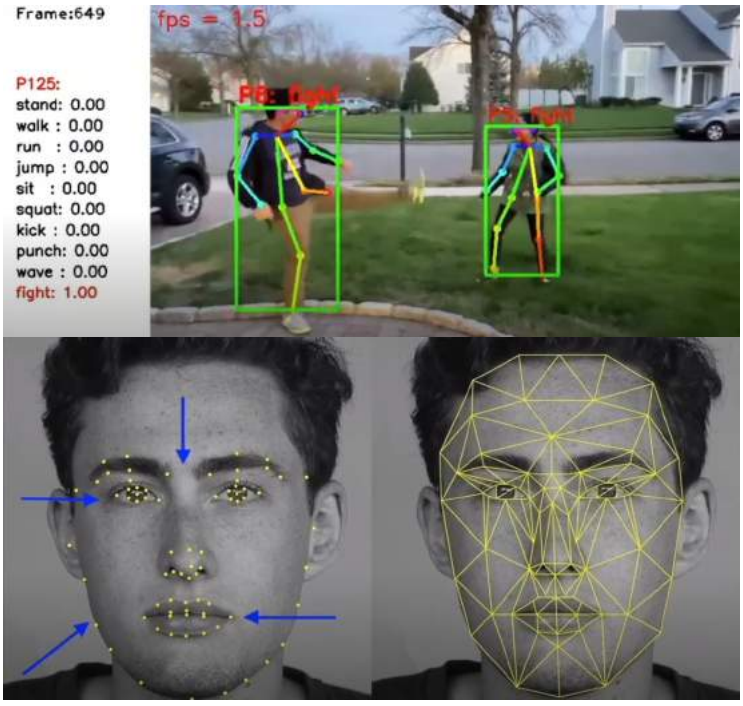
School of Engineering
Department of Electrical and Computer Engineering

# Capstone Program Spring 2021

# Senior year Design Projects

# At a Glance…



***S21-01*** ***Title***: *Energy Disaggregation using NILM*

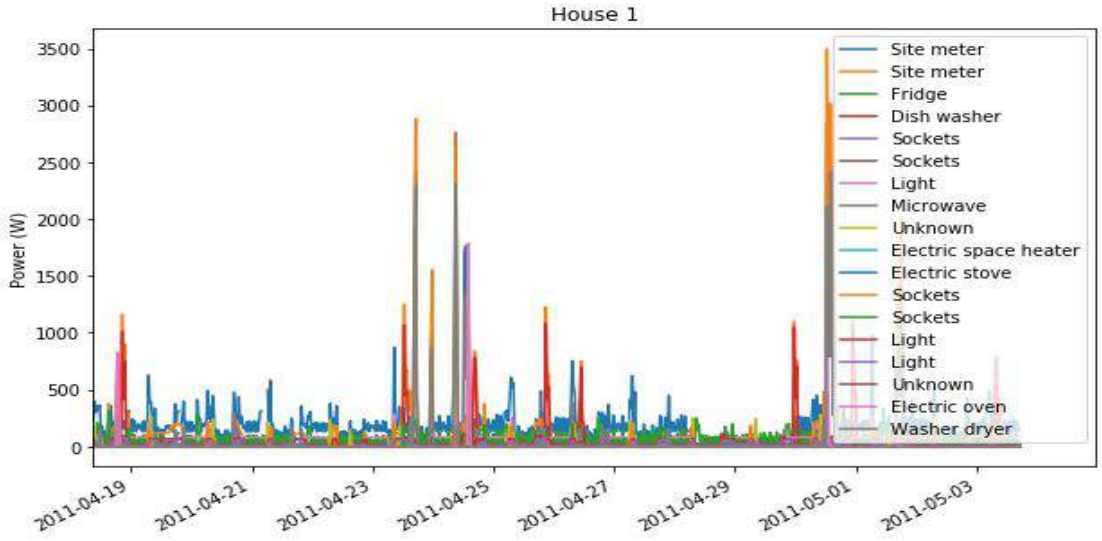
***Team Members***: *Lori Cheng, Elaina Heraty, Raul Mori, Jake Seary, Andrew Tomlinson*

***Advisor***: *Dr. Hana Godrich*

***Keywords*** REDD, Neural Networks, Non-Intrusive Load Monitoring, Energy Disaggregation, Autoencoders

***Abstract***

For this project we will be analyzing the topic of energy disaggregation through deep learning techniques similar to those done by Mario Berges and Hanning Lenge in their paper BOLT [3]. To do this we will use the Reference Energy Disaggregation Data Set (REDD) as detailed in [1]. The purpose of energy disaggregation is to calculate the energy consumption of individual appliances given the total aggregate power consumption of a system such as a house. The process begins with preprocessing data consisting of power measurements for both whole residential homes as well as individual appliances and devices within them. Once the data is cleaned and initially modeled, we experiment with various neural networks such as autoencoders and convolutional neural networks which will be fed the cleaned data. This network should then output different waveforms for which we will then have to label according to the appliances they represent. Once the inferred subcomponent waveforms are obtained and the labels are made, we will then present a way to visualize these results in a user interface. Ultimately, one will be able to obtain the power consumption of their home, visualize it, and be able to make better energy choices off it. This work is based on Non-Intrusive Load Monitoring (NILM) which seeks to obtain measurements on the loads of individual appliances in a building while only measuring the total load of the system. This allows us to eliminate the cost of installing multiple individual sensors to measure power consumption of single appliances. Instead, we can have one single apparatus hooked up to the central power system, and infer the subcomponents using deep learning.



**S21-02** **Title**: *Real-time Analytics of Hurricane Gliders*

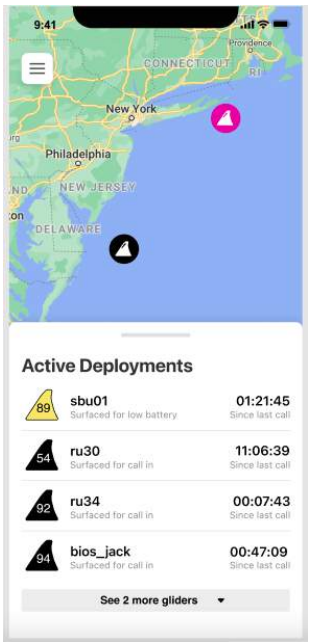
**Team Members**: *Radhe Bangad, Matthew Chan, Brian DelRocini, Kinjal Patel, Jasmine Philip*

**Advisor**: *Dr. Scott Glenn*

**Keywords** Hurricane Predictions, Machine Learning, Data Analytics, Mobile App Development, Web App Development

**Abstract**

In 2014, the National Oceanic and Atmospheric Administration created a pilot project that consisted of deploying underwater autonomous robots, called gliders, to monitor upper ocean conditions. The information gathered by these gliders has been crucial to improving hurricane intensity forecasts, a task that requires large amounts of data and has for the most part, eluded hurricane specialists. While the gliders are autonomous during their assigned "missions", they still require pilots for directional instructions. Glider pilots must sift through large quantities of data, usually in formats that must be parsed and converted to graphs for legibility and in various file types that make code-sharing a challenge. Pilots must then manually input directions to the gliders once they complete missions or have unexpectedly surfaced. Currently, pilots use a web application to deal with these matters. However, as it translates to a poorly accessible mobile application and the gliders could need pilot assistance at unpredictable times, there is need for a more accessible method of pilot-to-glider communication. With close coordination and direction from the Rutgers University Center for Ocean Observing Leadership (RUCOOL), this project will consist of creating intuitive web and mobile applications to integrate various datasets from the gliders and automate data analysis and communication with the gliders. These applications will be tested with active glider pilots at various research facilities. We aim to aid glider pilots in making better informed and quicker piloting decisions, alleviate their pressure and increase accuracy via automation, and ultimately improve hurricane predictions for general public safety.

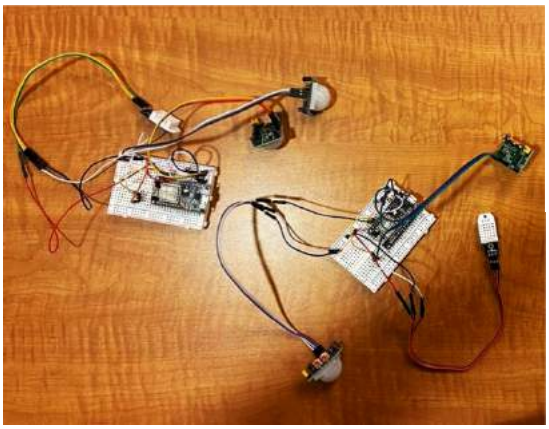
***S21-03*** ***Title***: *Saving Energy in The 21st-Century Through Real-Time Appliance Monitoring*

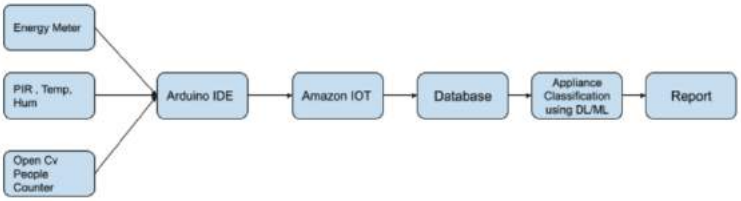
***Team Members***: *Karan Parab, Aashish Shashidhara Bharadwaj, Srinjoy DasMahapatra, Victor Abril*

***Advisor***: *Dr. Jorge Ortiz*

***Keywords*** Occupancy detection; energy data; smart meters; machine learning techniques; Arduino sensors.

***Abstract*** In this project, the challenging problem of occupancy detection in a domestic environment is studied based on information gathered from HVAC (Heating, Ventilation & Air Conditioning) data. The most popular machine learning techniques, along with their boosting versions, that are utilized for occupancy detection use measurements of a PIR sensor for training purposes. In order to evaluate information gained from electricity features and to reduce dataset sparsity, while maintaining the performance of classification techniques, mutual information is used as a feature extraction technique. In order to determine the most efficient parameter combinations of machine learning techniques, we performed a series of Monte Carlo simulations for each method and for a wide range of parameters. Our simulation results show a superiority of Random Forest learning technique compared to the other classification techniques with accuracy slightly over 80% and F-measure with almost 84%, respectively.






```
N_CLASS = 2
ctx = mx.cpu(0) #change context to execute on CPU
model = BaseRNNClassifier(ctx)
model.build_model(n_out=N_CLASS, rnn_size=8, n_layer=1)
model.compile_model()
train_loss, train_acc, test_acc = model.fit([X_train, y_train],
[X_test, y_test], batch_size=32, epochs=10)
```

***S21-04*** ***Title***: *Posture Alert System*

***Team Members***: *Rebecca Golm, Disha Bailoor, Nabeel Saud, Shaan Kalola*

***Advisor***: *Dr. Anand Sarwate*

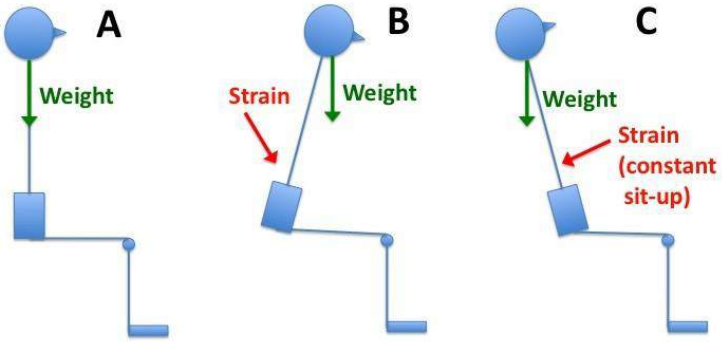
***Keywords*** Posture, Alert System, Sensor Matrix, Machine Learning Algorithm, Frontend UI

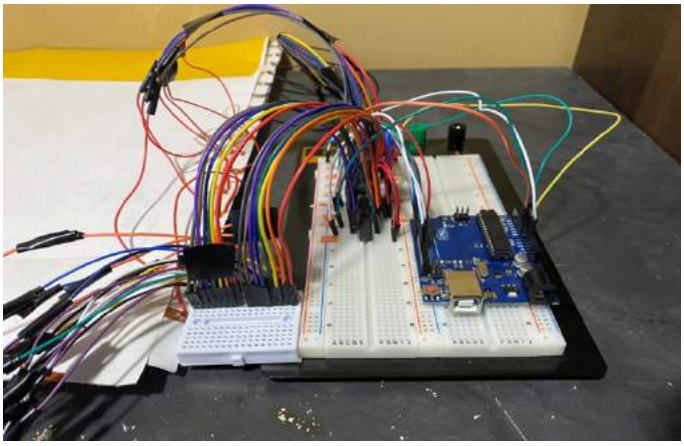
***Abstract***

Many people spend most of their day sitting in a chair working on their computer. Keeping good posture while sitting on a chair for long hours is important to prevent various health issues. While there are current solutions for this problem, most of them require the user to wear a device, which can feel intrusive and uncomfortable. Our solution to this problem is to create a posture alert system that notifies the user when they need to fix their posture. We will do this by creating a sensor pressure matrix to detect the user's posture by their weight distribution using a machine learning algorithm. This information will then be presented to the user through a user interface.

Goal: Create a smart seat cushion that detects incorrect posture and sitting time to prevent health issues caused by a sedentary lifestyle.

Impact: Help people with sedentary lifestyles make healthier choices in terms of posture and screen exposure.



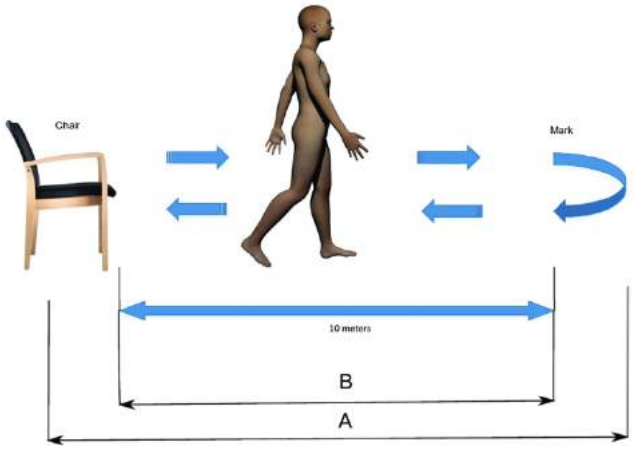
***S21-05*** ***Title***: *Wearable Fall Risk Detector*

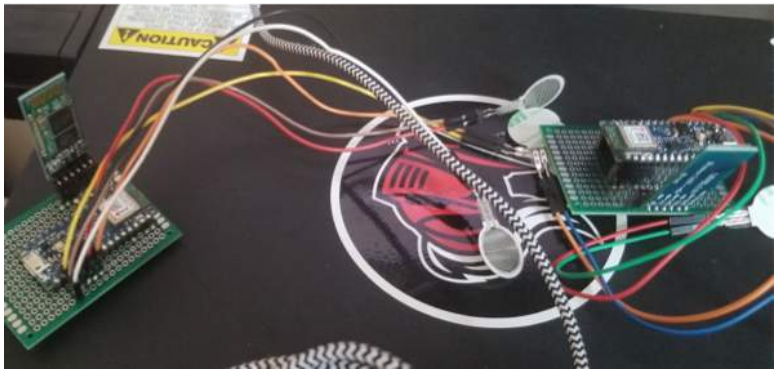
***Team Members***: *Joseph Akselrod, Ritvik Biswas, Tyler Hong, Heather Wun*

***Advisor***: *Dr. Umer Hassan*

***Keywords*** Discrete, Biomedical, Quantitative, Early Detection, Diagnostics

***Abstract*** This project intends to solve a growing problem of detecting elevated risk for falls in people with various medical problems, advanced age, changes in medications, mental status, and other factors. We design a discrete and non-invasive pressure sensing biosensor with the ability to perform a "Timed Up-And-Go Test" commonly used by medical professionals in order to quantitatively assess elevated risk for falls. Our solution is to be discrete enough where these tests are performed discretely throughout the day and will not require supervision by any medical professionals.



***S21-06*** ***Title***: *Charging Made Simple for You and the Economy*

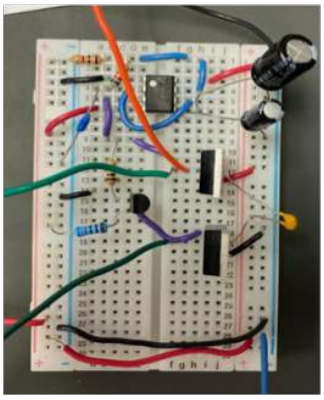
***Team Members***: *Debendro Mookerjee, Thomas Darlington, Daniel Audino, Pratik Patel*

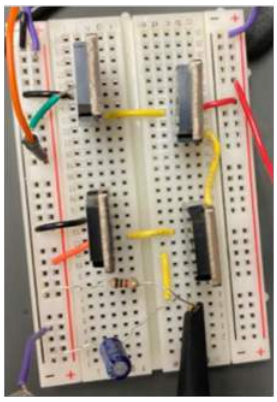
***Advisor***: *Dr. Michael Caggiano*

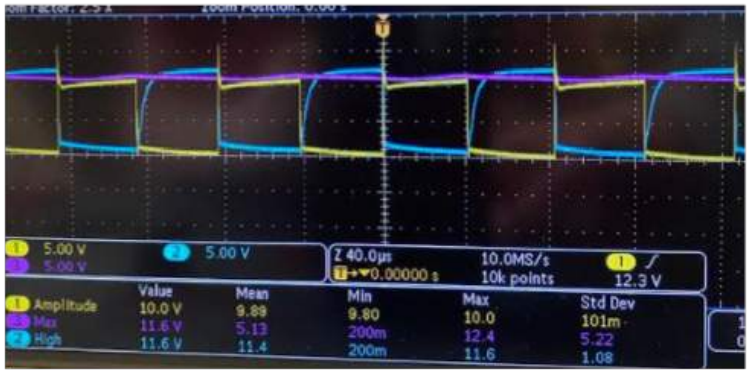
***Keywords*** Charging, electric scooters, environmentally friendly

***Abstract***

In this report we summarize the goals of our Capstone Project. Our project strives to improve the way Veo's electric scooters are charged by making battery charging simple, user-friendly, inexpensive, and environmentally friendly. These electric scooters are found in many on campus and off campus locations and are used by many residents and Rutgers students. We find that the current method of charging these scooters is inefficient and we believe that altering parts of the scooter design and shifting charging responsible from company to consumer will benefit everyone. In this report we explain the theory behind our planned alterations as well as explain how we plan to execute our ideas.





***S21-07*** ***Title***: *PiCamRU: An advanced dashcam that uses machine learning to improve driving habits*

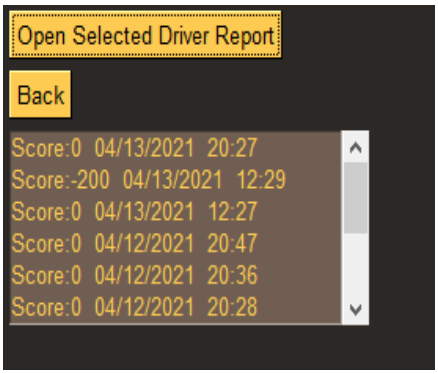
***Team Members***: *Abdullah Bashir, Nayaab Chogle, Nisha Bhat, Amali Delauney*

***Advisor***: *Dr. Bo Yuan*

***Keywords*** Ml, R-PI

***Abstract***

We present our plan to come up with a more accessible solution to existing dashcams while also expanding upon common features. Cloud storage and automatic file uploads should be standard in this day and age, but it is hidden behind a paywall that comes with unnecessary features. We have decided to use the Raspberry Pi Model 4B and we plan on implementing a graphics user interface through an LCD touch screen module with the device. The first functions to implement would be loop recording and file upload, followed by impact detection and event tagging. Computer vision libraries and established machine learning algorithms will be used to formulate a driving performance report. This will encourage the correction of negative driving habits and should lower the risk of an accident occurring.


***S21-08*** ***Title***: *Bike Head-Up Display Equalizer (B.H.U.D-E)*

***Team Members***: *Andrew Ceng, Weibin Chen, Ian Chiang, Shamehir Raja*

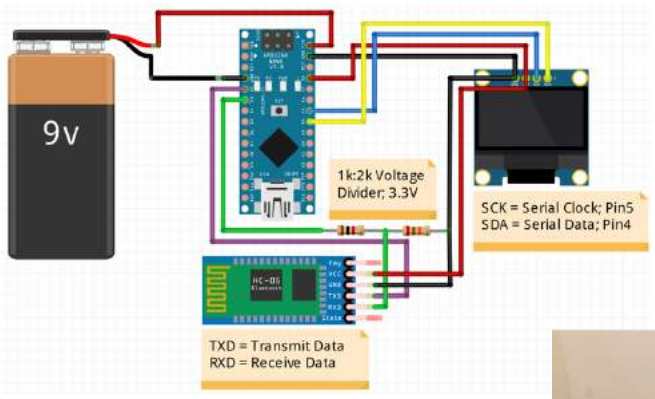
***Advisor***: *Dr. Wade Trappe*


| | |
|---|---|
| ***Keywords*** | Arduino, Bluetooth, heads-up display, helmet, motorcycle, safety |



***Abstract***

While cars have recently been enjoying a plethora of advances in crash prevention and safety, most notably with Tesla and their A.I. autopilot and automatic braking features, but the same could not be said for motorcycles. Over the past few decades, while deaths from car accidents have steadily gone down thanks to improved safety designs and features, deaths from motorcycle accidents have remained approximately constant. Thus, an incredible imbalance, in terms of safety, exists between a car and a motorcycle. Backup cameras have become a staple in nearly every modern car, whereas motorcyclists still require turning their head around and/or taking off their helmet. Close proximity sensors have also entered the mainstream, since they help alleviate blind spots and provide crucial information to the driver; however, motorcycles have yet to see widespread usage. Clearly, there is a need to equalize this disparity, which is what our group aims to do through the application of existing safety technology. By implementing features such as a heads-up display (HUD) into a helmet and close proximity sensors to the physical body of the vehicle, the rider will have more data available, which can help them make informed decisions and possibly save their life.


**S21-09** ***Title***: *Got it! Entity capture*

***Members***: *Joshua Hymowitz, Gautham Roni, Suraj Sanyal, Louis Shinohara*

***Advisor(s)***: *Dr. Shahab Jalalvand, Nick Ruiz (Interactions)*


| | |
|---|---|
| ***Keywords*** | automatic entity capture, Zoom API, redaction, conversation mediator/virtual assistant, WebRTC |



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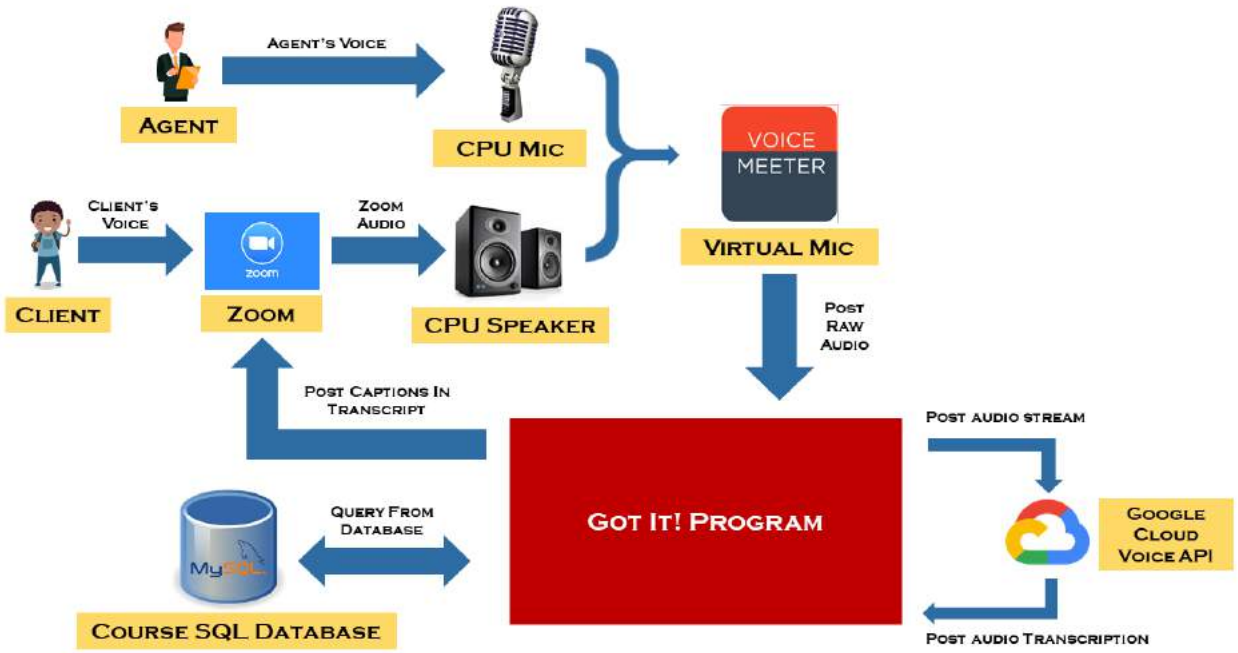
|---|---|
| ***Abstract*** | With the rapid public adoption of video calling technologies such as Zoom, Google Meet, and Microsoft Teams, there is an increasing opportunity to provide business services between customers and agents. This project aims to create a proof of concept design in which a conversation mediator attends a customer support call and captures important information in near-real time, using spoken language understanding. Similar to the Interactive Video-call Response project, the student will learn how to interface with a platform based on WebRTC, with the aim of capturing the customer and agents' audio. The conversation mediator will extract important entities like product names, account numbers, etc, by interfacing with existing spoken language understanding technology supported by Interactions. As a point of differentiation, Got it! also aims to support live, automatic redaction of sensitive information during video calls via a websocket stream of call audio sent to a natural language processor (NLP). |

***S21-10*** ***Title****: Improvements to the Viability of Solar Panels in the Field*

***Members:*** *Nathaniel Glikman, Alexander Laemmle, Nicholas Meegan, Bhargav Singaraju, Sukhjit Singh*

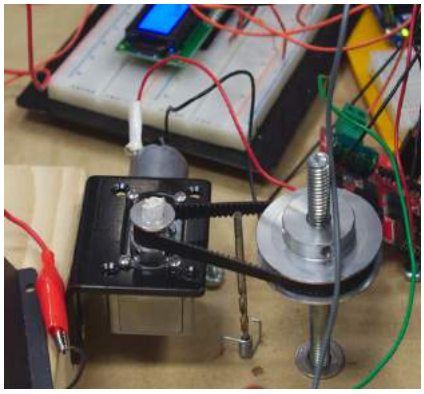
***Advisor(s)****: Dr. Michael Caggiano, Cameron Greene (L3Harris)*

***Keywords*** Rotating Solar Panels, Photovoltaic Cells, Solar Sensor, Micro-controller, Rotating Photovoltaic Cells, Solar Sensor, Microcontroller

***Abstract***

The capstone project, Improvements to the Viability of Solar Panels in the Field, aims to increase the amount of sunlight received by a solar panel in the field each day. According to statistics collected by Wholesale Solar, "Although your panels may get an average of 7 hours of daylight a day, the average peak sun hours are generally around 4 or 5 [hours]", where peak sun hours offer the maximum amount of power received. The proposed capstone project attempts to rectify this shortcoming of solar panel design by introducing a method to track the sun throughout the course of the day which increases the power absorbed, and efficiency.

Traditional methods of solar panel rotation require the use of databases collected by agencies such as NREL to provide the angle of rotation for the panel. However, this method is not always accurate; manual calibration of the solar panel may be required through its tracking, and accurate time and location data is critical. Instead, the proposed design utilizes a small solar sensor; photovoltaic cells in a recessed box with shadows cast on them by the roof. Data gathered from this allows the panel to point at the sun directly: this is the point where there is approximately equal light on all quadrants. Using artificial intelligence to compare with previous iterations of rotating the panel, adjustments can be made to the solar cell's location for increased efficiency.



**S21-11**

***Title***: *Project LOUIS*

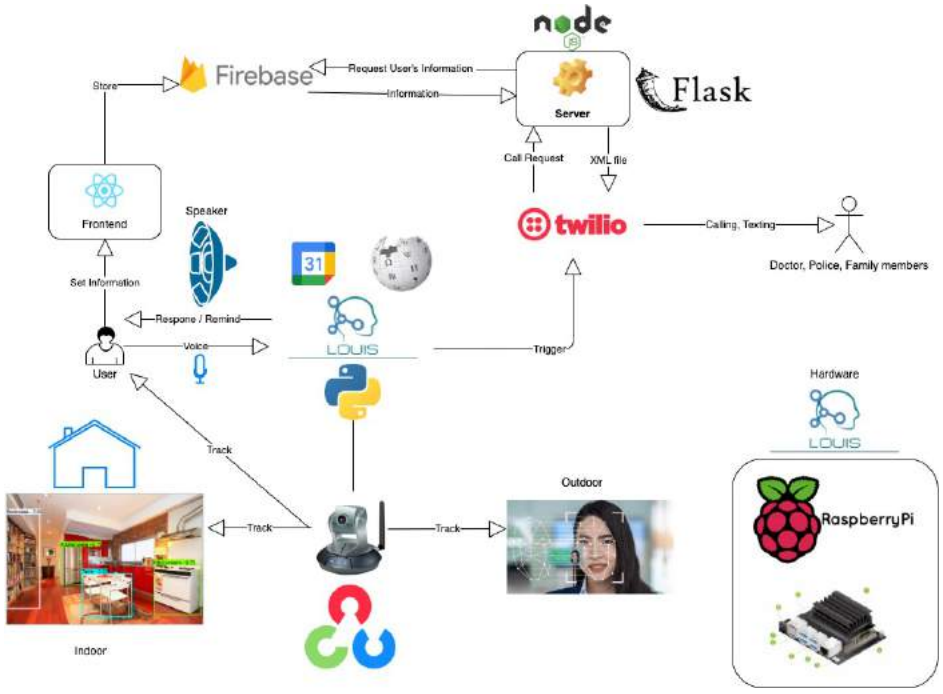
***Team Members***: *Sahil Patel, Darshan Singh, Luan Tran, Tan Ngo, Khanh Nguyen*

***Advisor***: *Dr. Kristin Dana*

***Keywords*** Computer Vision, Machine Learning, Alzheimer's

***Abstract***

Project LOUIS is an in-home network designed for the use of Alzheimer's and dementia patients. Project LOUIS offers action-based reminders to the patients based on their daily tasks and current actions detected by the system. The network consists of multiple devices strategically located around the house of the user in order to be able to collect and serve data and reminders to the patient based on their needs and requests. The modules include a central home module, with a speaker and microphone input to communicate with the user, as well and the other modules. The other type of module is a camera module, consisting of a camera, which sends and receives data to and from the home module for further processing. The modules will also be tasked with the computations necessary for our implemented technologies, including computer vision with object detection, as well as speech recognition and machine learning. With these technologies, Project Louis will be able to actively search for the patient in certain areas in the house and be able to offer reminders based on their location, as well as recognize objects in the room. In addition to computer vision, Project LOUIS is based on interaction with the patient, asking what tasks they would like to do, and be able to offer reminders based on the tasks the user describes. Machine learning is implemented in this step to better tailor the reminders to each patient, and their daily tasks. Finally, Project LOUIS will bring these together with the use of the modules around the house, ensuring no tasks be left undone, and creating a safer environment for the patients



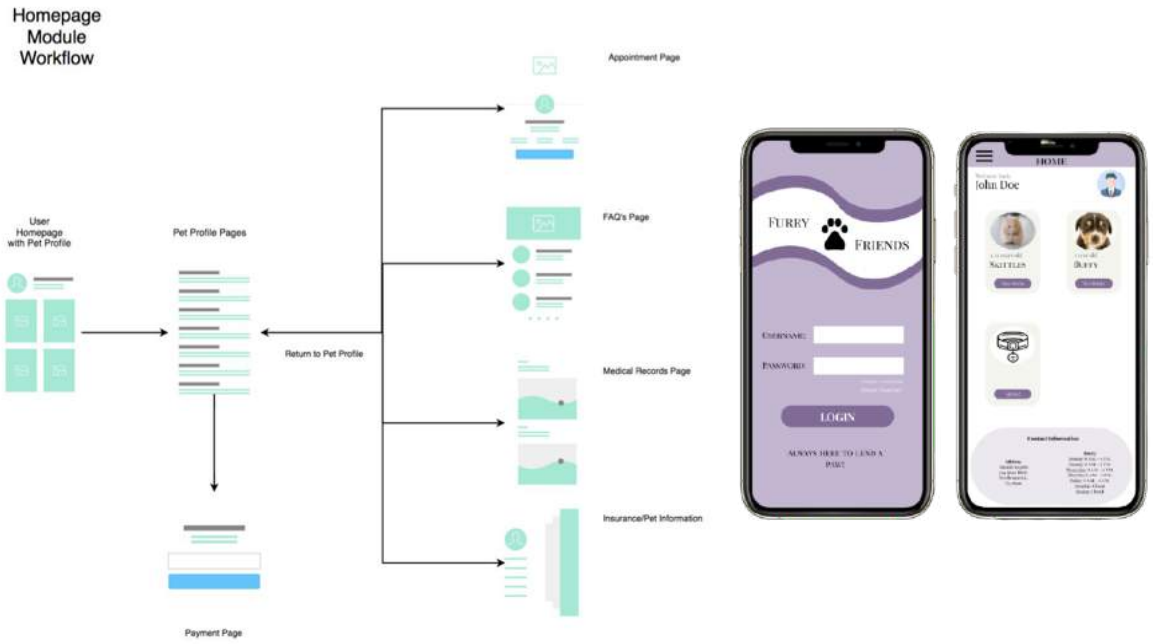
***S21-12*** ***Title***: *Mobile EMR Software Applications*

***Team Members***: *Aniqa Rahim, Sabian Corrette, Sidonia Mohan, and Siddharth Manchiraju*

***Advisor(s)***: *Dr. Hana Godrich*

***Keywords*** ndroid, iOS, MariaDB, ReactJS, React Native, XCode, telemedicine, mobile application, veterinary hospital, EMR, interface, appointment, prescription

***Abstract*** Mobile EMR Software applications aim to fill a void in providing clear, quick, and easy means for clients to monitor records for their animals, set up appointments, and make payments all from their mobile device. Through implementation on both Android and iOS devices, the mobile applications target providing a clean interface for the user that is simple to understand and makes sense. The effectiveness of the project will cut back on the need for clients to call the animal hospital ahead of time for any need dealing with their animals, will provide a quicker service time for the users, and relieve the hospital staff by freeing up the phone line. Overall, the applications aim to bring what is previously already seen available for humans in our hospitals and adapt it to be used in a setting for animal lovers.



***S21-13*** ***Title***: *Eagle-View: Realtime Onboard Monitoring in Agriculture for Weed Clusters*

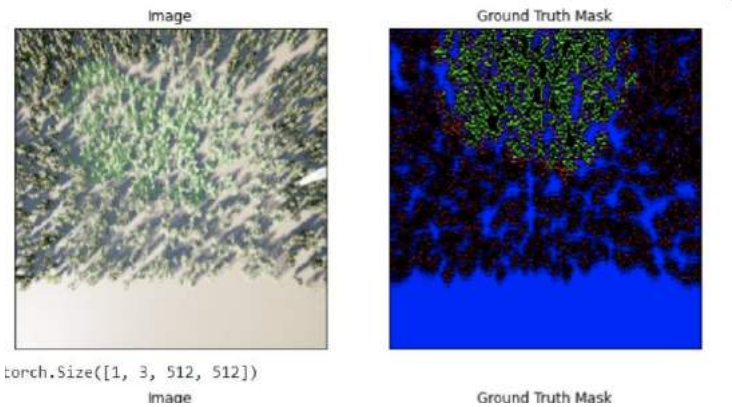
***Members***: *Andrew Dass, Andrew Vincent, Virajbhai Patel, Harsh Desai, Jeffrey Samson*

***Advisor(s)***: *Dr. Dario Pompili, Khizar Anjum*

***Keywords*** Drones, Agriculture, Real-time monitoring, Convolutional Neural Network, GPU

***Abstract***

In agriculture, weeds are plants that cannot be cultivated. These weeds form clusters around and steal valuable nutrition away from crops. In 2021, farmers spent on average anywhere from $4,000 to $20,000 on chemicals to rid weed infestations. By using a computer vision model that returns real-time results of weed cluster locations from the aerial images taken by a drone, we coordinate a team of drones to monitor crop fields and identify weed clusters while properly allocating each drone's limited resources such as battery life. By implementing a type of convolutional neural network model, the Feature Pyramid Network (FPN), drones process images and specifically find weed clusters in real-time. Since a drone's in-built CPU cannot process a complex computer vision model such as an FPN, a GPU is mounted on board the drones to run and process images through the model to return real-time results. Drones have limited resources, therefore the necessity of real-time results will be important in efficiently allocating these resources when monitoring large acres of farmland.



***S21-14*** ***Title***: *Contagious Disease Health Monitor*

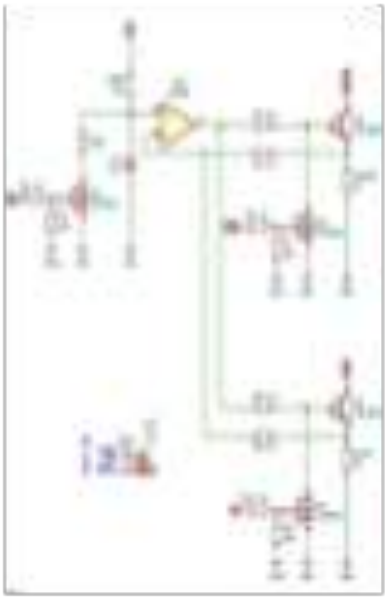
***Team Members***: *Shiwei Song, Krishna Patel, Josh Chopra, Marie Angelou Cabral, Justice Jubilee*

***Advisor***: *Dr. Hana Godrich*

***Keywords*** Medical, IoT, heart rate, montoring

***Abstract***

Our capstone project is to create a contagious disease health monitor that helps COVID-19 patients to be monitored using a remote IOT based health monitor system that allows a doctor to monitor multiple covid patients through the internet. This remote will help face three main issues- the issue in the fact that doctors need to constantly monitor patient health, the number of patients to manage is increasing, and doctors themselves undergo a risk of infection for each patient they manage. Our systems dashboard will be able to take into account the data from our hardware sensors that provide patients heartbeat, temperature, and blood pressure reading. By using sensors that include a heartbeat sensor, temperature sensor, and BP sensor, we can then be able to pick-up real-time data live from patients. This data will be transferred by connecting the hardware to Wi-Fi. Patient data will be available on an application that we will develop where doctors will be able to monitor and treat their patients without putting themselves at risk. Our solution will allow doctors to not only seamlessly monitor patients' health without risk of infection, but they can expand their dashboard to include metrics for over 500 patients at once. The system will also be mounted at the patient's bedside and will constantly be transmitting live data to the dashboard so that doctors can always attend to an individual once a certain metric is in the red. This fast paced, live public health monitor can transform the COVID-19 landscape for the average American without the need of immediate in-person checkups.



***S21-15*** ***Title**: Register.io*

***Team Members**: Rishab Ravikumar, Maxwell Legrand, Michael Giannella, Praveen Sakthivel*

***Advisor**: Daniel Arkins (BlackRock)*

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|---|---|
| ***Keywords*** | micro-service, nodes, load-balancing, scalable, distributed systems, redesign, cloud |

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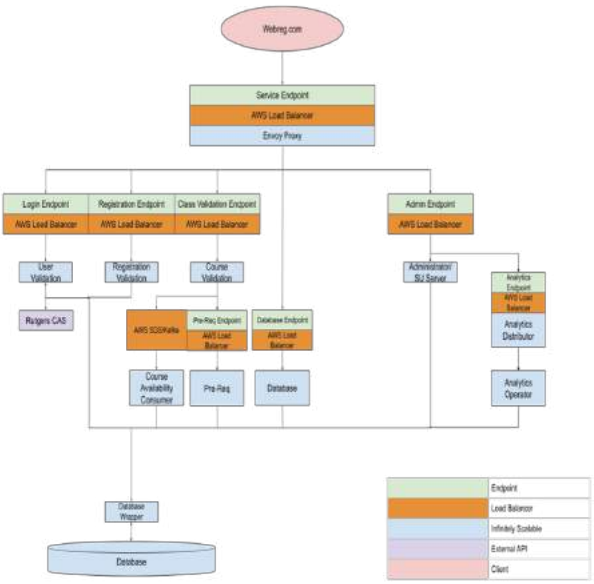
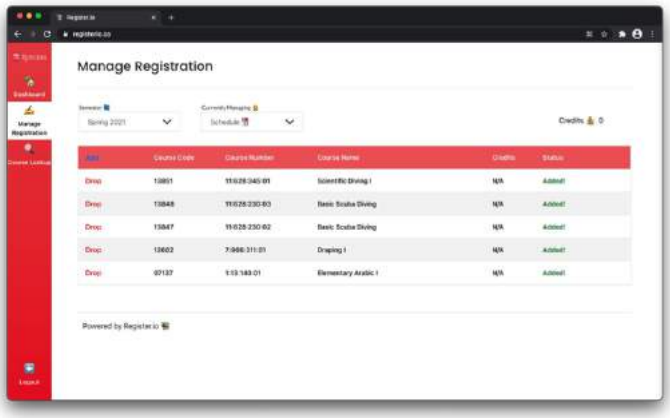
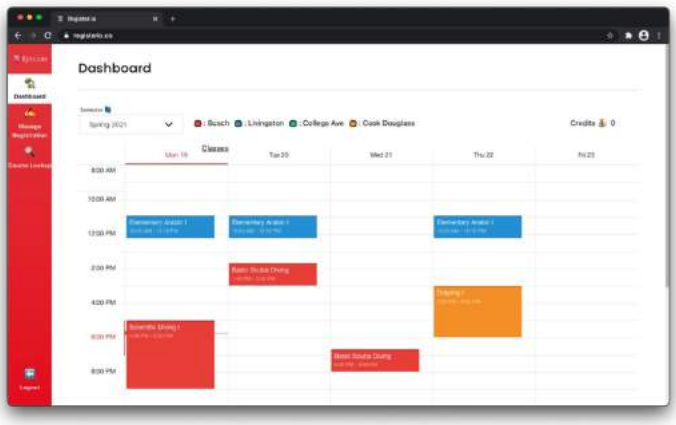
| ***Abstract*** | egister.io is a redesign and overhaul of the existing web registration system used to enroll in classes. Currently the system is prone to being overloaded when flooded with requests. Our goal is to re-imagine this service as a set of distributed nodes in order to effectively manage high-load usage and scale up or down as necessary. |



**S21-16** **Title**: *nCharge - Solar Power Battery Bank*

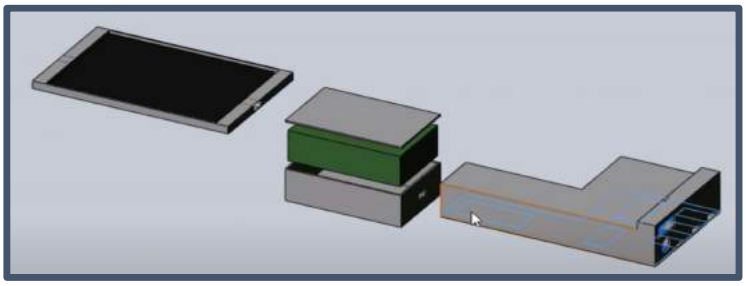
**Members**: *Kush Patel, Mya Odrick, Myles Johnson, Jenna Krause*

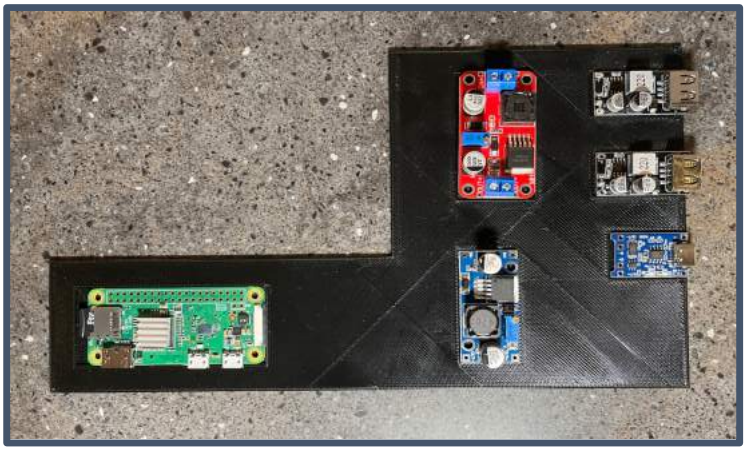
**Advisor**: *Dr. Hana Godrich*

**Keywords** Renewable Energy, Power Electronics, Data Analytics, Hardware Design, Solar Power

**Abstract**

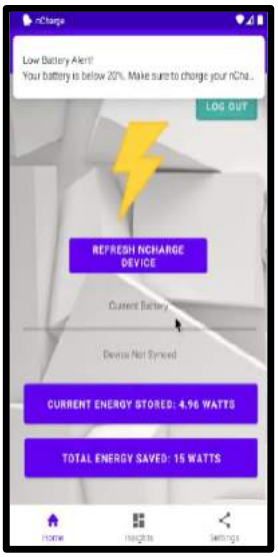
The main objective of our project is building a solar power battery bank that will reduce energy consumption. We want to develop a modular power bank that can support charging devices like cell phones to laptops, and if time allows bigger appliances like televisions, dishwashers, and refrigerators. The power bank will connect to a mobile application, and the user will be able to track how much energy is saved through using the power bank. They will also be able to track when it's low on battery and peak times to charge the bank. We want to optimize our users' everyday energy consumption, so as our world shifts to cleaner options, our users will be able to adjust accordingly.





Hardware

Application



***S21-17*** ***Title***: *QuickShift*

***Members***: *Swetha Angara, Ariela Chomski, Bracha 'Brooke' Getter, Neha Nelson and Param Patel*

***Advisor(s)***: *Dr. Hana Godrich and Andrew Levine (Commure)*

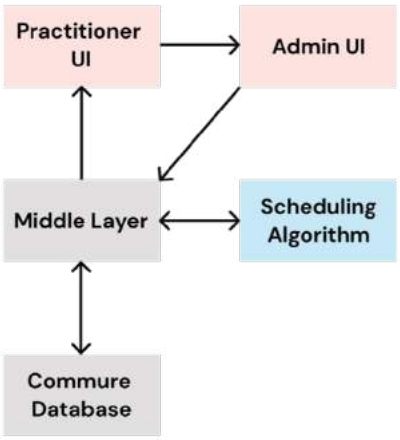
***Keywords*** FHIR, React.js, Commure, Healthcare, Scheduling, Optimization, QuickShift, etc.

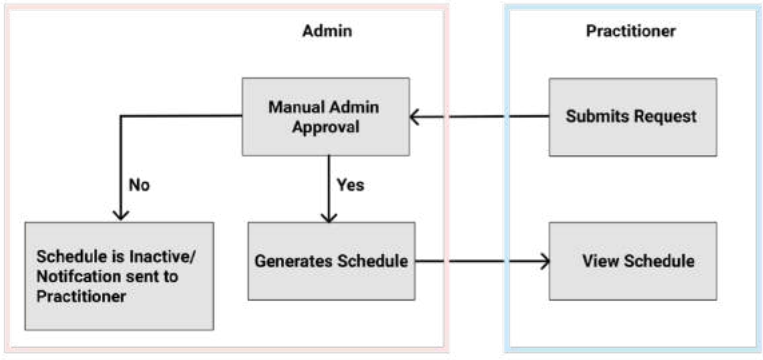
***Abstract***

Hospitals spend excessive time and money on scheduling their practitioners. This causes frustration due the inefficiency and inability to access critical information in a timely manner. The project objectives are: (1) Create a user-friendly web interface using Commure's React

Components; (2) Create a robust back end using Commure's FHIR-based APIs and OptaPlanner's scheduling algorithm.

QuickShift's user flow starts when a practitioner logs in to their account, from there they can see their work schedule and submit requests for days off with the priority of why they want that day off. That request then shows up as pending on their calendar and gets sent to the admin for approval. Once the deadline to submit requests has passed, admins can approve or reject these to get started on generating a work schedule. The schedule gets generated with feedback on the feasibility. If there is an issue the admin can manually change the constraints and generate a new schedule. The generated schedule gets displayed on both the practitioner and admin end.



**S21-18** ***Title***: *Wireless Power Transfer*

***Members***: *Peter Wu, Andrew Simon, Naomie Popo, Crystal D'Souza*

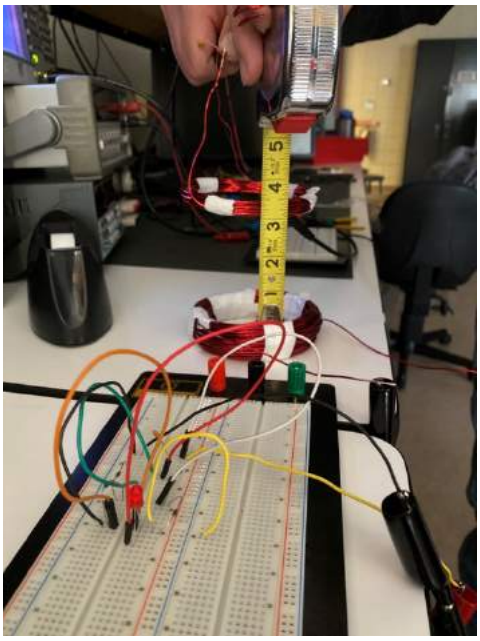
***Advisor***: *Dr. Micheal Wu*

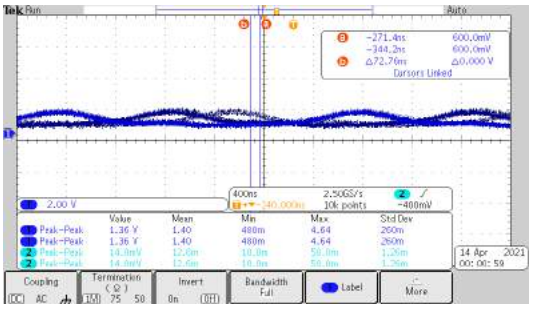
***Keywords*** Inductor, rectifier, capacitor, resonance, power electronics, inductive coupling

***Abstract***

The purpose of this project is to create a wireless power transfer device capable of supplying power to devices within either a two to one foot radius of the device. The project will consist of largely two parts, an emitter which will transmit power via inductive resonant coupling and a receiver which will collect the power and rectify the output voltage. Our aim is to wireless transfer power to a light emitting diode.

The project consist of largely two parts: an emitter which will transmit power via inductive resonant coupling and a receiver which will collect the power and rectify the output voltage.





**S21-19** ***Title**: ColorFind*

***Members**: Kenny K. Bui, Jephtey Adolphe, Nishad Ramlakhan, Pavan Kunigiri*

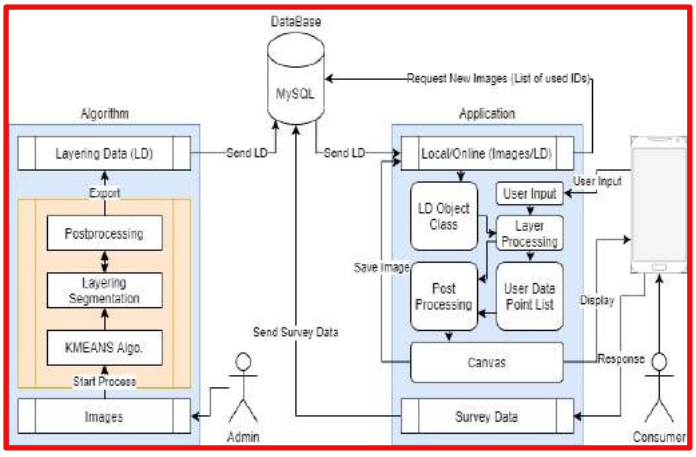
***Advisor(s)**: Dr. Kristin Dana and Dr. Roy Yates*


***Keywords*** application development, stress, java, america, adult, children, color



***Abstract***

To combat escalating stress levels and provide a generally engaging user experience, the idea of Color Find was created. Color Find provides a novel, exciting, and calming way users can color, different from the leagues of coloring applications that have come before it. In Color Find, users find themselves discovering hidden images through color. The project uses decomposed images and compiles layering data, so the user transverses the image one layer at a time. Every layer is colored, but the user never sees the final, finished picture until they have completed it. In terms of engineering, Color Find is broken into three main categories. The algorithm responsible for image decomposition, the coloring UI, and software allowing for the communication between the two. The image decomposition component inputs an image and outputs layering data by identifying similar areas of the picture. Similar areas can be identified based on color and proximity. The algorithm will favor explicit, cartoon flavored images because they are relatively uncomplicated and have a wide appeal. The UI component accommodates all ages and is intuitive and accessible even to young children. Therefore, there will be relatively few screens to access, and the necessary coloring procedures such as switching between colors will be made evident and easy to use. Also, Team 19 plans to take the project even further and modernize the planned design by integrating database compatibility. The database will allow for images to be stored online, and therefore unlock the amount of images users will have access to.


**S21-20** **Title**: *$CO_2$NSUME*

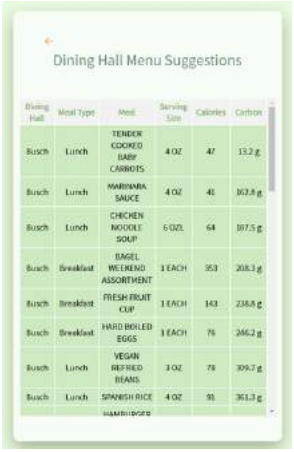
**Members**: *Samantha Moy, Shreya Patel, Atmika Ponnusamy, and Nandita Shenoy*

**Advisor**: *Dr. Jorge Ortiz*

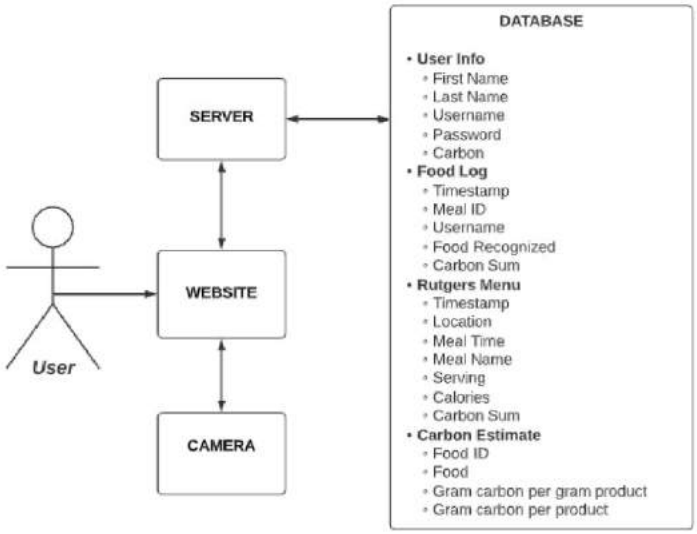
**Keywords** sustainability, carbon tracking, machine learning, mobile application, image processing

**Abstract**

One of the most pressing issues of our time is the damage done to our earth's atmosphere by carbon emissions over the past several decades. The mobile application, $CO_2$nsume (pronounced like the word "consume"), aims to educate and empower college students so that they are aware of their carbon footprint and able to make lifestyle choices that minimize humanity's impact on the earth's atmosphere. $CO_2$nsume utilizes machine learning algorithms to identify foods via smartphone images and calculate the $CO_2$ emissions associated with producing and transporting the foods. It also integrates university dining hall menus in order to suggest more sustainable (and typically healthier) meals to students. Ultimately, $CO_2$nsume aims to raise student awareness of the environmental impacts of their eating habits, and consequently, encourage a healthier, more sustainable lifestyle.







**S21-21** **Title**: *Tracking Cleaning Progress with Computer Vision*

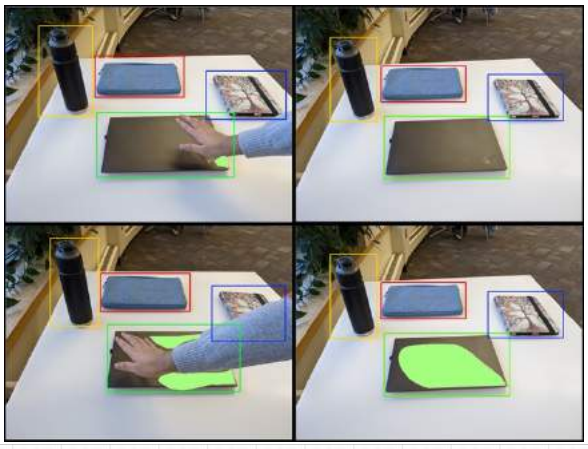
**Members**: *Andrew Ko, Edler Olanday, Parth Patel, Piotr Zakrevski*

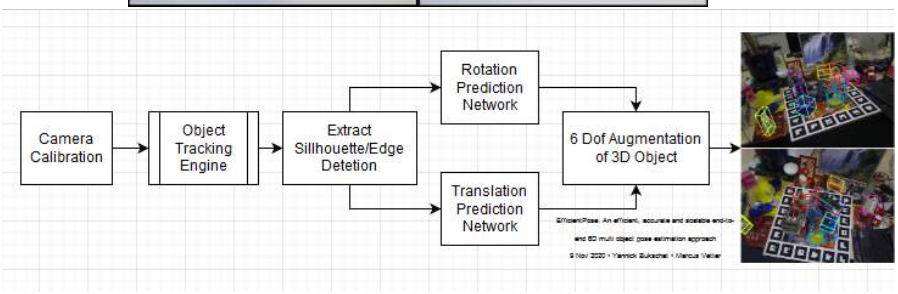
**Advisor**: *Dr. Yuqian Zhang*

**Keywords** public health, sanitation, augmented reality, object recognition/tracking

**Abstract**

The onset of the COVID era quickly garnered attention to the hazardous nature of microbes spreading through common surfaces. With a possible lifetime of 72 hours, COVID-19 is capable of quickly sickening any whoa approach or touch that surface. The reality of the situation ushered a new drive-in individuals to disinfect general use surfaces. Maintenance teams are expected to properly, regularly, and quickly disinfect surfaces between users. Computer vision and augmented reality, along with a camera and a display, can be used to strengthen this trust both ways. There are many applications in a mobile environment that use these approaches to track objects and project information into the real world. These applications include SketchAR, Snapchat filters, and multiple solutions in Google's MediaPipe. Similar implementations can be done to solve the issue of mass sanitation. By tracing the movement of a cleaning object (i.e., hand or glove) across a surface and the objects on that surface, a heatmap is created that shows well a surface has been cleaned. This heatmap can then be displayed to maintenance staff to keep track of how well they are cleaning a surface. Furthermore, this information can also be shared with individuals who will use that area to verify how long ago and how well a surface has been cleaned. As both the cleaner and the user know how well a surface has been sanitized, both can be assured that neither are susceptible to infectious pathogens.





***S21-22*** ***Title***: *User Behavior Analytics*

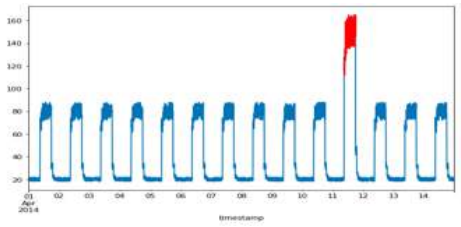
***Members***: *Fares Elkhouli, Osama Trabelsi, Shardul Patel, Steve Hill, and Dimitriy Zyunkin*

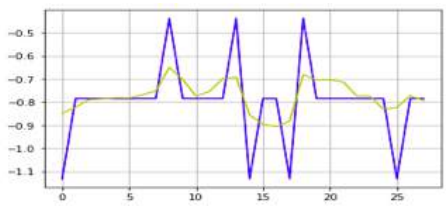
***Advisor***: *Dr. Yuqian Zhang*

***Keywords*** cybersecurity, insider protection, user behavior analytics

***Abstract*** Cybersecurity has evolved from a mathematical abstraction of the 60s and 70s to being an integral part of our everyday life. More and more, users are trusting corporations with sensitive data such as PII (personal identifying information), medical records, and employment history. Unfortunately, many conventional cybersecurity measures employed today are not well equipped to deal with the ever-evolving landscape of attack vectors employed by malicious intruders. Most cybersecurity tools used today such as firewalls, DNS servers, and proxies operate under an understanding of a secure perimeter - the notion that once the external components of the network are secure, the interior is safe from cyberattacks. This approach is poorly equipped to deal with malicious insiders and compromised accounts within the domain. Perimeter security tools offer no internal visibility into the domain, rendering the system vulnerable to hackers who obtained login credentials of a certified user, or malicious insiders who aim to obtain sensitive data from within. User Behavior Analytics (UBA) offers a novel approach to detecting and preventing cyberattacks from within the domain. By collecting metadata records on each user, UBA builds a model for each user in the domain and establishes their respective 'norm'. What are their normal working hours? How many files do they access each day? What sort of custom scripts do they run from their account? What does their DNS traffic look like? This metadata gives an understanding of the standard workflow of the user. Any deviations from the normal user behavior are flagged by the UBA algorithm and preset tasks are set in place in the event that a particular alert is triggered by a user.







**S21-23** **Title**: ***Automated Fluorescent Microparticles Counting App***

**Members**: *Yongyu Xie, Yichen Fan, and Mufeng Zhu*

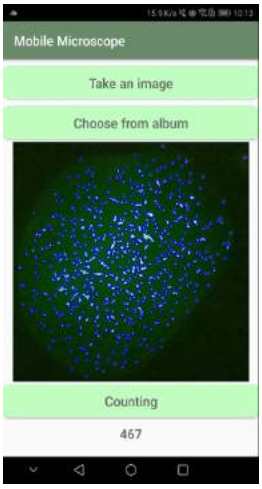
**Advisor(s)**: *Dr. Umer Hassan*

**Keywords** smartphone-based fluorescent microscope, microparticles counting, image processing, mobile application

**Abstract**

Fluorescent microscopes are widely used to observe fluorescent objects. However, traditional benchtop fluorescent microscopes are limited to high cost and non-portability. Thus, smartphone-based fluorescent microscopes appear, which capture images using smartphone camera with the help of external optical device, and conduct image processing such us microparticles counting on other computers. In order to fully take advantage of smartphone's CPU, we plan to develop an automated fluorescent microparticles counting app, where images capturing, fluorescent microparticles counting and results displaying can be completely conducted on the smartphone itself. Our desired app is based on the existing smartphone-based fluorescent microscope design but can get rid of assistance of computers. Compared with existing smartphone-based fluorescent microscopes, our app should be able to not only capture and display images of fluorescent objects but also achieve microparticles counting using the strong processor of smartphone. The core of the app is the image processing part and our task is to achieve as high counting accuracy as possible.






***S21-24*** ***Title***: *Driver Attention Detection (DAD)*

***Members***: *Mazal Choudhury, Jianhong Mai, Kang Jun Lee, and Jonathan Ye*

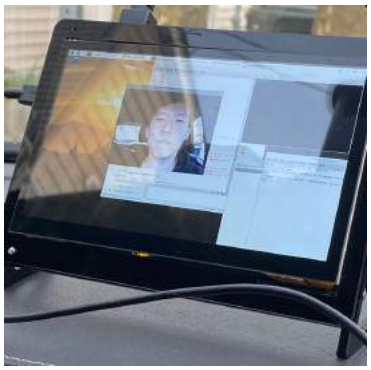
***Advisor(s)***: *Dr. Maria Striki*

***Keywords*** Safety, Control, Awareness, Security, Trouble-free

***Abstract***

Background: Traffic accidents due to inattentive driving has cost many lives and will continue to cause problems if not addressed. To address this problem, we have developed the Driver Attention Detector to combat the problem, which will incorporate a camera in the car that will be aided by computer vision to detect the driver's eye movements and facial expressions to examine whether the driver is paying attention to the road and remind the driver to focus if needed.

The system will be implemented as an app installed on a smart android-based dashboard, which will be connected to an Arduino and camera. The camera would then send visual data to our software, which would incorporate computer vision using OpenCV to scan the users face and detect their emotional state as well as their eye positions. This will allow us to detect if the user is distressed, experiencing road rage, unresponsive, or simply not paying attention and will deploy different measures accordingly.



***S21-25*** ***Title***: *Deep Learning Market Analysis Tool*

***Members***: *Alex Malynovsky, Adil Rashid, Aryaman Narayanan, Steven Negron, and Rishabh Chari*

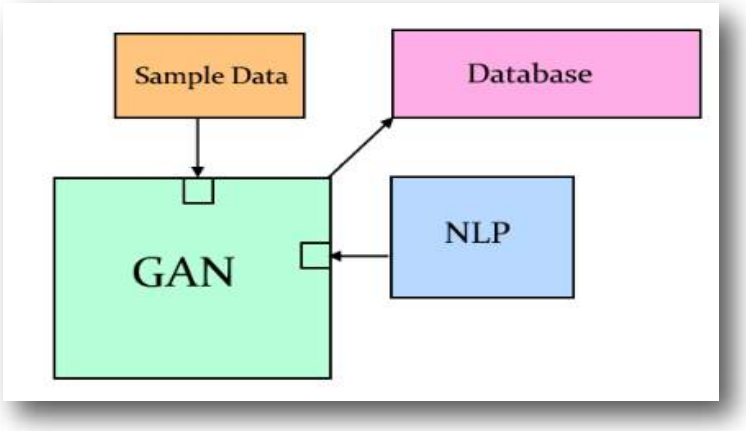
***Advisor***: *Dr. Roy Yates*

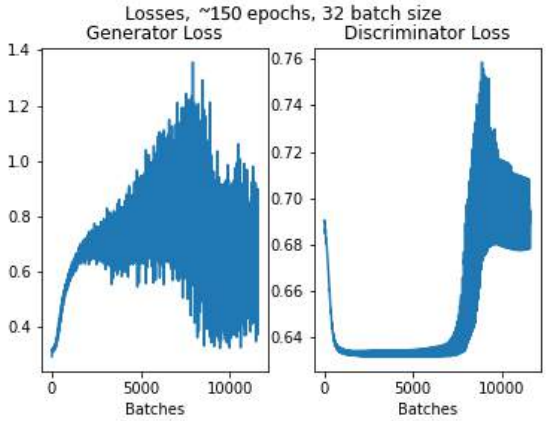
***Keywords*** Deep Learning, Algorithms, Autonomous trading, Market Analysis

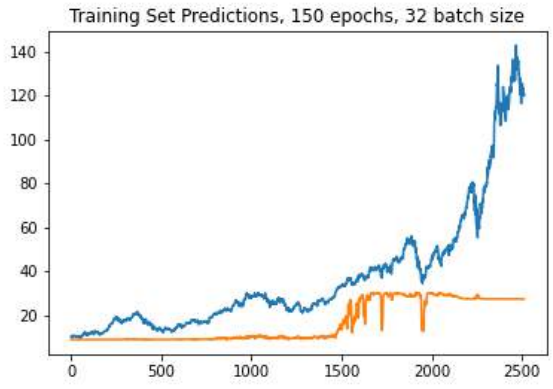
***Abstract***

Humans are prone to making mistakes, whether it be in their personal lives or on Wall Street. Unlike computers, we are unable to process information the same way that computers can; completely impartial and neutral. Today, this advantage is being utilized in a variety of ways on the stock market in order to aid investors in turning a profit. However, a lot of the methods being used include well-known algorithmic approaches tailored to the observation of certain market indicators and increase ROI for the investor.

Our team aims to implement a machine learning algorithm that learns from the historic data of various stock indices in order to make profiting predictions without any reinforcement (human intervention). We plan on feeding historic stock market data, primarily the stock open, close, volume and adjusted close, to generate predictions. We also plan on using QuantConnect to backtest and paper trade our algorithm.



**S21-26** ***Title**: Solar Drone*

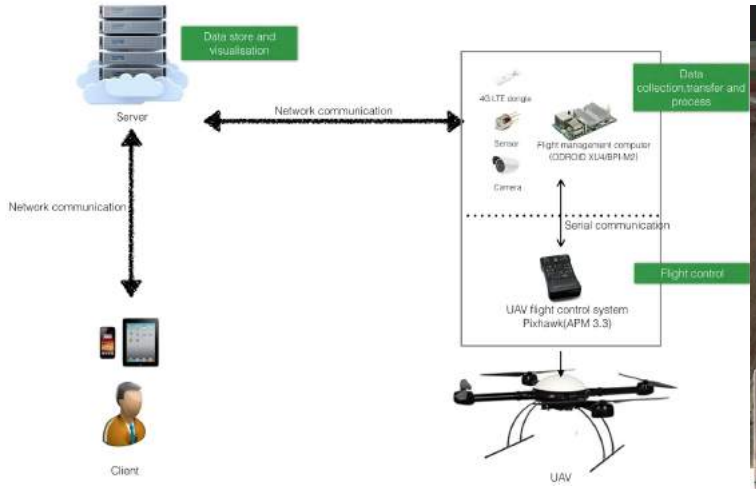
***Members**: Sabbathina Agyei, Justin Rucker, Taranvir Singh, Juergen Benitez, Jagmeet Singh*

***Advisor(s)**: Dr. Michael Caggiano*

***Keywords*** Drone, Battery life, solar power, app dev

***Abstract***

People may not realize it, but the need for drones is growing before our eyes. The problem at hand is how battery life is integrated into a drone whether it be a 100% solar drone or a battery powered drone, battery life has always been an underlying issue when it comes to drones. Our capstone team is proposing a fix to this problem by creating a design that incorporates the mixture of both battery power and solar power to help catapult the drone to new limits. Drones are expanding their abilities by being used in things such as filmmaking, surveillance, industrial inspection, powerline inspection and roof inspection. These drones can cost thousands. We are going to provide a cost-effective approach to high quality drones and by designing our own application to contain the features of the drone ranging from things like its camera, location, battery life and more.




**S21-27** **Title**: *Slide-Puzzle: Localized Repositioning of Adversarial Inputs*

**Members**: *Neel Amin, Nathaniel Arussy, Rizwan Chowdhury, Talya Kornbluth*

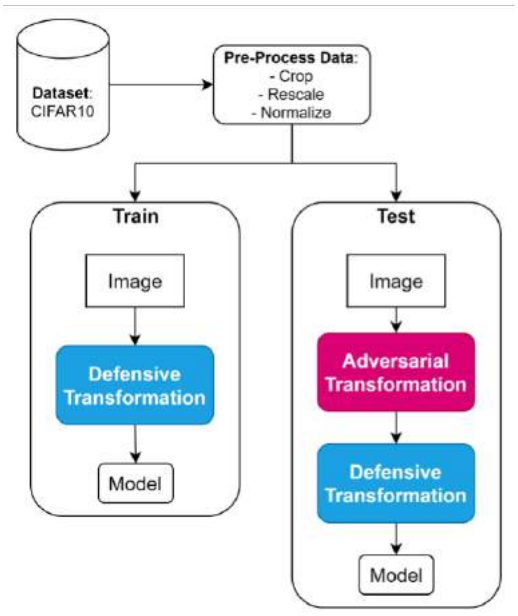
**Advisor**: *Dr. Saman Zonouz*

**Keywords** Machine learning, adversarial attacks

**Abstract**

The world of machine learning is rapidly growing, and with it comes an inherent danger of possible attacks. From biometric scanners to self-driving cars, the world of image classification is especially fraught with issues that could arise when a neural network does not function correctly. Many papers have been written on possible attacks and countermeasures to ensure safety. Our goal is to understand the possible threats and defenses, assess effectiveness of an existing defense that uses input transformations (Guo et al. 2018[1]) using some newer attacks and models. Input transformations are any change to an image that might change the pixel arrangement or values that make it up, such as cropping and rescaling or changing colors. We then can proceed to develop further ideas for defenses with given time. We hope that through our research and assessments, we can find ways to improve on the pre-existing, or create new effective efficient defensive techniques against adversarial attacks.

Our goal is to research the current edge of the adversarial machine learning field with the ultimate goal of making some contribution to the field. Machine learning is becoming more prevalent in all aspects of society. Applications of machine learning algorithms can be found in instances ranging from security at airports to navigation systems for autonomous vehicles. With widespread use of machine learning algorithms comes the risk of severe damage if the machine learning models were compromised. Adversarial machine learning is the field dedicated to the study of how weaknesses in machine learning algorithms can be exploited to cause erroneous results or information leakage and in turn how to prevent such actions. Our project will involve exploring different types of adversarial attacks and defenses as well as gauging their performance against each other.



***S21-28*** ***Title***: *Mo' Light, Mo' Communications*

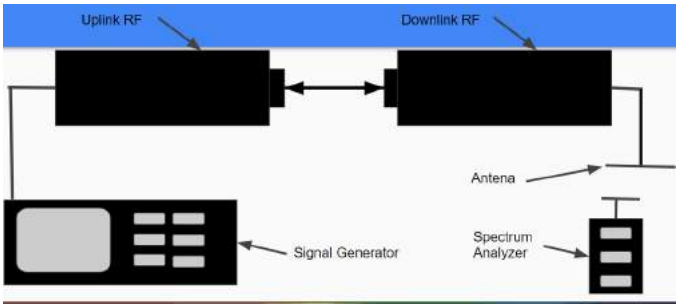
***Members***: *Collin Enright, Ceara Gagliano, Pablo M Hernandez Juarez, Anish Seth, John Plaras*

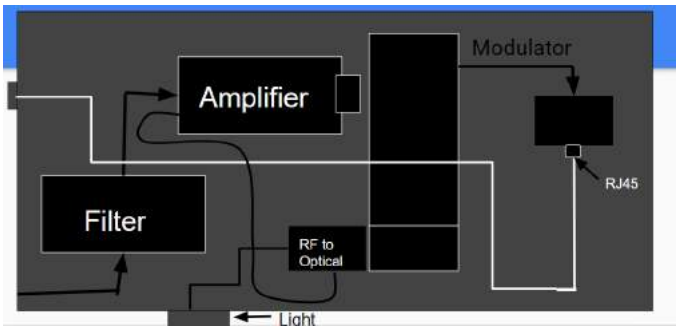
***Advisor(s)***: *Dr. Anand Sarwate*

***Keywords*** RF, downlink, uplink, optics, communication, security.

***Abstract***

Radio communication has become a very cluttered atmosphere. With the current and upcoming massive growth of electronics, means of communication are getting harder to separate. An alternative for certain applications is optic communication – which is desirable when a communicator has a line of sight with the target. Intercommunication and change between light and RF can also cater to the need of communication for each specific device. Light communication creates another level of security as you would have to be in line of sight to intercept the transmission. Our approach will consist of a radio sending out a modulating signal to a receiver within a black box, which will represent an RF uplink receiving module of an antenna to optical converter. The signal received will be filtered to eliminate surrounding noise, amplified to reach a level that the then laser board will be able to read. This laser board will convert the RF signal to optical. The optical signal will be amplified, modulated, and transmitted via a blue LED. The fact that we project to only perform this test effectively at a range below 5 feet blue will be a high enough frequency that the signal should carry effectively. This signal will then be sent to our RF downlink module. After being received by our optical receiver we will attenuate and demodulate the signal. Which will be converted back to RF amplified, filtered, then transmitted via antenna to a second radio that will demodulate the signal and make it audible



***S21-29*** ***Title***: *Mask and Temperature Recognition System (MATRS)*

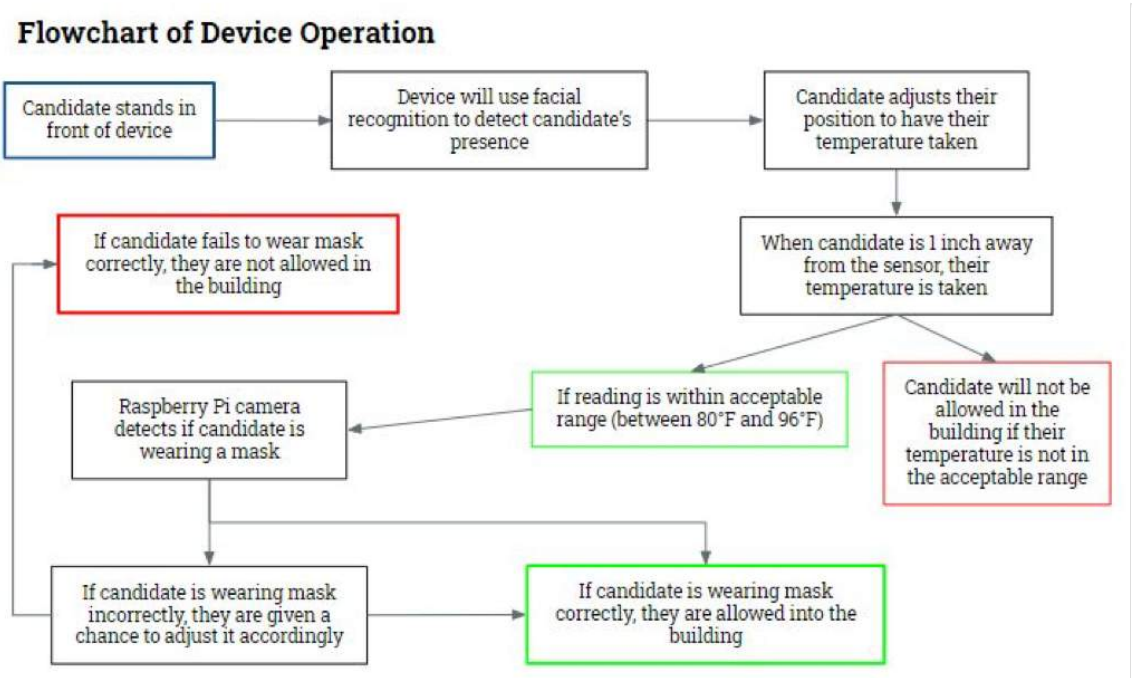
***Members***: *Ansh Gambhir, Rishi Shah, Anurva Saste, Srinivasniranjan Nukala, Kyle Tran*

***Advisor***: *Dr. Umer Hassan*

***Keywords*** COVID-19, Mask Identification, Temperature, Object Detection, Machine Learning

***Abstract***

Our project aims to reduce the rapid spread of COVID-19 by making sure people have an acceptable temperature and are wearing suitable masks prior to entering a building. This will be done by using machine learning and object detection combined with computer vision to see if a mask can be identified on the user. An IR sensor will also be used to measure the candidate's temperature. These electrical components will be connected to a Raspberry Pi, which will act as our centralized component and main communications hub for our device. These components will work in conjunction to make sure that the two aforementioned conditions are met and will not let the user into the building until they are satisfied. Overall, the device we intend to make will be a tremendous step towards reducing the spread of COVID-19, while also spreading awareness of how it can be prevented.



**S21-30** ***Title***: *Mobile Application for Speech Therapy*

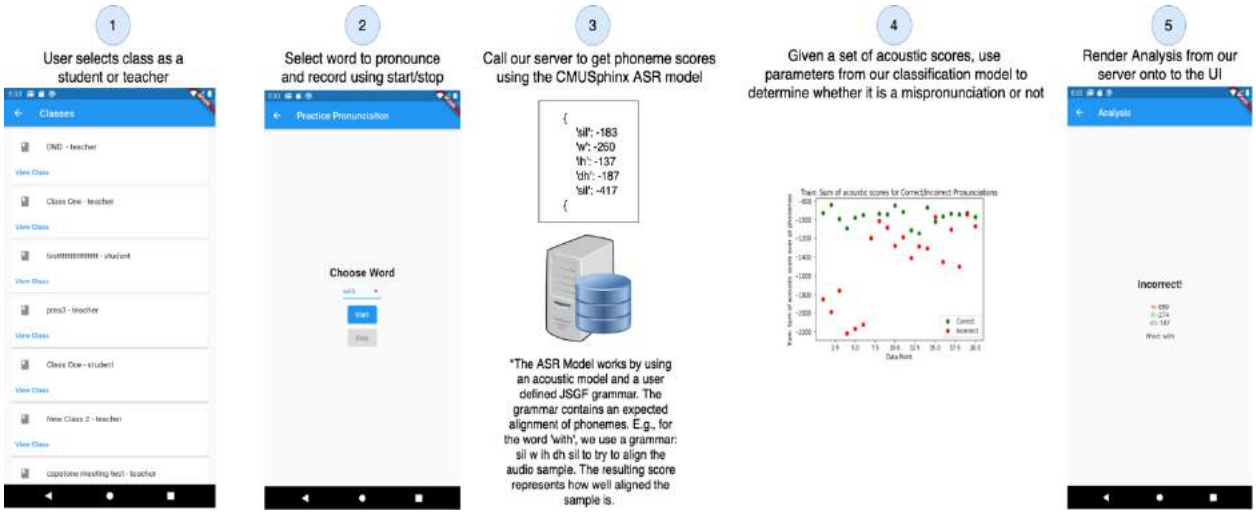
***Members***: *Duc Nguyen, Samuel Minkin, George Soto, Gaurav Sethi*

***Advisor(s)***: *Dr. Bo Yuan*

***Keywords*** Deep Learning, Automatic Speech Recognition, Voice recognition, Mobile Application, Flutter, Firebase

***Abstract***

There is a definite need for ways for those with issues pronouncing words to get help so they can speak as smoothly as everybody else. Although there are several school programs meant to resolve this issue, several times it is not enough. We will create a mobile application that allows users to improve their speaking, reading, writing, and listening skills on their own. One of the main features will record a user's voice when he or she speaks and analyze the pronunciation of each word using speech recognition. The analysis will display a resulting view with the input either being designated as correct or wrong. Additionally, if the input is determined to be incorrect, the user will be able to replay the input and play the correct pronunciation. This will help them in discovering areas where they may have pronunciation issues that need more practice. At the same time, this will help them with their reading, listening, and speaking skills. Users will practice reading common words or phrases, speaking them into the device, and then listening to their pronunciation, which will reinforce those skills. Furthermore, we can add features for children to learn and play at the same time. This application can also help children from around the world to learn English.



**S21-31** ***Title***: *Occupancy Monitoring System with Computer Vision Algorithms*

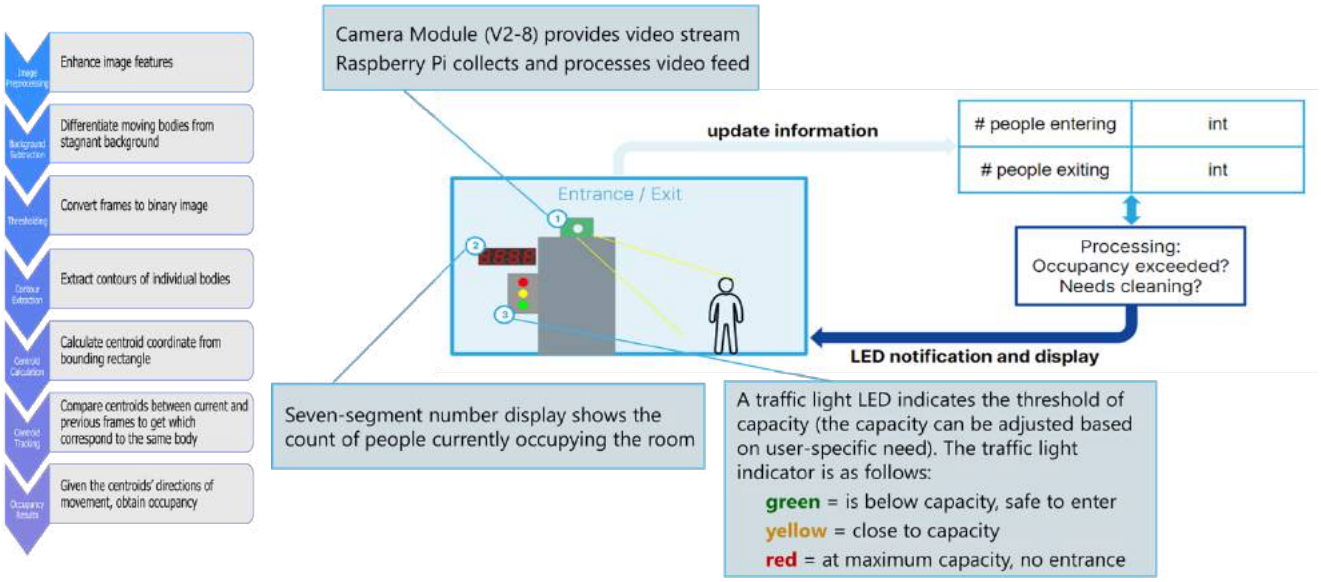
***Members***: *Samantha Cheng, Kylie Chow, Sonia Hua, Sneh Shah*

***Advisor(s)***: *Dr. Yuqian Zhang*

***Keywords*** social distance, maximum capacity, cleanliness, computer vision, safety, occupancy sensor

***Abstract***

The Occupancy Monitoring System will keep track of the traffic in a small area to avoid spreading infectious diseases and to keep these areas clean. Currently, many stores keep track of the number of customers by stationing an employee by the doorway to monitor the statistics manually. However, this process becomes increasingly inefficient in establishments such as department stores where there are multiple entries, as well as clusters of people going in and out at once. Furthermore, as indoor dining opens up, bathrooms are another important entrance to monitor since the foot traffic directly relates to the sanitation quality. The data collected can help store management determine how often the bathrooms should be cleaned and can help notify customers if the bathroom is safe. The system will have a camera module at the entrances of these areas that monitors incoming and outgoing traffic with the use of computer vision. This data will be used to determine if the room/area needs cleaning or if the maximum capacity of a room is exceeded. The camera would keep track of how many people have been in this area and once the number passes a certain threshold, the management will be notified that the bathroom needs to be cleaned. Customers would also be notified if the area is safe to enter/if it has been cleaned recently. This system can help many indoor facilities safely open back up since it would be closely regulating areas that encounter a large number of people.



**S21-32** ***Title**: Post-fall Syndrome: A Sensor Based Solution*

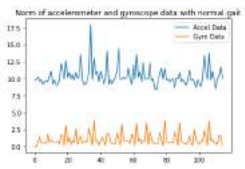
***Members**: Aravind Manivannan, Saikiran Nakka, Elizabeth Ward*

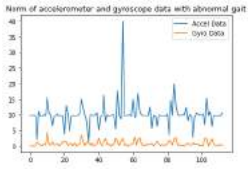
***Advisor**: Dr. Umer Hassan*

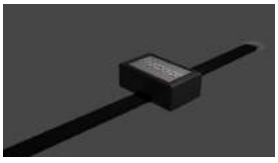
***Keywords*** Post-fall syndrome, sensors, machine learning, geriatric medicine, wearable technology

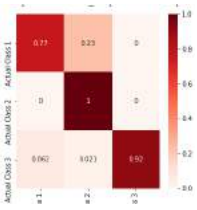
***Abstract***

Post-fall syndrome is a hesitancy or anxiety that an individual may develop after suffering a fall, most commonly experienced by the elderly. This hesitancy leads to a change in the individual's walking patterns, whether consciously or not, which unfortunately tends to make them even more likely to fall than before. Our project aims to help with this condition by creating a wearable sensor device that will collect data about the user's movement as they walk. We will develop a machine learning algorithm to analyze the gait parameter data for optimality, and the user will be able to view a report of the findings and advice on how they can improve their walking via mobile application.







***S21-33*** ***Title***: *Tongue-to-Computer Interface*

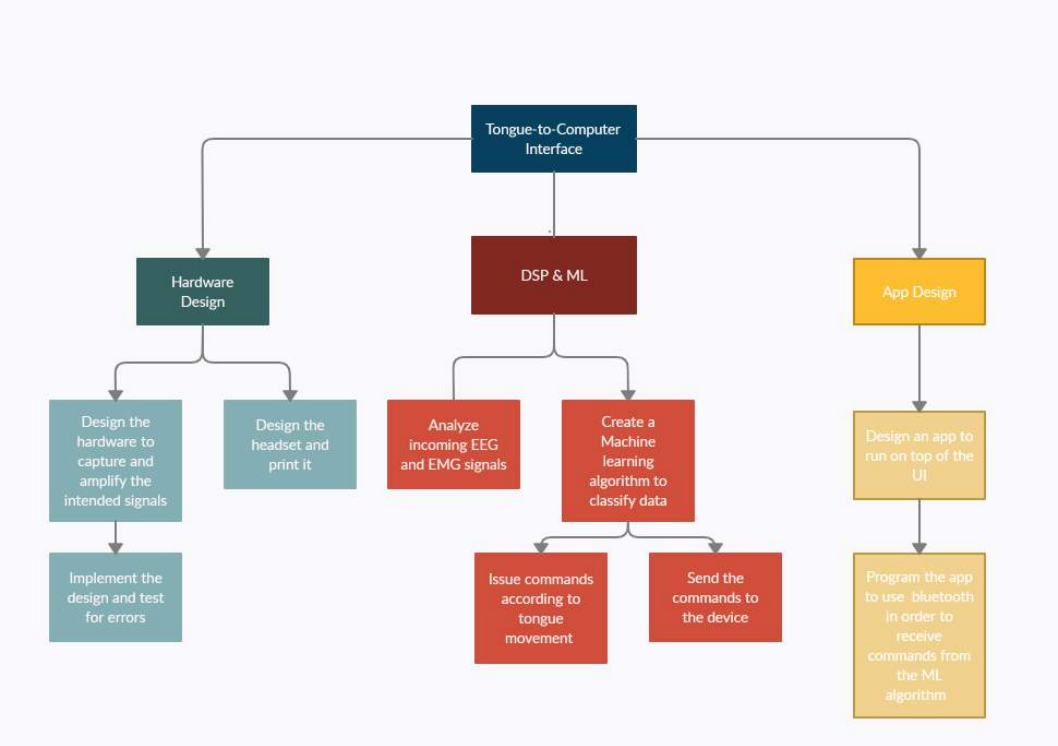
***Team Members***: *Joe Shenouda, Peter Rizkalla, Fady Shehata, Matthew Hanna, Andrew Rezk*

***Advisor***: *Dr. Yingying Chen*

***Keywords*** Biosensors, Neuro Engineering, Machine Learning, Human Computer Interference

***Abstract***

The goal of this project is to provide a way for people to interact with their electronic devices through their tongue movements. This would benefit people who have certain disabilities that prevent them from interacting with their devices normally. In order to extract information regarding tongue movement, certain bio sensors that can read EEG and EMG signals would be used. A headset would be 3D printed in order to hold these sensors in place. The sensors would be placed near the back of the ear that way it would be able to capture the EEG and EMG signals accurately. The EEG signal contains information regarding brain activity while the EMG signal contains information regarding muscular activity. Signal processing techniques can be carried out in order to extract information regarding tongue movements from these signals. This information can then be used to classify each type of tongue movement through the use of some machine learning algorithms. Then, an app will be designed to take this information and use it to control a device in a similar manner as to how the accessibility feature on a smartphone would. Overall, this would allow a user to move their tongue and tap different teeth in a certain way in order to communicate and control their device with ease solely from the movements of their tongue.



***S21-34*** ***Title***: *SMART Glove*

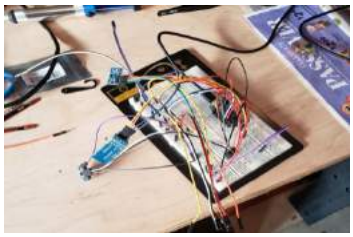
***Members***: *Erik Castro, Brian Cheng, Nicholas Chu, Gary Qian, Thomas Luy*

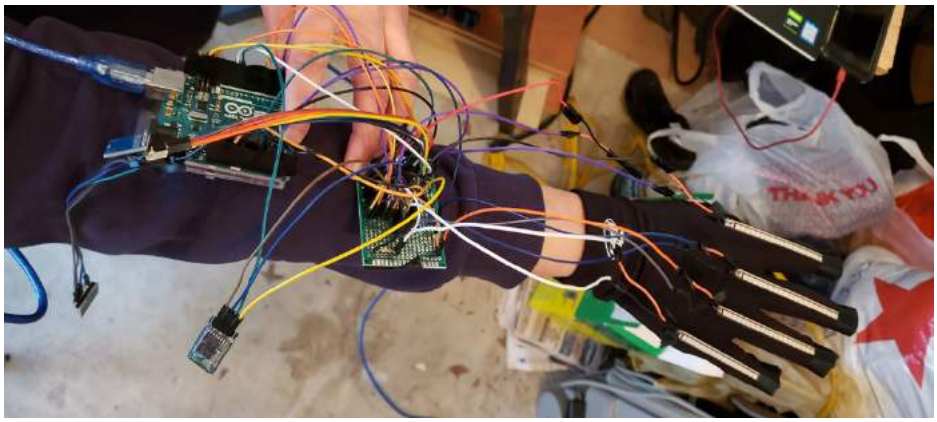
***Advisor***: *Dr. Hana Godrich*

***Keywords*** sign language, education, application development, wireless communication, sensors

***Abstract***

We want to make a SMART Glove that can recognize the position of the subject's hand to execute predetermined actions. Our specific focus on this project is to help people learn sign language. This will be done by using the glove's sensors as feedback to help users learn sign language interactively. The glove will be able to detect the bend of every finger, rotation of the hand, and acceleration of the hand. The glove will be wirelessly connected to a smartphone app which will have sign language learning modules. The app will be split into two separate sections, one for learning, and the other for testing the user on their sign language accuracy. In the learning section, pictures will be provided for the user to mimic in order to move on to the next letter. Feedback will be given if the fingers are not in the right position. The user would also have the option to choose which letters to practice more. In the testing section, both games and quizzes will be used to test the user's sign language knowledge. We will use the results of these tests to give feedback on the letters the user may be struggling to sign. Other than sign language, this glove and app configuration could be set up for other creative functions such as controlling your smartphone, giving PowerPoint presentations using gestures, and directing remote controlled cars.





**S21-35** ***Title**: A Machine Learning Based Model for Replicating Vacuum Tube Audio*

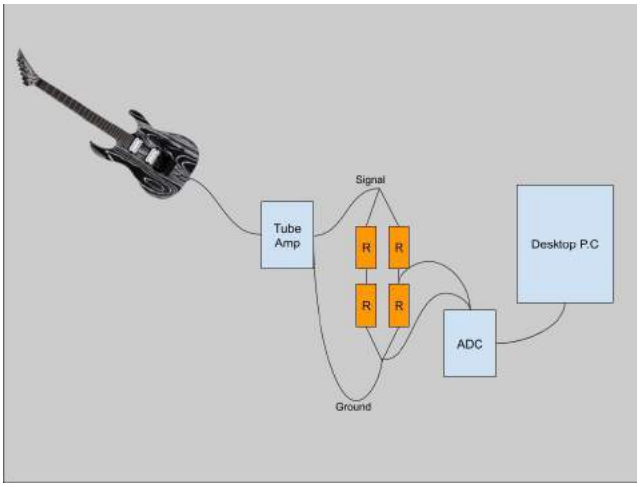
***Members**: Nicholas Cooper, Joseph Florentine*

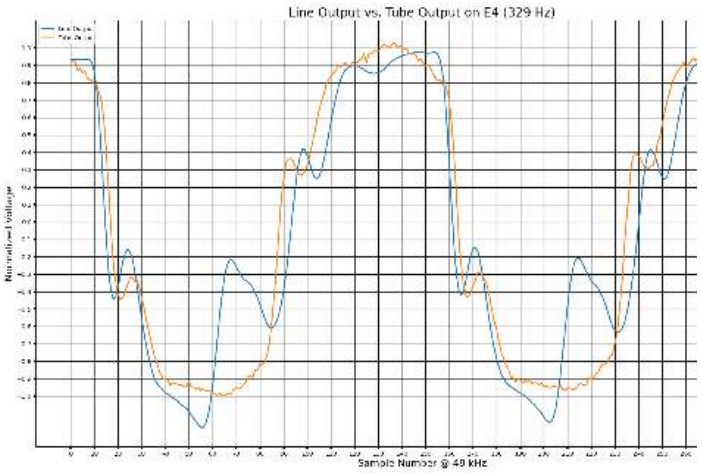
***Advisor(s)**: Dr. Dr. Rich Howard, Dr. Kristin Dana (Rutgers University), Dean Telson and Dillion Houghton (L3Harris)*

***Keywords*** Machine Learning, Guitar Amplification, Vacuum Tubes, Signal Processing, PCB design

***Abstract***

Despite being developed over 115 years ago, vacuum tubes remain at the forefront of guitar amplification today. Their highly desirable overdrive characteristics and other subjective auditory qualities have proved to be the gold standard for guitarists, particularly those involved in genres such as Rock and Metal. However, vacuum tubes are power inefficient and fragile, and must be replaced over time. Due to the inherent high impedance nature of vacuum tube inputs and outputs, tubes require high voltages to operate. As a result, heavy transformers are necessary for voltage supplies and output impedance matching, increasing the overall weight significantly. Clearly, there are good reasons to want an amplifier that avoids these antiquated technologies. Sadly, most solid-state amplifiers and software plugins fall short of this elusive "tube sound", as vacuum tubes are notoriously difficult to model. To this end, we propose a novel method of emulating the vacuum tube in software, using machine learning algorithms. We investigate the quantitative differences between current solid state and vacuum tube amplifiers on real and synthetic signals, and experiment with several styles of neural networks. We will implement our model on the Nvidia Jetson mobile computing platform, for integration with a speaker cabinet, volume control, and equalization.



***S21-36*** ***Title***: *Viroid*

***Members***: *Karneet Arora, Guru Ragavendran Sivaram, Saagar Patel.*

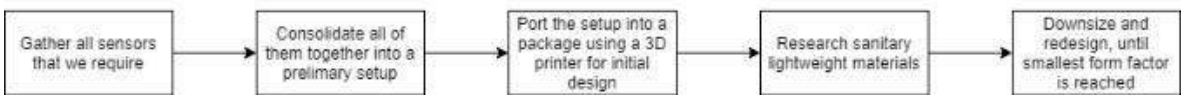
***Advisor***: *Dr. Roy Yates*

***Keywords*** Wi-Fi, Object Classification, COVID-19

***Abstract***

Inspired by the recent COVID-19 Pandemic, the ViRoid bot aims to help control the spread of coronavirus while simultaneously gathering data in order to distinguish patterns, predict future outbreak hotspots, evaluate demographics, and find out more information about the virus. The bot is comprised of a fusion of multiple sensors into a portable package that scans any human at entrances of businesses, events, homes, and/or any venue. Using sensors such as: infrared temperature scanners, weight/height scales, we can accurately predict if someone is displaying any symptoms of a disease. The robot would also employ self- sanitation mechanism which would clean the robot after each use, so it's sanitized and safe to be used again by another person. Individuals who seem to display symptoms of the virus, like have a high temperature, would be denied entry to the business or venue. All computations and sending/receiving data would be handled with cloud technology using a server. There would also be a convenient website for admins, showing the results for the day/week/month/year along with other quick metrics at the tap of a hand. This website would also support a live feed of the robot doing its work regarding testing the public. With a large-scale compatibility, this data can be used to control spreads, allocate more resources in specific areas, and better understand the side effects of any affliction


Hardware Flow Chart



***S21-37*** ***Title***: *IoT Security for the Layman*

***Members***: *Ajay Vejendla, Jake Totland*

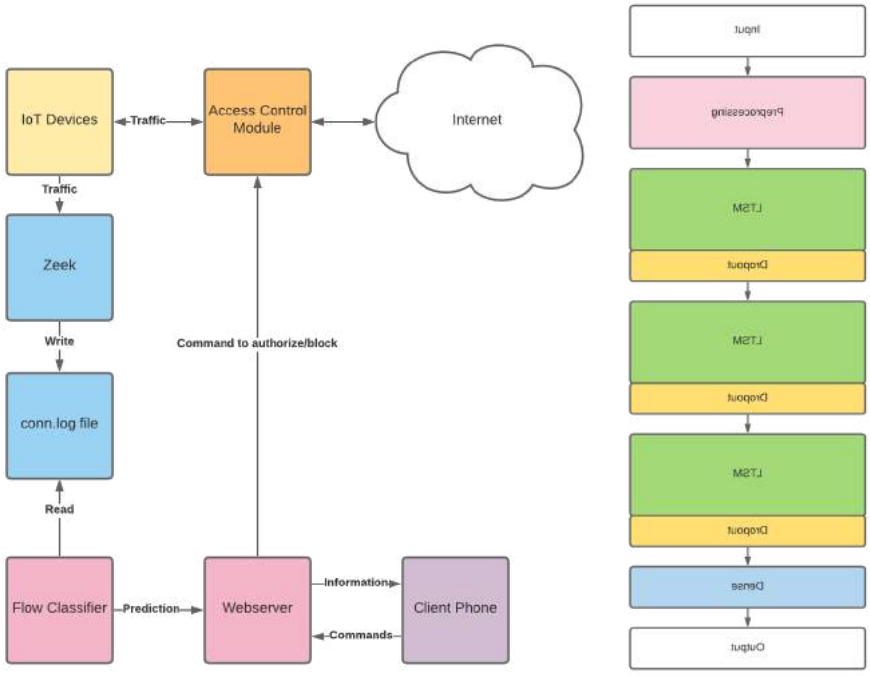
***Advisor(s)***: *Dr. Wade Trappe*

***Keywords*** IoT, Security,

***Abstract***

IoT devices are becoming an increasingly present item in the technologically connected household. The home market is expected to grow from $24.8 Billion in revenue for 2020 to as high as $108.3 billion in 2029. Despite this, there's a distinct gap in low-cost security focused IoT software and appliances, a niche that needs to be filled when coupled with the relative insecurity of IoT devices currently, where even major companies like Ring have produced insecure software in the past.

Current IoT gateways require lots of manual configuration and are too feature rich for people without the requisite technology experience. The objectives of this project are to detect and automatically quarantine compromised devices and alert user through accessible UI.



**S21-38** **Title**: *F-SCAN DS: Foot Splinter, Cut, and Nick Detection System for the Purpose of Preventing Amputations in Diabetics*

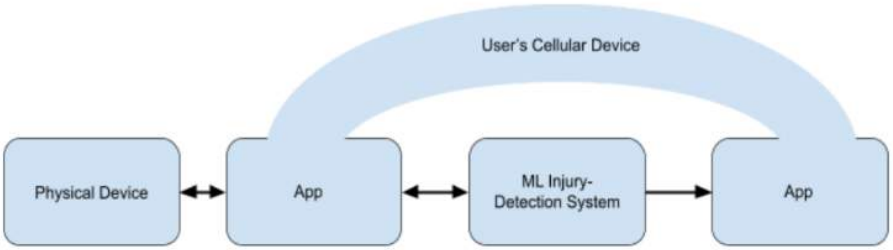
**Members**: *Amber Haynes, Maria Rios*

**Advisor**: *Dr. Jorge Ortiz*

***Keywords*** Biomedical, Image detection, 3D Printing, Machine Learning, Sensors, App Development

***Abstract***

With a substantial portion of the US population suffering from diabetes, we feel that it is important for there to be a tool that will help patients identify any cuts that could turn life-threatening. Since diabetics have a weakened immune system and neuropathy, they are prone to cuts on their feet and often are unable to detect them. Our goal is to create an imaging system that will help diabetics identify these cuts/injuries and relay that information to a healthcare professional. This system will be split up into 3 major components. The first component is the physical F-SCAN DS scanning device. The device will contain a hardware mechanism that sends information to the Machine Learning (ML) System and the app. The ML System, which is the second component, works to identify any cuts or injuries in the image. The ML System then calls the app. The app, the third component, receives information from the ML System regarding the type of injury and the location. One of the major constraints we face with this project is assuming that the user already owns a smartphone. Additionally, the user would need to own an Apple device since the app will only be compatible with the iOS system for the time being. In the future, we hope to make the app compatible with Android. Information regarding our project timeline can be found in a table at the end of the report.



**S21-39** **Title**: *M.A.G.E. – Mobile App Garden Experience*

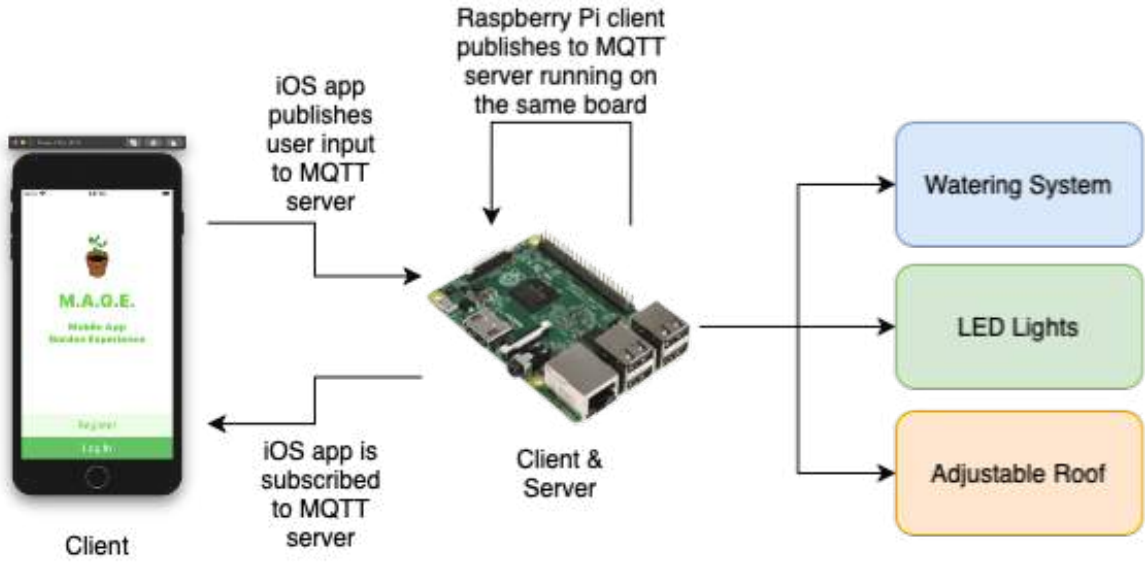
**Members**: *Gregory Giovannini, Jikai LaPierre, Max Lightman*

**Advisor**: *Dr. Athina Petropulu*

**Keywords** horticulture, photo-diet, drip irrigation, Raspberry Pi, smart timer

**Abstract**

Beginner and intermediate gardeners are often unaware of how the quality of light plays just as big a role as proper hydration to see effective plant growth. The proposed project is made to meet the needs of beginner to intermediate gardeners by giving them access to a cheap, easy-to-use gardening infrastructure. The primary objective of this project is to pair a user-friendly mobile application with simple installable hardware for automating and expanding one's gardening experience. The user will be able to manage their plant care easily through the application and hardware while still being able to improve their own skill by learning the process of horticulture themselves through planting and harvesting. The proposed project would use LED lights to provide a custom photo-diet for plants from selected light colors. Additionally, the application will integrate with a drip irrigation system to provide automatic watering for plants on a user-configurable timer. Similar automatic planters on the market frequently require individual setup by pairing lighting systems with other water systems or vice-versa. The proposed project will give an all-in-one home gardening experience that can be monitored and controlled from a simple mobile app interface, and the height of the lights on the roof will be adjustable through the app. Additional features can also be added to meet more needs of indoor gardening and improve the experience, such as an automatic system to adjust the height of the LED lights in sync with the plant's growth without need for manual adjustment through the app.



***S21-40*** ***Title***: *Smart Port Scooter*

***Members***: *Khalid Masuod, Arshad Vohra, Brendan Lindsey, Abdullah Nasir*

***Advisor***: *Dr. Hana Godrich*

***Keywords*** storage, cloud, Wi-Fi, Bluetooth, app

***Abstract***

Living on a college campus in our generation, we are seeing a new wave of transportation take over. So out with the old bikes and unreliable Rutgers Busses, and in with a new form of transportation that integrates the next big technologies with traditional forms of transportation, the smart E-Vehicle Kit. We wanted to tackle this transportation dilemma ourselves by creating our own optimized, reliable prototype.

The objectives of the project are to Implement a program that connects port to Google Maps API; Develop a port system with trackable ports that are visible on a scooter display which provide a centralized drop off location for scooters; Successfully ping server upon detecting movement; Report location data to a central server via a user's cellular connection; and implement discount system for returning vehicles

***S21-41*** ***Title***: *Cryptocurrency Sentiment Analysis Model*

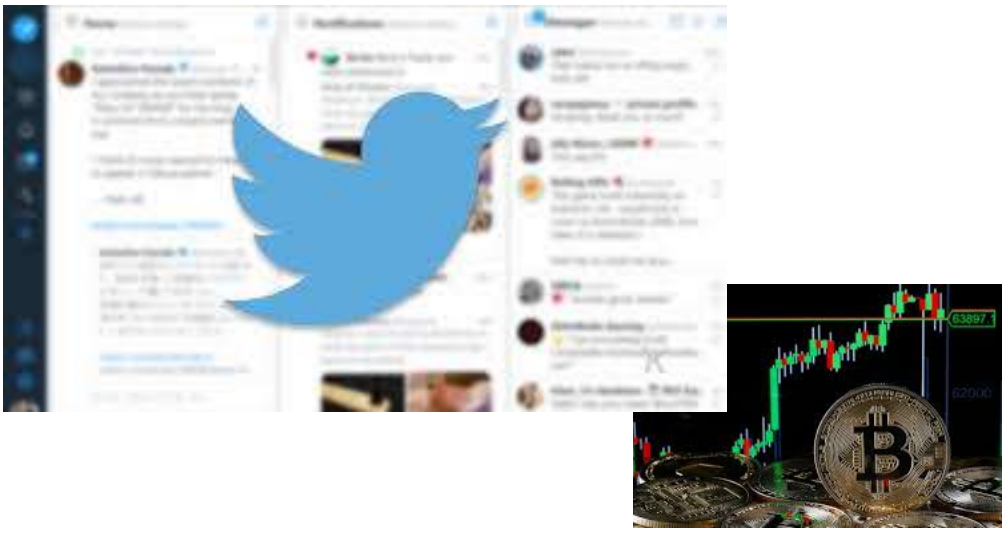
***Members***: *Anmol Mynam, Nikhil Kumar, Yuhang Cao*

***Advisor***: *Dr. Emina Soljanin*

***Keywords*** Crypto-Market Prediction Model, Deep Reinforcement Learning, Sentiment Analysis, NLP, Quantitative Trading, Twitter, Reddit

***Abstract***

Using Twitter and Reddit, we will analyze user submissions to the respective sites. We will organize a dataset of submissions, mentioning crypto, company name, or a response to submission with one of these expressions. We will run the submissions through a program to look for certain terms that indicate a sentiment. We will compute a table with crypto/company names, and associated sentiment results for said crypto/company. This will take an aggregation of those sentiments in conjunction with other parameters like time period, price movement, and volumes of coins traded. Based on the aggregation of submissions, sentiment scores, and other mentioned parameters, we will predict the trending of crypto in the near future. We will train this prediction using deep reinforcement learning. By running our captured data through an algorithm, we will compare it to past crypto market movement, and past social media sentiment, to compare and train our algorithm. After our model has been trained we will continue to tweak the parameters, and backtest it on current data to see how accurate we are. In addition to the algorithm and data collection, we will also implement a bot that will buy or sell crypto based on the recommendation of the algorithm. We will then test the algorithm and see whether our bot turns our predictions into a profit or loss. After this, we will continue to tweak our parameters for the algorithm and bot to optimize profit and better trades.



***S21-42*** ***Title***: *Capstone Management App*

***Members***: *Andrew Awad, Visshal Suresh, Nate Smith, Ketu Patel*

***Advisor***: *Dr. Bo Yuan*

***Keywords*** Martial art, training, DensePose, Caffe2

***Abstract***

We are providing an affordable and safe way to stay in shape during this pandemic. Usually, the Martial Arts trainers are hard to find and most people cannot afford it. We are providing a stay-at-home alternate solution to train in the proximity of one's own household. We are providing an automated training system to train at home under the supervision of machine learning algorithms. We are using high speed motors on a sturdy metal frame with a target attached in the center that will use the camera input from the DensePose full body mapping algorithm and project the trajectory of the movements of the trainee in the camera frame to move the target to avoid getting hit. A solution like this has not yet been implemented. The target audience would be UFC fighters, boxers and athletes that are trying to stay in shape and trying to improve their target practice as well as work on their reflexes. This would serve as a repetitive exercise to improve one's ability according to personalized needs.

***S21-43*** ***Title***: *Fix My Mix*

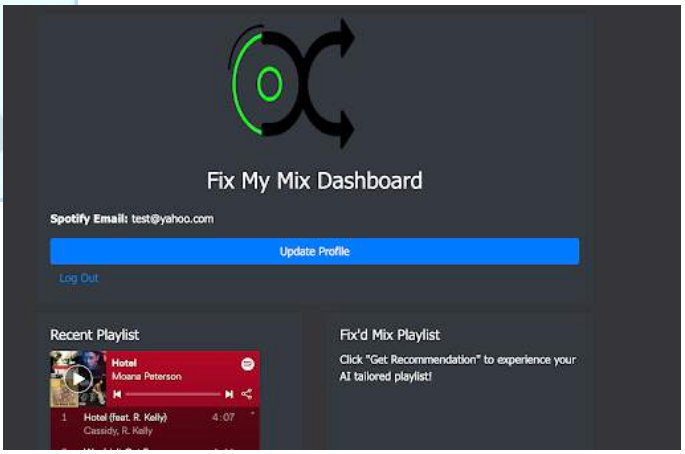
***Members***: *Omar Faheem, Akshat Parmar, Gabriel Ajram*

***Advisor***: *Dr. Predrag Spasojevic*

***Keywords*** TensorFlow, Heroku cloud, content based filtering

***Abstract***

A daily music recommendation service through a deep learning method. Currently music platforms recommend tracks based on your previous listening history. Along with your history, songs may be recommended based on what similar listeners are listening to. Our web application, Fix My Mix, allows users to create an account and grant us access to their spotify accounts. Using Spotipy, a python library for the spotify API, we are able to collect data such as relevant time information and statistics regarding the composure of the music being streamed by users. These data points serve as nodes in our model. Our model is based on Long Short Term Memory (LSTM) Recurrent Neural Networks. Through user feedback and Spotify's large music streaming dataset, we are able to provide a continuous enhancing playlist. Hence the project name, Fix My Mix, we are able to provide users with a more efficient listening period through reducing the time spent shuffling through songs. Within the past month, Spotify has received a patent for a similar concept regarding music recommendation based on emotion. Spotify is using speech recognition to figure out what setting the user resides in. For example, if Spotify hears you are in a party setting, it will recommend party songs. Unlike Spotify, users need to be listening to music for our model to make consistent changes. Although collecting more data points then may make our model more complex, it would allow for a much better listening experience. Therefore, we have gone as far as breaking down every song that meets our criteria as a successful "listen" to understand why users allowed the song to play over others that were rapidly skipped or briefly listened to.

***S21-44*** ***Title***: *RLAD: Time Series Anomaly Detection through Reinforcement Learning and Active Learning*

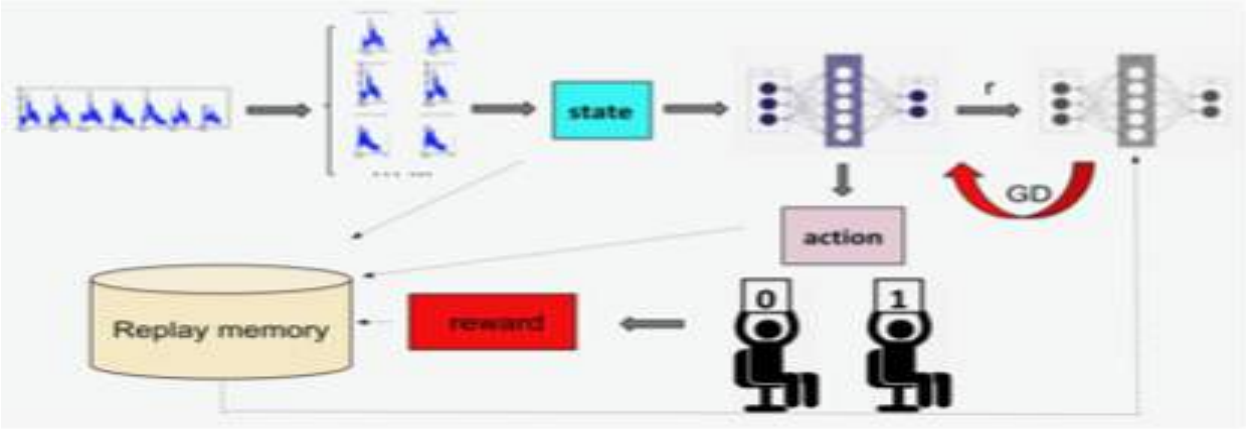
***Members***: *Qizhen Ding*

***Advisors***: *Dr. Jorge Ortiz and Tong Wu*

***Keywords*** Detection, Machine Learning

***Abstract***

Scalable data collection and labeling is a necessary feature for smart environment based on ubiquitous sensing and computing. However, this is challenging in highly dynamic environment where multitude of applications occur simultaneously as labels are costly and users can be forgetful to real- time labeling. This work proposes Maestro, a data collection and labeling platform that can sense ambient information in real-time, provide context to put less burden on users for offline labeling, and can evolve as a system at scale to many users. We demonstrate how Maestro, coupled with a web application to enable a user-centric labeling process, can be used for quick deployment and data collection for machine learning enabled sensing applications. Preliminary results show that we can achieve accuracy >95% for our applications (occupancy counting and activity recognition) by using only <10% of labeled training data and active learning.



**S21-45** **Title**: *RU-Therapy*

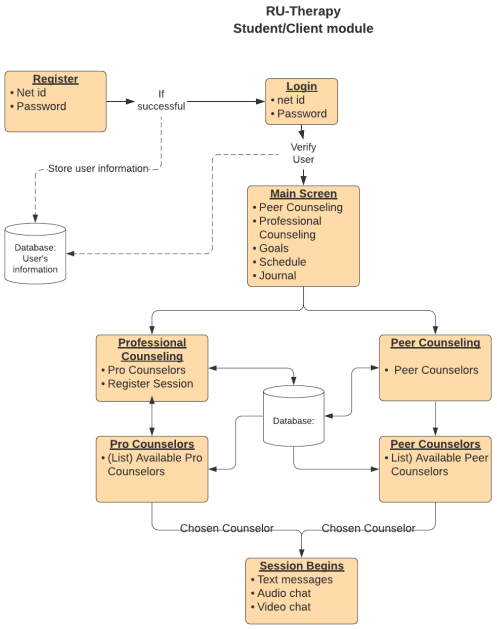
**Members**: *Khizer Humayun, Akash Govindaraju, Sianna Arruda, Rebekah Bediako, and Hedaya Walter*

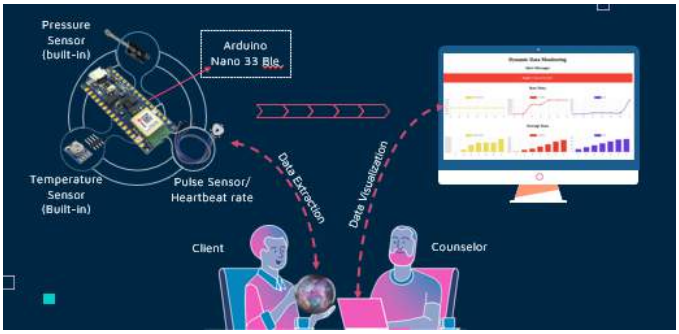
**Advisor**: *Dr. Hana Godrich*

**Keywords** therapy, virtual counseling, mental health, peer counseling, web application, Therapy-ball

**Abstract**

The project goal is to create a web-based/mobile application which will allow Rutgers students to virtually attend counseling when needed. Due to covid-19, especially, in-person counseling has become difficult to attend. Also, in normal conditions, at times it is difficult for students to meet in-person with their counselors because the appointment times never line up with their class schedule. Therefore, having a software application will allow students to attend counseling anytime and from anywhere. The need of counseling is essential for one going through anxiety and stress because it could lead to affecting their decision making. A student dealing with one of these disorders can experience negative effects on their attention, interpretation, concentration, memory, social interaction, and physical health. It can be difficult for teachers to identify anxiety and depression because these disorders often show up differently for different people, but therefore knowing the combinations of behaviors to look for is key. Another important implementation in RU-therapy will be the peer-counseling. Due to the tight schedule of counselors, it may become difficult for some students to attend even virtual counseling sessions. Therefore, this issue will be addressed through peer-counseling. The goal for designing RU- therapy is to encourage students to attend counseling and therapy to promote optimal health around the campus.



***S21-46*** ***Title***: *Hydro-Homie*

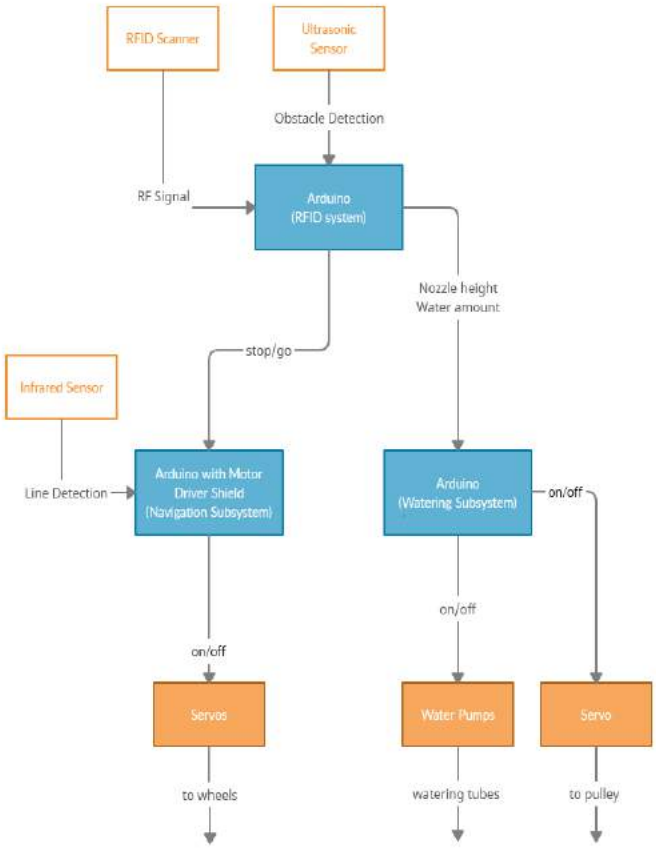
***Members***: *Andrew Catalano, Erick Camerino, Davin Kim, Tom Markos, Isaac Tan*

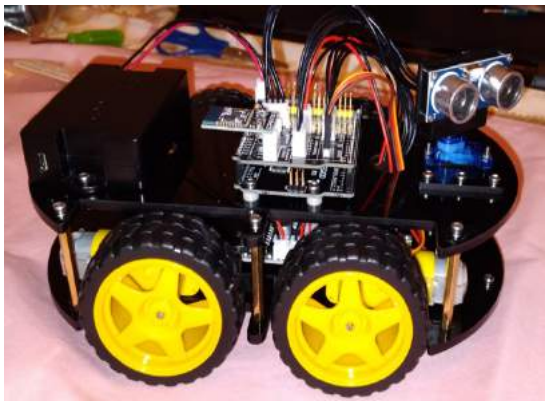
***Advisor***: *Dr. Wade Trappe*

***Keywords*** robotics, Arduino, automated, potted plants, sensors, RFID

***Abstract***

The Hydro-Homie is an automated robot that navigates a confined space. It will follow a predetermined path and be able to go around or stop if an object or obstacle is blocking its path. While it is navigating the area, the Hydro-Homie will water marked potted plants that are in its path. It will use a water pump to take the water out of the tank, and the nozzle will be able to move up or down so that it can water pots at different heights. Furthermore, we explain the reasons to create such a tool and why certain pieces are necessary. We will discuss the current plan on how the pieces of the Hydro-Homie will be tested and put together, and we will discuss how the project will be split up.



**S21-47** **Title**: *Real-Time Drone Control via Single Outside Observe*

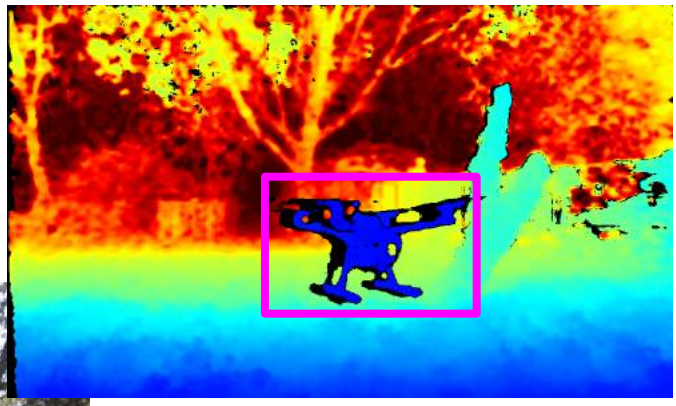
**Members**: *David Sukharenko, Bryan Zhu, Anthony Weiss, Kris Caceres, Roman Nikolin*

**Advisor**: *Dr. Predrag Spasojevic*

**Keywords** computer vision, object detection, distance/depth estimation, unmanned aerial vehicle (UAV), drone

**Abstract**

In the past decade, drone usage has grown beyond the military sector and seen wide-ranging commercial and civilian use. As drones and drone research grow in popularity, there is a newfound need for a portable drone control system external to the drone itself. Current drone positioning systems work well in controlled indoor environments, but lack the flexibility, reliability, and portability that outdoor environments require. In addition, the variable nature of piloting drones requires a skill that new users may not immediately have or have the time to acquire. We propose a singular outside observer computer vision solution. An RGB-D camera locates a drone within its viewport using object detection algorithms, and the drone's calculated position and orientation are used to control its flight patterns. Our solution allows us to use a compact, portable computer vision system to fly a drone in an intuitive manner without modifying or making additions to the drone itself. The initial prototype will use an Intel RealSense D435i depth-sensing RGB camera attached to an NVIDIA Jetson Xavier NX for object detection and depth measurement. UWB transmitters may be used to increase accuracy and range of the latter. Object detection will be run with a real-time detector such as YOLO or RetinaNet on Nvidia DeepStream. Once the drone is detected, controls will be sent to the drone via radio. Our system will be tested in compliance with all local and FAA regulations regarding recreational drone use.



**S21-48** **Title**: *Active Noise Cancelling w/ Machine Learning*

**Members**: *Ryan Davis, Priya Parikh, Parth Patel*

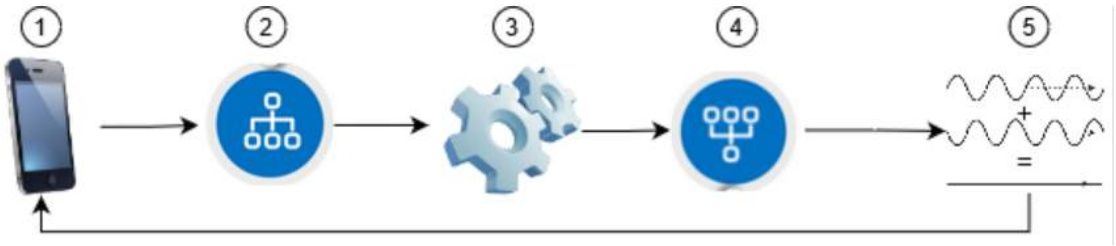
**Advisor**: *Dr. Jorge Ortiz*

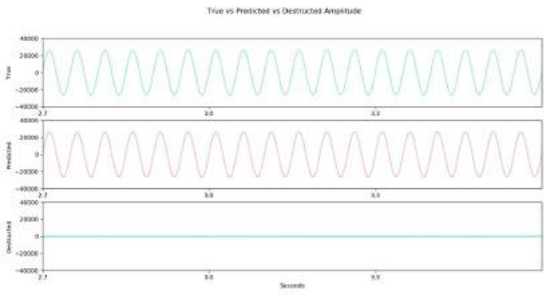
**Keywords** Machine learning (ML); active noise cancelling (ANC); adaptive filtering; neural networks; smartphones

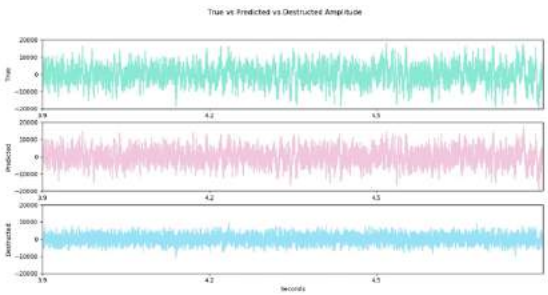
**Abstract**

The project we are pursuing applies machine learning techniques to improve digital adaptive filtering algorithms for active noise cancelling (ANC) on smartphones. Active noise cancelling is a process that uses additional sound signals to cancel out unwanted noise. Modern ANC systems use adaptive filtering using recursive least squares (RLS) or least mean squares (LMS) filters. The use of machine learning methods in ANC could improve its performance, as modern neural networks are able to adapt to signals with very complex internal structure. The goal is to leverage the computing power of smartphone systems for machine learning to provide real time active noise cancellation. The different types of neural networks that will be explored are long short-term memory networks (LSTM) and convolutional neural networks (CNN) stacked with LSTM layers.

The features we expect to add that are unique from current noise cancellation applications are the use of neural networks on resource constrained devices as well as providing ANC for high frequency and complex signals. While the current scope of this project is limited due to environmental constraints, the idea could improve ANC technology, better handle high frequency signals, and potentially give or apply ANC capabilities to any headphones and audio output. A possible future prospect is a mobile application that provides real time filtering on any capable mobile device with or without headphones.





**S21-49** **Title**: *Mental Health Chatbot: KANA*

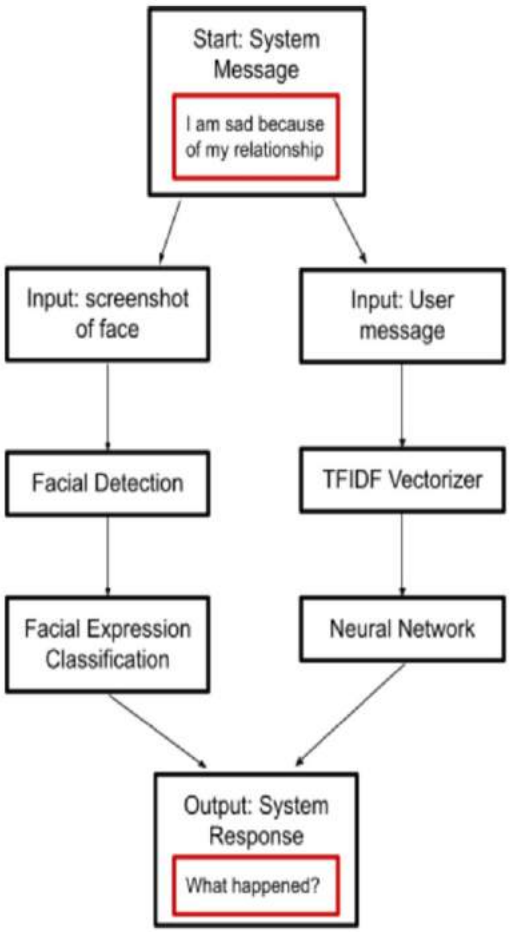
**Members**: *Jennifer Huang, Samuel Zahner, Nishad Nalgundwar, Vincent Chan*

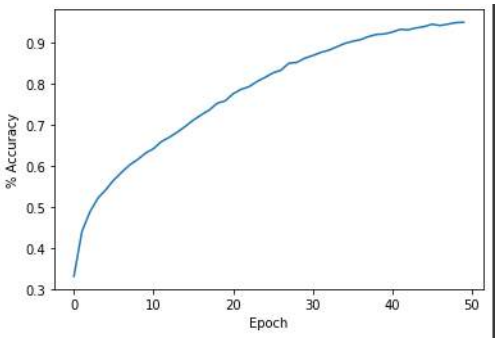
**Advisor**: *Dr. Kristin Dana*

**Keywords** Artificial Intelligence, Machine Learning, Computer Vision, Mental Health

**Abstract**

Mental health involves the well-being of an individual's mind, as well as an individual's ability to endure stressful events. While stressful events, irritation or frustration may build a tolerance, it can also quickly deteriorate an individual's ability to function at their highest potential. People often overlook how mundane daily tasks serve as a stressor to our day-to-day lives, thus leading to overwhelming negative feelings which will accumulate to have detrimental effect(s) on an individual's mental health. With our Artificial Intelligence Dialogue system, individuals will now have a means to prevent the aggregation of obstructive feelings and thoughts. Our system is designed to help individuals locate resources for their unique situation through an emotionally aware virtual dialogue system. With this system in place, anyone will be able to have access to comfort, companionship, as well as unbiased information from accredited sources. While the system is not meant to be a replacement for therapy, it provides people with a means to take a further step towards the positive growth of mental health.



***S21-50*** ***Title***: *Covid_19 Face Mask Check System*

***Members***: *Nianyi Wang, Kebin Li*

***Advisors***: *Dr. Hubertus Franke (IBM) and Dr. Yuqian Zhang*

***Keywords*** Deep Learning, Machine Learning, Image processing

***Abstract***

Due to the Covid_19, personal protection in the public area becomes much more important. Everyone is required to wear a face mask to stop the transmission of the virus. However, it is impossible for a human being to check if the face mask is up to standard due to thousands of types of face masks. We will develop a system to detect the type of face mask Consumers just have to stand in front of the camera, we can just take a picture of their face and put it into the trained model to get the corresponding type of mask. If that mask matches the qualified face mask type, our system will let the consumer in.

***S21-51*** ***Title***: *Potential Vulnerability in K8S*

***Members***: *Vulnerability Assessment, Exploitation, Information Gathering, Reconnaissance Discovery and Scanning*

***Advisor***: *Dr. wade Trappe*

***Keywords*** Vulnerability Assessment, Exploitation, Information Gathering, Reconnaissance Discovery and Scanning

***Abstract***

In this project, we are mainly discovering all possible security vulnerabilities in a popular commonly used K8S architecture. The work is split into at least 3 stages.

Containers are a big revolution in software development because they bring the production to our local environment. No more worry about Linux or Windows compatibility. With containers, all issues are easily reproducible in all workstations. Moreover, each environment is portable with no extra effort. Developers have the power of package applications and this is good because they know how the application should work. On the DevOps side, containers are beautiful because each deployment system handles only one kind of artifact: containers. Moreover, all build processes can be described in Dockerfile on the dev side, and this means that you will use only one way to build things, the same in local dev and continuous integration.

We are going to research what is the most commonly used K8S architecture for small business. And then reimplement it on a vmware ESXI server with 1 master node with at least 3 worker nodes.

***S21-52*** ***Title***: *I.O.Clean*

***Members***: *Jonathan Banks, Edward Gaskin, Alex Martorano*

***Advisor(s)***: *Dr. Kevin Lu (Stevens) and Dr. Hana Godrich*

***Keywords*** Bacteria Detection, Automation, Cleaning, Disinfecting, Monitoring

***Abstract***

Hygiene is essential for health and safety, and yet can be difficult to manage. A survey by the American Cleaning Institute found that 34% of respondents were concerned about whether they were cleaning enough, and 31% were not sure they were cleaning correctly. Users of real estate, public or private, owner or renter, would all benefit from having an easy way to manage the cleanliness of their property. I.O.Clean utilizes IoT smart technology to give users a dashboard on their phone to help keep their spaces hygienic. The system is modular, which enables it to be easily scaled, customized, and future-proofed. It is easy to forget about an invisible threat. I.O.Clean smart devices work to assist in the management of cleanliness as well automating certain cleaning processes within a work or living space. Utilizing I.O.Clean deters virus and bacteria accumulation, and helps maintain the overall safety of families, tenants, and employees occupying a space.

**S21-53** ***Title***: *Automatic monitor distance adjustment system*

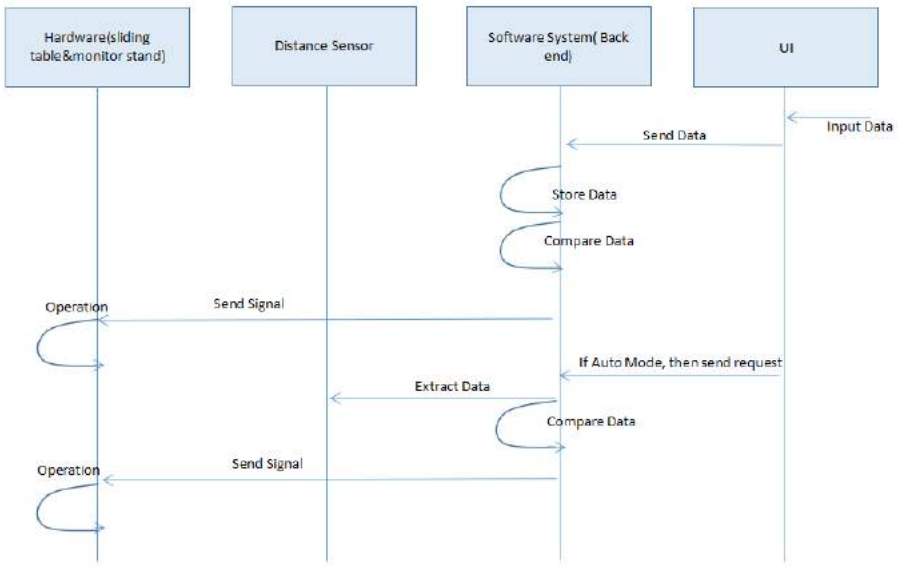
***Members***: *Yuxiang Wang, Gaohaonan He*

***Advisor(s)***: *Dr. Maria Striki*

***Keywords*** Sensor, Javafx, Sliding Table, automation.

***Abstract***

The automatic monitor distance adjustment system can maintain a certain distance between the users' eyes and the computer screen automatically by controlling the screen to move along the open belt table. It contains four sub-systems which include control system, Distance Sensing, Hardware System, and APP(UI). The control system will obtain signals from the Distance Sensor which is installed at the back of the user's chair. The control system can recognize whether the distance is within the threshold or not. If not, the control system will send signal to hardware system in order to adjust the belt table as the distance that has been already set in the APP. The project is targeted to be customer-oriented that it can be fully customized by the users. They can choose to open or close the function as well as set the distance.



***S21-54*** ***Title***: *Voting in the 21st Century*

***Members***: *Hrishit Joshi, Christopher Rosenberger*

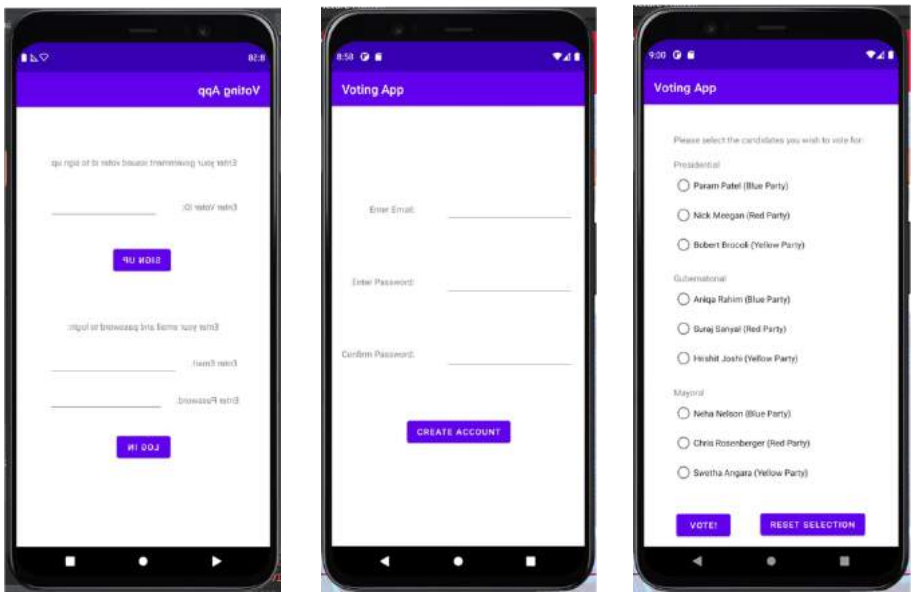
***Advisor***: *Dr. Maria Striki*

***Keywords*** Voting, Innovation, Technology, Digital voting, Application, Elections

***Abstract***

Currently voting is done through either casting ballots in person or mailing in ballots. Both of these two solutions are inconvenient in their own ways; in-person ballots require voters to wait in long lines whereas mail-in ballots can be casted in the comfort of a voter's home, however mail-in ballots take multiple days to count whereas in-person ballots can give election results typically on election day. Our plan is to utilize computers to create a voting method that allows for fast, convenient voting, that is to create a secure voting app that lets voters vote from the comfort of their own home.

The current state of voting, in the United States at least, is a hybrid system. Most states, by and large, use a combination of hand-marked paper ballots and electronic voting count machines. The paper ballots are gathered in hand-marked paper ballots through in-person polling locations as well as mail-in ballots. The electronic voting machines are mostly used for tabulation, and in some cases are used as ballots themselves, however most of the country simply uses scanning machines to tally votes for each candidate. This hybrid situation is present in most states, with each state using varying degrees of technology in their voting and counting processes. To fix this issue, we propose the development of an application that allows someone to vote through their electronic device. We want this application to encompass 3 features: Voting is easy, simple for the user, all votes are secure and cannot be hacked, and the results of the votes are fast to compute.



**S21-55** **Title**: *Parking Violation Detector*

**Members**: *Wenhao Xie*

**Advisor**: *Dr. Zoran Gajic*

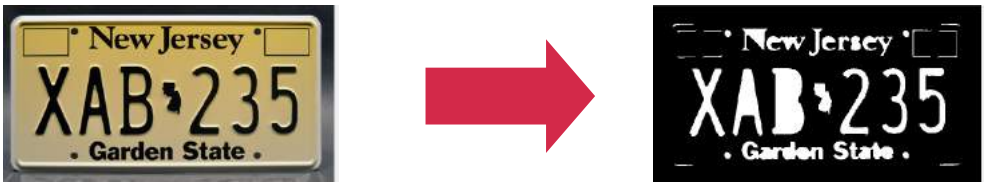
**Keywords** Automation; Image processing; Car license plate recognition

**Abstract**

It is very annoying that we cannot find a parking space even if we buy the parking permits. The reason is that many students who do not buy the parking permits still park their cars in the permit-controlled lots. Although some staffs will scan the car license plates and impose fines on people who park illegally, the problems still exist because of the lack of efficiency. Manual operation can be restricted by many unpredictable and uncontrollable factors, such as weather condition, time and workload. Also, Rutgers have to spend lots of money hiring the staffs to protect the interests of people who buy the permits.

The objective of the project is to design a device which can automatically scan and record the car license plates when cars enter the parking lot. Then, the data will be uploaded to the system that can determine whether the cars are legal or not. Staffs can receive the feedback at the end of the day and impose fines on these violators easily.

The approach consists of costs-effective cameras, sensors and processing programs. By adding the night-vision unit and waterproof materials, we can make the device more efficient and stable. Additionally, the device can replace manual operation and reduce cost. Students who buy the permits will feel satisfied about the university when their interests are protected adequately.

**S21-56** **Title**: *AI Teaching Assistant*

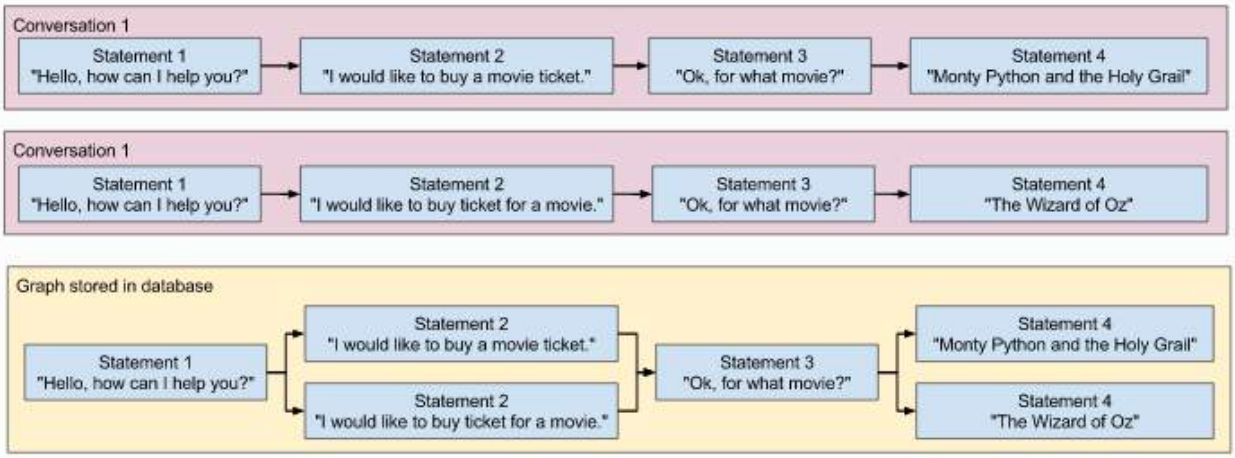
**Members**: *Palak Patel, Oleksandr Kalynyak, Hyunmin Choi, Francis Paul Reyes*

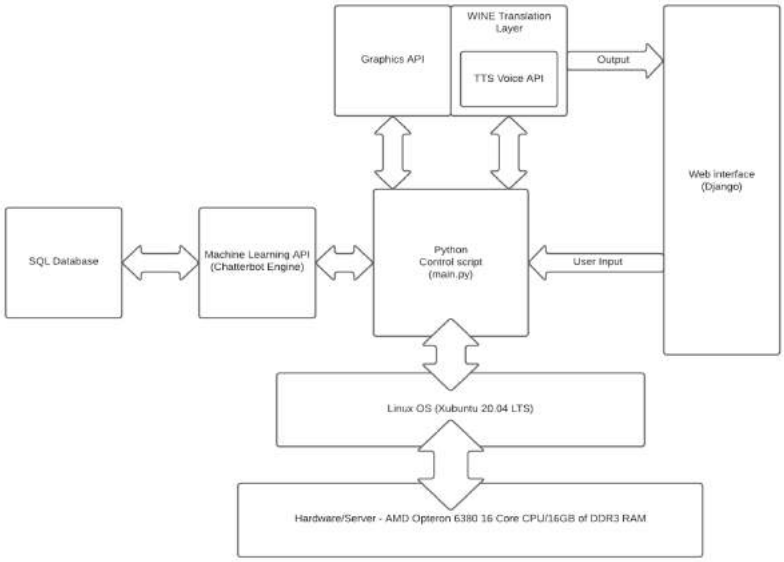
**Advisor**: *Dr. Hana Godrich*

**Keywords** Parsing, Web Scraping, Chatbot, Education, Database, A.I. Engine

**Abstract**

The purpose of this project is to create an A.I. Chatbot that takes in questions from the user and provides the most accurate answer. The chatbot that will be created should be able to answer any conceptual questions the user has. The main goal of this project is to make an algorithm that parses user queries and identifies keywords and phrases against the training database in order to return the most accurate answer to the question being asked. The project will be divided into three parts, which will be creating a front-end system, medium (which is the chatbot), and lastly creating a back-end system.



**S21-57** **Title**: *Fridge.it*

**Members**: *Natalie Kim*

**Advisor**: *Dr. Jorge Ortiz*


| | |
|---|---|
| **Keywords** | mobile app development, computer vision, OCR, consumer food waste, behavioral intervention |



**Abstract**

Managing food and groceries within the household still remains a manual chore that consumes personal time and energy; inevitably, the task is subject to various human errors, such as accidentally letting items expire, buying too much (or too little), and general forgetfulness. The smart home food management system proposed in this project targets inefficiencies on the consumer end of the food life cycle by providing a mobile application for keeping track of grocery items at home. Such inefficiencies are reduced through application features such as providing food expiration reminders and connecting the user to food banks to donate unused items. While the primary objective of the application is to achieve an overall reduction in consumer food waste, it is imperative to provide features that improve the usability and appeal of the app in order to ensure its practical viability. As such, the app also entails a custom recipe suggestion feature, a method of automating item input, and an interface that adheres to user experience principles.

Perhaps the most significant research problem involved in this project is the grocery receipt scanner, which aims to automatically extract each food item from an image of a receipt. Parsing this information into structured data provides an interesting challenge in regards to not only semantic understanding, but also interpretation of spatial information. This project will explore the research problem as it currently exists and attempt to implement a solution that is optimized for the mobile application format.