School of Engineering
Department of Electrical and Computer Engineering

Capstone Program Spring 2020

Senior year Design Projects

At a Glance...



S20-01

Title: *Phased Patch L-Band Antenna Array*

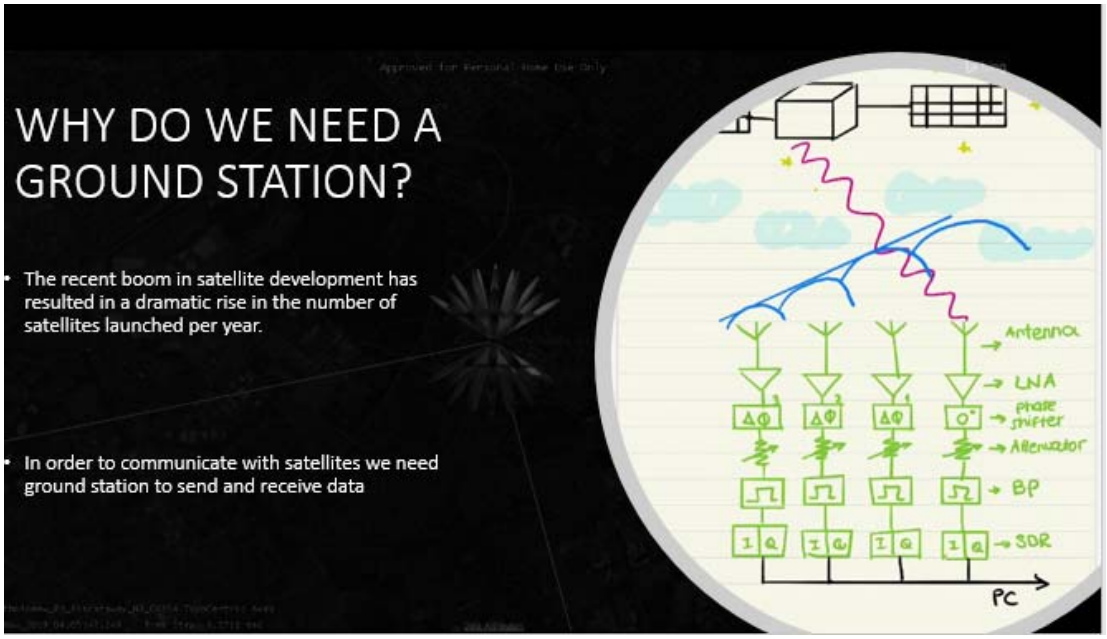
Members: *Daniel Toth, Marissa Navarro, Cameron Greene, and Stephen Dahl*

Advisor(s): *Dr. Anand Sarwate, Dean Telson (L3Harris), and Alejandro Pieroni (Cellgain)*

Keywords Ground-station; Communication; Satellite; Phased-Array; L-Band

Abstract

The next decade will experience a massive surge in the amount of satellites located in lower earth orbit – 5 times the amount of satellites launched within the past 60 years. The majority of which will be delivered as satellite constellations, such as SpaceX's Starlink and Amazon's Project Kuiper. The ambition of the two mentioned and many other complementary companies is to provide communications, including internet access, that will be available worldwide. Inevitably, this surge will create crowding in higher frequency bands ranging from L (1.5 GHz) to Ka (up to 40 GHz). Our project seeks to fill the need for a low-cost solution to tracking and acquiring satellite signals in support of this future infrastructure. Traditionally, ground stations that have been designed over the years are mechanically steered, clunky, and high cost. Taking a note from cutting-edge 5G cellular networks, we propose a light-weight solution by using digital beamforming techniques through a phased array to implement electronic steering and improved signal-to-noise ratio. For processing incoming satellite signals, the phased array ground station will have onboard DSP through a fusion of rising trends in software defined radios and GPU accelerated programming techniques. Overall, the techniques discussed will be synthesized together in a standalone system using the NVIDIA Jetson Nano for computing and low-cost SDRs, LNAs and patch antennas for RF to form a lightweight solution with respectable signal fidelity.



S20-02

Title: *Disaster Response Drone (DRD)*

Members: *Taylor Hanson, Juan David Beltran, Angie Flores, and Ashish Sareen*

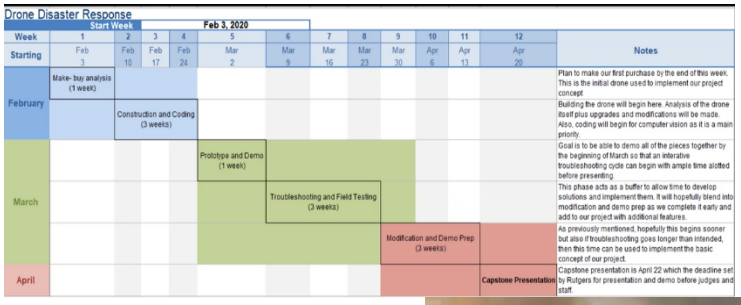
Advisor(s): *Dr. Phillip Southard, Howard Cohen (L3Harris), and Manoj Viswambharan (L3Harris)*

Keywords Search and rescue drones; natural disasters; computer vision; OpenCV; Image processing

Abstract

Unmanned aerial vehicles or drones have historically been employed in short and medium ranges for military missions. Nowadays, these devices have a variety of uses in agriculture, wildlife conservation, and rescue operations. Every year natural disasters take the lives of 90,000 people and affect around 160 million people worldwide according to the world health organization. The Disaster Response Drone team recognizes that rescue team responders use extreme methods of transportation that put their lives in danger; therefore, this project is aimed to develop a long-range drone that would increase the chances of rescuing survivors and minimize the risk of human life in the case of a tsunami, earthquake, flooding, and any natural disaster.

The Disaster Response Drone is a pre-build device that would scan areas for survivors on the ground in adverse and low-visibility scenarios. While the drone is being deployed, it streams a live video to the computer that would be used as the input for the algorithm. By utilizing computer vision techniques, this algorithm would identify and locate people on the ground in real time; furthermore, the team plans to perform several field tests in the drone designated area at Garret Mountain Reserve located in Woodland Park in southern Passaic County and expect to achieve a 91% of accuracy in the algorithm.



S20-03 *Title: Text – to – Braille Converter*

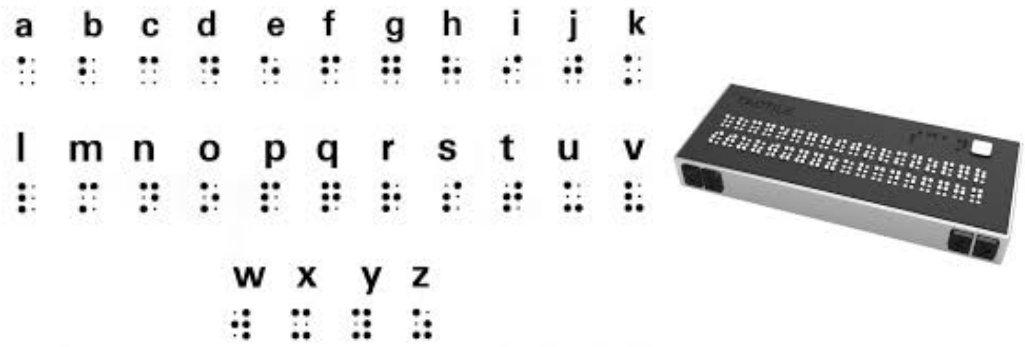
Members: Erika Jean-Pierre, Sumedha Mendiratta , Maham Aslam , Tiyon King

Advisor(s): Dr. Wade Trappe

Keywords Accessibility, Raspberry pi, Electrical, Software.

Abstract

For our project we decided to focus on Accessibility. Accessibility is the quality of being easily understood or appreciated, of being easy to obtain or use, of being able to be reached or entered. A Lot of companies today are always looking for how they can make their product more accessible to and for everyone. For our capstone we are focusing on making products more accessible for people who are blind and or deaf. The problem addressed is how people with blindness use smartphones today. In this day and age most people text, however if you are blind you can't read these texts or reply in a timely fashion. Because of this we decided to make a text to braille converter starting with simple phone text messages and hoping to get larger for emails and things as such. The objective of the project is to awareness to accessibility and make a social impact on our community.



S20-04

Title: *MediHealth Tracker*

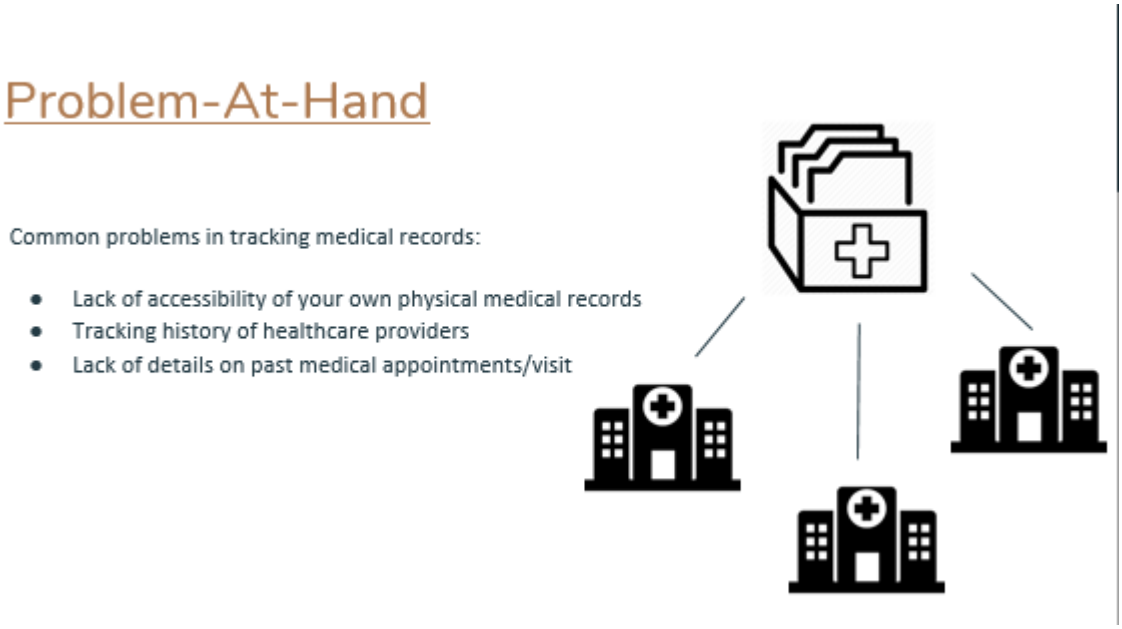
Members: *Rameen Masood, Purna Haque, Nga Man Cheng, and Holly Smith*

Advisor(s): *Dr. Hana Godrich*

Keywords Health, Organizer, Patients, Medical, Efficient

Abstract

Have you ever lost track of your medical records? Which doctor's office did you go to? Which hospital? Our project tackles the issue of tracking medical records. With humans constantly using different doctors and practices, we wanted to create a mobile application that helps with this issue. Our application, MediHealth Tracker will provide users to take complete control over their health information. Users will receive direct access to their medical documents and general information. Along with this, there will be features such as uploading files through camera, manual input for immunizations/medications, and an appointment manager. Our approach is to design the app and use Material UI, React Native and Firebase to create the application. We will have four main subprojects to work on: User Functionality, Designing using Material UI, Authentication, and Creating the Database. Our aim for the project is to have a functional application that will be useful for users to use.



S20-05

Title: *Floor Printing Robot*

Members: *Akash Nayak, Abhishek Chaudhuri, Ryan McGuire, and Sri Sai Krishna Tottempudi*

Advisor(s): *Dr. Anand Sarwate*

Keywords Robotics, Raspberry Pi, Wireless Communications, Automation

Abstract

It is the 21st century and these things can be automated to reduce the burden of road workers and allow for more complex designs in a short amount of time. This would lessen the load on the road companies to hire workers and would allow for more complex parking lot configurations to be implemented. Previous work has dealt with robot drawing on walls. We want to focus on drawing on floors.

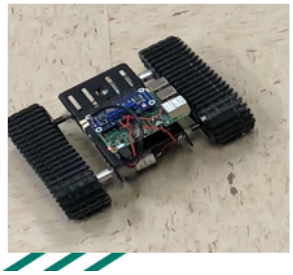
The problem is that spray painting the ground is tedious and must be maintained regularly so why not automate (reduce load for physical workers). The paint has to be maintained regularly due to weather and human intervention

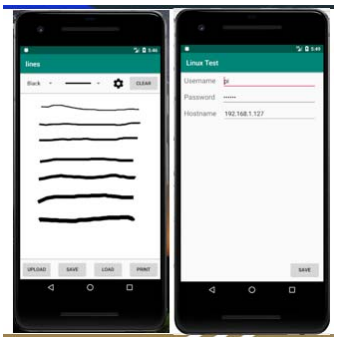
The objective is to require a robot to draw and navigate using sensor/signals on the ground using cutting edge technology The robot can draw autonomously (small scale (~ 1:10 scale)) and the minimal viable product (MVP) is a robot that can print a simple square through an app.

The adopted approach is implementing Mobile Apps and Wireless Communications technology through a raspberry pi 3b, some motor controllers and image files. The mobile apps technology is developing an Android app to tell the robot what to draw (scripts, data processing image) and the wireless communications technology is communicating between phone and robots, to draw on various surfaces

(calibrations).

Pictures of the bot:





S20-06 *Title: MusiMove*

Members: Aishwarya Nair, Jennifer Solidum, Nithya Kandappan, and Suomiao Xing

Advisor(s): Dr. Waheed Bajwa

Keywords Music, tracking, learning

Abstract

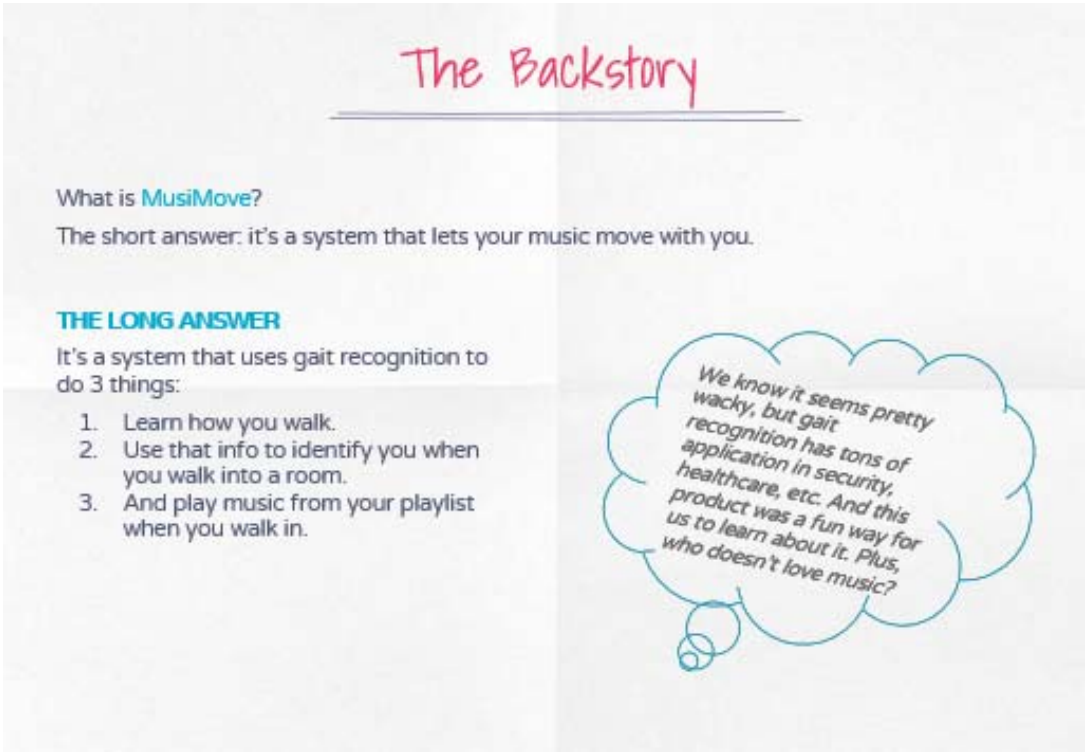
What is MusiMove? The short answer: it's a system that lets your music move with you.

It's a system that uses gait recognition to do 3 things: Learn how you walk, use that info to identify you when you walk into a room, and play music from your playlist when you walk in.

We planned to create a system that detects motion, records the person walking, classify the person and play music from their playlist or radio choices, aiming for mid to high 90% accuracy.

We may restrict ourselves to an environment that is not very crowded so that the environment is not very cluttered and data collection and analysis is easier.

We may extend this project to work when the input is coming from a variety of camera and person angles instead of limiting ourselves to only the side profile.



S20-07 *Title: FSO Communication: Li-Fi Radio*

Members: Michael Chang, Shantanu Ghosh, Srikrishnaraja Mahadas, and Vishal Venkateswaran

Advisor(s): Dr. John McGarvey

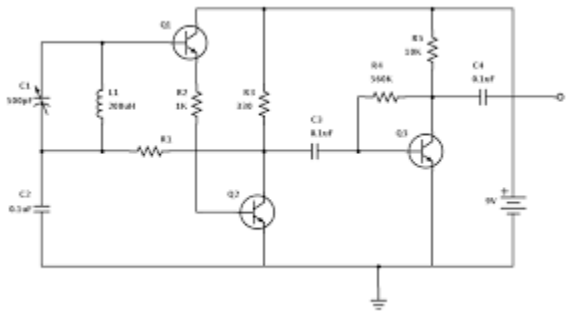
Keywords FSO, duplex, LED, modulation, communication

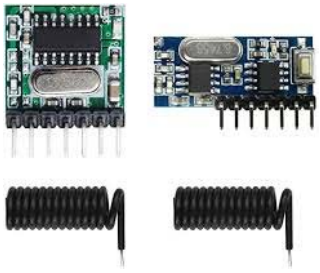
Abstract

Our project is a free-space optical communication system using Light Emitting Diodes (LEDs). In a world where there is a growing demand for primarily wireless communication, free-space optical systems provide an alternative to RF-based communication. Current implementations of wireless communication are limited in their bandwidth, require a broadcast/spectrum license, and can have high installation prices. On the other hand, an FSO based communication system does not require a license, can have a relatively wide bandwidth, and are typically relatively inexpensive to implement. There are many advantages to using FSO as a form of communication. These potentially include wide bandwidth, more secure communication, and a high degree of immunity to radio frequency interference.

We will implement a duplex (two-way) free space optics communication system. Our primary light source will be LEDs. Because of the angular divergence of LED light, we will also be using lenses to collimate the light beam at the transmitter and to focus the light beam on the detector at the receiving end. With this implementation, we currently plan to transmit signals up to 200m. The main goal of the project is to use the FSO to send audio signals, such as voice, in the form of a light beam from the transmitter to the receiver for

medium-range communication. The transmitter will modulate a carrier signal based on the output from a microphone. The receiver will use a photo-detector, such as a photodiode or phototransistor, to convert the information-carrying light beam to an electrical signal, demodulate it, and then convert it back to sound.





S20-08

Title: *Trading Application*

Members: *Kanak Borad, Andrew Lau, and Vancha Verma*

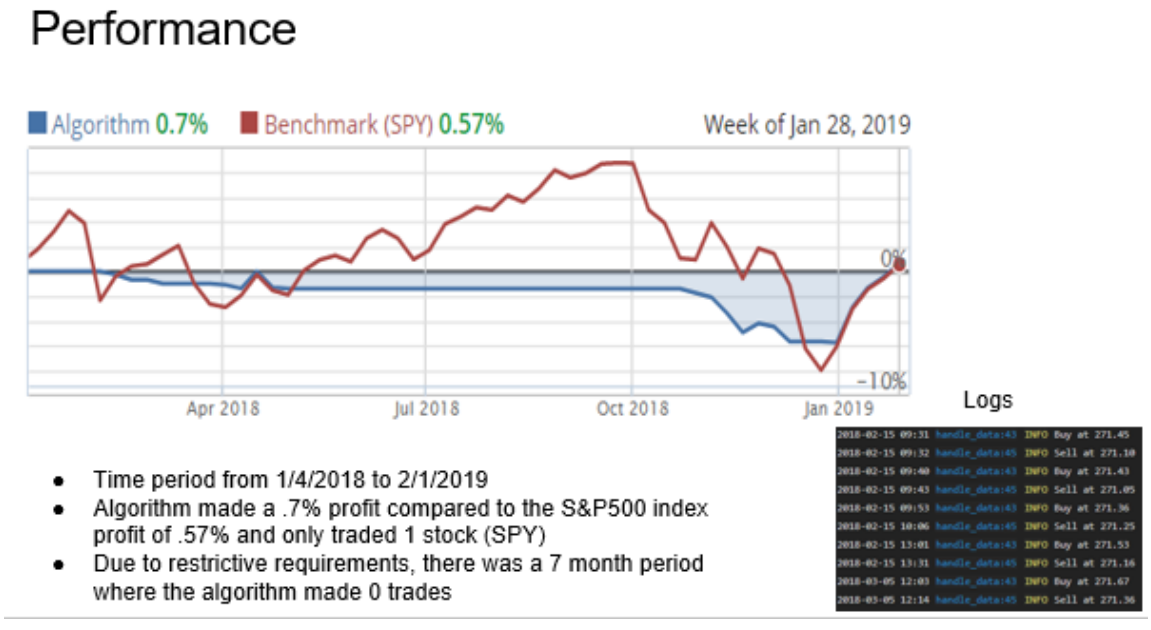
Advisor(s): *Dr. Wade Trappe*

Keywords Algorithm, Trading, Stocks, Market

Abstract

The stock market is where shares of publicly listed companies are traded. Most adults have some kind of money tied to the stock market whether it's a 401k, IRA, or they are a retail investor or trader. Retail investors and traders buy and sell stocks using their own personal money as compared to professionals who work at banks and hedge funds. It is estimated that there is around a 10% success rate for day traders which means the vast majority of people trading stocks are losing money.

There are many reasons why traders money. This includes, guessing when to buy and sell, trading with emotions, missing trading opportunities, and not having a trading strategy. Our team's proposed solution is to make an algorithm that does the trading for the typical retail investor. Having an algorithm trade, fixes many of the common mistakes that cause people to lose their money. An algorithm makes trades faster by eliminating the manual clicking required for typical brokerages and does not require someone to constantly watch the market. Furthermore, the program will trade with a consistent strategy which eliminates the emotional and guessing aspects of typical retail traders. Using python, Alpaca API, and Quantopian we can code and test our algorithm on previous and live market data. The algorithm will use a variety of market indicators such as SMA, EMA, and RSI to dictate the trades. The future of retail trading will be automated and will provide a significant advantage over manual trading.



S20-09

Title: *IntelliGEST: Intelligent Gesture*

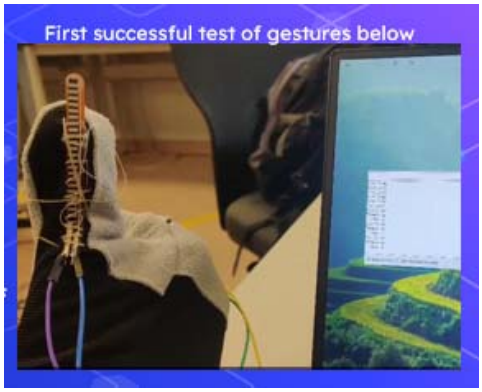
Members: *Adam Piziak, Asmaa Hasan, George Melman-Kenny, Jason Cariaga, and Jon Tsai*

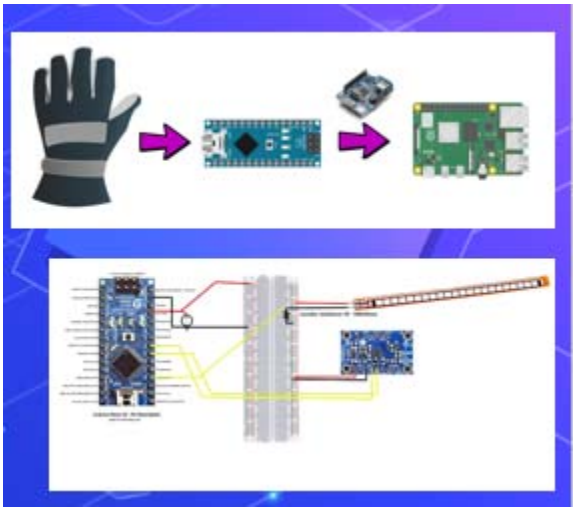
Advisor(s): *Dr. Hana Godrich*

Keywords Gesture, control, sensors

Abstract

This project is aimed at developing a versatile means of control to smart devices and physical objects. It utilizes Arduino and Raspberry Pi capabilities to leverage user customization and control. A wearable lightweight glove alongside flex sensors, accelerometer, gyroscope and Arduino Nano board are connected to log user input. The user input is consisting of hand movements or gestures that are differentiated according to the degree of bending of flex sensors and values received from the accelerometer and gyroscope. The data is later used to perform programmed actions remotely. As a proof of concept, a mini-car is used to demonstrate the remote control functionality. In addition, data from the Arduino is transmitted to a Raspberry Pi W Zero via a Bluetooth module. The Raspberry Pi displays the data for future analysis and allows for connection to multiple APIs where the gestures can perform useful actions. Possible APIs include Spotify or Movie Player APIs. The project offers versatility allowing a broad spectrum of applications to become feasible. Some of these applications include but are not limited to interpreting the American Sign Language (ASL), Wheelchair control for people with limited movement, remote control of devices or robots that undergo hazardous conditions for maintenance...etc. It is exciting to implement such a mode of control and explore the endless possibilities.





S20-10 *Title: Video Customer Service*

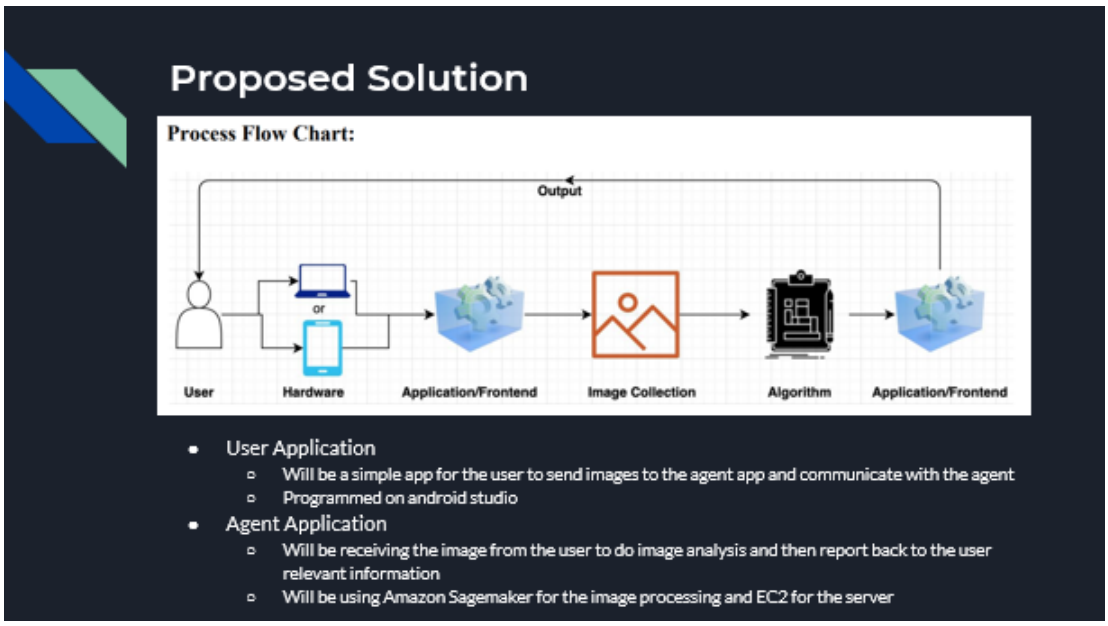
Members: Rahul Katyal, Anthony Matos, Alan Patel, and Akshat Shah

Advisor(s): Dr. Shahab Jalalvand (Interactions)

Keywords Customer Service, Machine Learning, Android Studio, Cloud Computing, App development

Abstract

Currently, the procedure in terms of customer service requires a lot of adjusting. Many companies employ artificial intelligence chatbots and voice calls, but do not take use videos or pictures as another means of extracting more information from the customer. With our solution, we hope to provide a real-time image analysis of houseware and electronics where AI detects a technical problem which a technician can provide a reasonable solution for. An advantage to this is that the customer is relieved of the burden of having to explain the problem over voice. With our project, we hope to achieve a seamless and effortless transition from the current customer service techniques to our video interface that allows both the user and the technician to meet and discuss in a face to face manner. Our application will aid both the user and the technician in getting the exact model of an object instead of rummaging through millions of manuals and trying to find which one applies to the object in question. We plan on doing all of this through a mobile application, which will send a photo to our server on AWS, which will then run an algorithm on the photo to detect exactly which it is and the issue, and provide some caption for both user and technician. When both the client and technician can see what the AI is analyzing, they can understand the problem right away and get started on coming up with a solution without having to waste time.



S20-11 *Title: RU Graduating?*

Members: Avin Abraham, Amany Elgarf, Yuqing Feng, Nicholas Heah, and Varun Ravichandran

Advisor(s): Dr. Wade Trappe and Michael Lynn (MongoDB)

Keywords MongoDB, Course Planning, Mobile App Development, Progress Visualization, Data Modeling

Abstract

All students at Rutgers University have their progress towards attaining their degree tracked by a website called "Degree Navigator". However, many students struggle to use Degree Navigator because they find its interface unintuitive and confusing. For example, it does not provide clear visuals on how close students are to completing their degree or give any suggestions to ensure that they will graduate on time. In addition, Degree Navigator's backend logic often does not align with program curricula, resulting in more confusion for students and advisors. As such, Degree Navigator is inefficient for administrators trying to develop degree pathways and for students trying to envision what lies ahead before graduation.

Therefore, the objective of our proposed mobile app, "RU Graduating?" is to be a more effective service than Degree Navigator. We intend to fix present backend issues while maintaining core functionality, and provide a novel, personalized experience for all of our users via a simpler interface to display degree progress and completion. Users can plan their future courses with assistance from our app's course recommendation engine, streamlining their scheduling experience.

Our backend platform is MongoDB Stitch. MongoDB is the database where we are storing all courses, prerequisites, and requirements for program completion. We will use Stitch to allow our application to query and update the database. While we are currently focusing on making an Android app version of "RU Graduating?", an iOS app should be attainable after we ensure quality app performance on the Android platform.

- Spring Semester: focusing on simply developing the Android app for RU Graduating
- Architecture to be implemented
  - Data model/schema in MongoDB with sample data loaded for ECE
  - MongoDB Stitch backend API
  - Android app with:
    - Program progress visualization
    - Course recommender
    - History and plan of courses

S20-12

Title: *Smart Hair-Clipper*

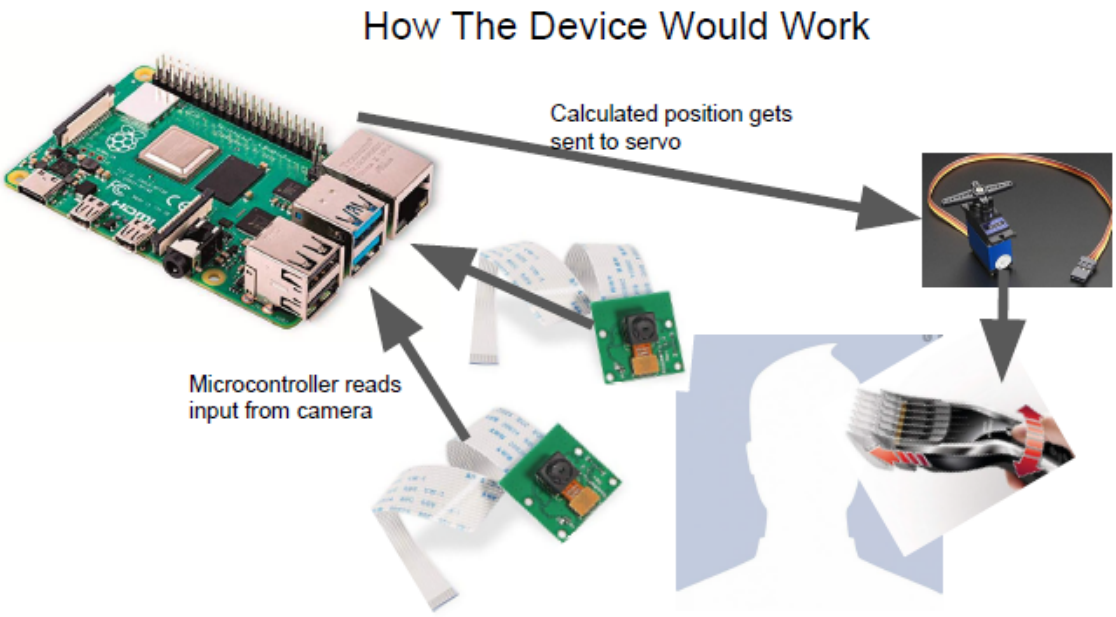
Members: *Urmil Bhansali, Jovan Konatar, Eric Roberts, and McWilliam Mawuntu*

Advisor(s): *Dr. Yingying Chen*

Keywords Object-tracking, Intertial-Sensing, Raspberry-pi, Motor-Control, Self Hair-Cut

Abstract

We intend to make a Smart-Hair Clipper that people can use to cut their own hair. We hypothesize that many people don't want to pay high prices for a hair-cut, and would much rather settle for something quick and simple that can be done at home. Therefore, we intend to make a hair-clipper with a self-adjusting guard. The guard will adjust the length of the hair being cut based on the location of the device. We are going to use a Raspberry Pi to control a motor placed on the device. The motor will be connected to the gears that will adjust the guard length. The tracking of the device will be explored in different ways. We are exploring various technologies such as Computer Vision using cameras, an intertial sensor, Bluetooth Low Energy and even a simple timer. We want to use a combination of these technologies for an efficient tracking system. The closest state-of-the-art technology we could find was the Philip Norelco Men's Hair clipper which allows a single clip to adjust manually between 24 lengths. We also found the Whal's Autopilot Hair Clipper, which had a similar concept to the one we are trying to create. They apparently used GPS sensing, but we assume this information to be inaccurate, or the product discontinued due to a bad product-market fit. We believe this technology has potential to hit the market- if marketed correctly- which is a problem we will only solve once the product is ready.



S20-13

Title: *Commercial Building Occupancy Tracker*

Members: *Charles Owen, Desmond Johnson, Brett Daugherty, Adam Novak, and Roberto Cruz*

Advisor(s): *Dr. Saman Zonouz*

Keywords !

Abstract

Tracking the occupancy of a building, there are various state of the art equipment that are currently available. One of these being the Density DPU which uses sensors and deep learning algorithms to track the density in a room. Another state of the art equipment is the Affinitech Security Systems which uses cameras and computer vision technology in order to also keep track of people.

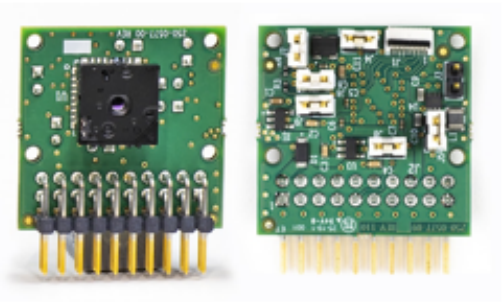
Research has shown that over the course of a little over 50 years there has been an increase of mass shootings. A study starting it's research in 1966 showed that 33% of the recorded data happened since 2010. Further research has shown that since 2013, as of 3/1/2020, there have been 46 mass shootings and 4 mass murders with the use of guns. Our hope is that with our product we can reduce/prevent the number of deaths caused by shootings.

The objective of our product is to place sensors in the rooms of a facility and keep track of the occupancy. This information can be used by emergency services when they are arriving or at a call. By knowing the location of where people are in a building a plan can be made as to how to handle a specific situation.

Our approach consists of using cost-effective alternatives that are able to provide the aforementioned services. By using a FLIR Thermal Camera we can track more than just the occupancy of a room. Additionally, by using RFID Technology we can better keep track of individuals coming in and out of a building in a more precise manner.

Our Solution

- System of sensors that utilize computer vision and RF technology to accurately determine room occupancy in commercial buildings.
  - FLIR camera
  - Active RF



S20-14

Title: *Refrigerated Delivery Drone System*

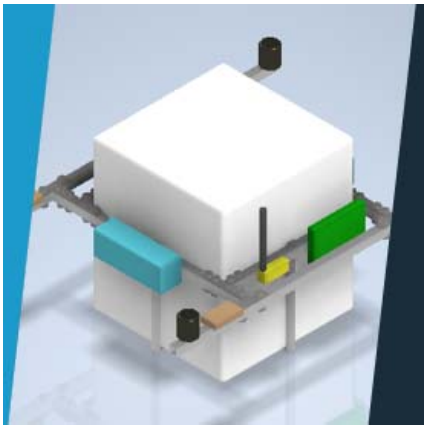
Members: *Peter Doroshenko, Alex Ameri, Eric Kraut, Philip Jeszeck, and Williear Glimniene*

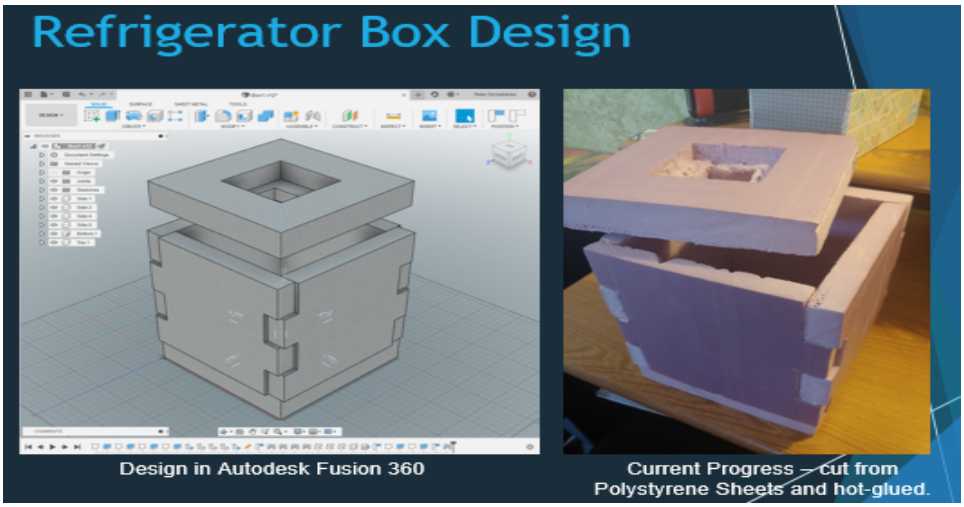
Advisor(s): *Dr. Laleh Najafizadeh*

Keywords Medical, Drone, Emergency, Delivery, Autonomous

Abstract

During emergencies, people need rapid access to refrigerated supplies, such as vaccines, medicine, and a variety of other goods. Depending on the area and situation, conventional transportation such as trucks and ambulances may be unfeasible, inefficient, or expensive. Helicopters can avoid closed roads in disaster areas but are expensive to operate. For our project, we decided to tackle this problem by designing a lightweight thermoelectric refrigerator that can be transported autonomously by a drone. Our drone is designed specifically for the task of carrying a cargo box and utilizes artificial intelligence to guide its takeoff and landing procedures. This approach is both affordable and scalable, allowing multiple drones for when more supplies need to be shipped. No cargo drones to date, such as those used by Amazon, are designed to handle refrigerated goods, which is why we want to explore the possibilities. Our primary objective is to transport small cargo at temperatures below 10°C, for at least 15 minutes, on an automated drone mission, and record data to verify that temperature requirements were met for transporting vaccines.





S20-15 *Title: OPUS: Gamifying Piano Learning*

Members: Justin May, Salman Omer, Yash Shah, Skyler Lee, and Jonathan Hong

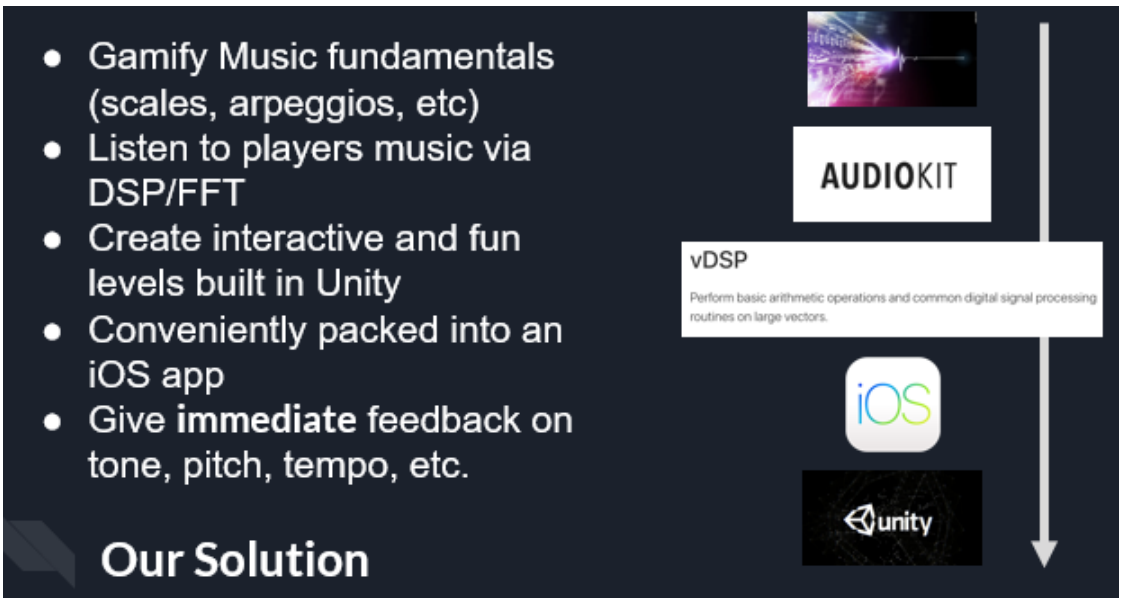
Advisor(s): Dr. Waheed U. Bajwa

Keywords Digital Signal Processing, iOS, Unity, Music

Abstract

Popular play-along music games, such as “Guitar Hero” and “Rock Band”, currently allow users to play along in real time to a song using a controller designed to mimic an actual instrument. For example, the guitar controller has five colored buttons that are to be pressed in different combinations using the left hand, and a strum bar to be pressed by your right hand to imitate strumming. The players are then given a visual aid of five vertical lines, each line corresponding to a button for the left hand. Bubbles automatically scroll down these lines and the player must be pressing the correct buttons with their left hand while hitting the strum bar with their right. While users may learn and gain a stronger intuition of some musical concepts such as rhythm, the skills required to play these games will not translate into playing the actual corresponding instrument because of how simplified the controller is.

Thus, our project is a musical game where the controller is a real, physical piano instead of an electronic-instrument analog. When the user plays along with our game on the instrument, we will use signal processing on the samples collected from the microphone of an iPhone, so that we can accurately identify in real-time what notes are played based on their frequencies and will also determine the timing of these notes. We will create our game using Unity and make different levels that test different skills (e.g. keeping tempo, playing notes in the right sequences). As a result of our approach, the player will learn more effective skills necessary for playing real instruments than they would learn from playing traditional music games like “Rock Band”.



S20-16

Title: *Follow-Us Drone*

Members: *Anthony Merheb, Alec Rodrigues, Brian Girgis, and Rani Sayed*

Advisor(s): *Dr. Maria Striki*

Keywords Drone, Machine Learning, Assistant, Tracking

Abstract

Recently, the use of commercial drones has become a lot more popular. Many consumers enjoy flying drones around during their free time, taking advantage of their flight for use in photography, filming, and even something simple such as drone racing. Our group members are very fond of drones and aim to enhance the personal experience of owning a drone. Most drones that are currently in use require the use of a controller, which can be a hassle depending on what the user is doing.

The goal of this project is to enable a small personal drone to track and follow a user utilizing an array of sensors and cameras, as well as be able to be controlled verbally by said user. We wanted to make it possible to have a drone identify the user, follow them around, and follow voice commands from said user. Unlike most commercial drones, a physical controller won't be required to operate the drone. Everything will be done onboard the drone, with the option of having a mobile app being integrated into the system later on.

Our current approach is to take a commercial drone and utilize a raspberry pi microcontroller to control the drone. The pi should also be able to perform all of the calculations needed to perform the movement tracking. This is a proof-of-concept to show that it does not require advanced knowledge in making drones and to encourage others to participate in drone development.

Updated Scope of Work

- We will take an existing drone and replace its flight controller with a Navio2 Flight Controller
  - We will be able to program the Navio flight controller to do as we please
  - The Navio flight controller is a hat used with a Raspberry Pi that has several sensors to help control the flight of the drone as well as making sure it can reliably follow its target.
- Convenience
  - Once the drone is started, the user can pair to it with their phone and have the drone automatically follow them
  - The drone will be able to listen to voice commands to follow basic tasks, such as take a picture.
- Follow Multiple Subjects
  - The drone will be able to follow multiple users at once.

S20-17 *Title: Train Ticket Scanner*

Members: Suvranil Ghosh, Avani Bhardwaj, and Kutay Kerimoglu

Advisor(s): Dr. Hubertus Franke (IBM)

Keywords Electronic payment, web app, sensors

Abstract

We've all ridden a train before. The process of riding a train involves buying a ticket either at one of the automated machines, the station ticket booths operated semi-manually by a person or on a phone app/train company website. Once on the train we show the tickets to one of the conductors who has to walk up and down the entire train multiple times making sure every passenger has paid for their ticket. This task can be quite tedious.

Hence, we came up with a solution for easing the job of the conductors and saving the passengers a bit of hassle. Our proposed solution includes a single device attached to the front of each passenger for scanning tickets. These devices would be connected wired/wirelessly to a server in the train which in turn would be connected to the train company server in order to verify each scan. Now we discuss minimal specifications of the device mentioned: it would be based on an Arduino/Raspberry PI board with a display and/or an indicator to tell if the passenger has scanned their ticket already. This way the conductor can just pass by and tell if the passenger seated has paid for the ticket. To add to that, the display on the device should show the passenger's destination or at least some form of encoding only known to the conductor. This encoding is to prevent any other passenger from knowing where that particular passenger is going to. The device also has a proximity sensor to detect whether the passenger is in the seat or not. This will help the device make decisions of resetting itself for a new incoming passenger or reserving the seat for when the passenger leaves to go to the lavatory. Coming to the software part of the device, there are a lot of use cases we have in mind for this device: showing the time, current location of the train, ETA, transfer seats, connecting train timings/status (if there are any), etc. Our adopted approach for this design would be starting off with the simple use cases like scanning the ticket, signaling the indicator and adding necessary hardware and software implementation for each use case.

S20-18

Title: *Drone-Eye: Utilizing the Computational Power of Graphics Processing Units to Run Deep Learning Algorithms across multiple drone agents*

Members: *Nikunj Jhaveri, Kaushal Parikh, Miraj Patel, Nirav Patel, and Ashwin Suresh*

Advisor(s): *Dr. Dario Pompili*

Keywords Unmanned Aerial Vehicle, Autonomous Drone Flying, Graphical Processing Units, Human Detection and Recognition, Surveillance

Abstract Our team is looking to mount GPUs onboard drones in order to perform computations to carry out deep learning algorithms such as human detection and recognition. The current CPUs within drones are not as capable of performing these functions – GPUs can be 250 times faster than CPUs in training neural networks. This application can be useful in solo extreme sports ventures – a companion drone constantly tracking a skier will be able to contact emergency services in the event of an avalanche and give the most amount of information in a search and rescue operation. Should we be successful in achieving this, we will look to utilize the Multi-Agent Deep Reinforcement Learning (MADRL) framework to efficiently collect information and infer important conclusions by allocating data aggregation tasks across multiple drone agents. This will reduce the loss of human lives and help make relief operations more successful. GPUs mounted to the drones will conduct computations mid-flight in order to cut down the time needed to compile the final result. We will also look to integrate FPGAs for their inferring power, which can aid in the success of recognition and reinforcement learning algorithms and drastically better the performance of the drone's surveillance abilities.

S20-19 *Title: RU Recycling Correctly?*

Members: James Pasko, Mihir Patel, Nicole Cianci, Piero Batarseh, and Daniel Bolanos

Advisor(s): Dr. Wade Trappe

Keywords Sustainability, OCR, Recycling

Abstract

RU Recycling Correctly? was formed on the belief that many people do not properly sort their recyclables. This causes delays and potential errors in the recycling process since recycling center employees must filter and sort the items themselves. By creating an app that will provide information on recycling types and instructions, the goal is to increase awareness on how to discard certain items, encourage recycling by facilitating the process, and decrease the need for additional sorting at recycling centers. Many items are able to be recycled, and a common belief is that the symbol means one can simply discard all of these items together. However, sometimes that is not the case. This app allows one to scan the recycling symbol or input the info from the symbol to determine where and how an item should be recycled. The app also provides helpful tips for recycling, which includes information about how to dispose of mixed-material packaging, such as cereal boxes.

S20-20

Title: *GlassKey - The Universal NFC Key*

Members: *Harshil Parekh, Shivum Mehta, Shaan Parikh, Avi Patel, and Adarsh Gogineni*

Advisor(s): *Dr. Chung-Tse Michael Wu*

Keywords NFC, Android Application, Lock and Key Manager

Abstract

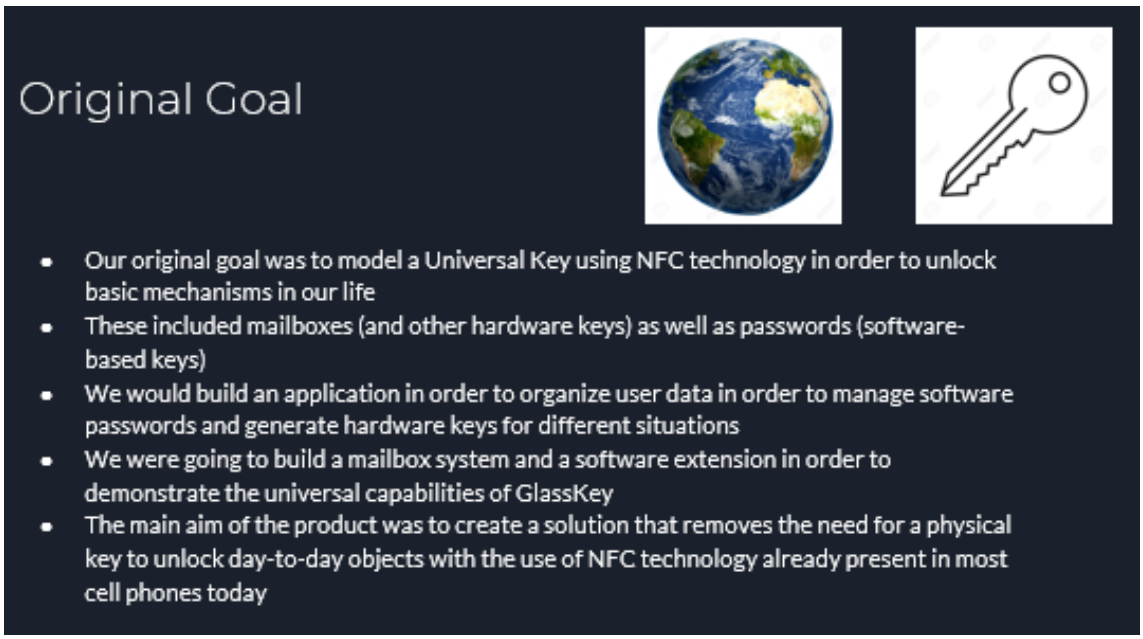
Many mechanisms in today's world require different keys to unlock (password managers, door keys, mailbox keys). Because of this, we are forced to carry multiple different physical keys, in order for us to unlock various things in our everyday lives. We can eliminate the need to carry these keys, when we can replace the keys with our smartphones.

NFC (Near Field Communication) is a technology that uses a radio frequency field to exchange data between devices. Because smartphones now implement NFC technology, users can transfer data with a simple touch. When combining this with Raspberry Pi and Arduino boards, we can create more efficient ways to open/unlock doors and different objects.

Our objective is to remove the physical key from people's pockets and instead implement a technology already used in most modern mobile devices today, Near Field Communication

(NFC). Mobile phones are already one of the most secure pieces of technology, and they're only getting better, so our aim is to take advantage of this.

We aim to create a proof of concept that shows this in action. We will centralize our solution and create a single smartphone application to develop a way for users to unlock anything in their daily life without the need for a physical key or digital key (passwords). Using NFC in our phones, our application will be able to send a specific key to its corresponding lock. Using this, we hope to show that any lock can be unlocked with only a smartphone.



S20-21

Title: *Body Detection Employing mmWave (BDEm)*

Members: *Michelle Curreri, Ziad Mallah, Brandon Tong, and Dante Torello*

Advisor(s): *Dr. Yingying Chen*

Keywords mmWave, gesture, detection,

Abstract

Millimeter wave technology refers to frequencies of the radio wave spectrum between 30GHz and 300GHz. This technology is becoming more present and more utilized due to the sensor's small size and its high accuracy from the small wavelengths. mmWave Technology is fairly new, and as such, there are very few developed platforms allowing developers to leverage the technology in application. We plan to take advantage of this by developing modules which effectively track and detect posture changes in the observed individual, such as raising or extending arms. The technology can also be used to distinguish people from background objects.

The TI AWR1642 Evaluation Module is a radar with onboard transmitters and receivers that will be used to detect the position, angle, and velocity of an object in its range. The radar will transmit an electromagnetic signal called a chirp, which is a technique that transmits a linearly increasing frequency from 77GHz to 81 GHz that objects will reflect in its path and would then be captured by the receiving antenna. We will be able to identify some basic human postures by detecting a person through training a machine learning network to find 17 points that can be used to identify the body as a human.

First, the signals generated and received by the radar are collected through mmWave Studio. Python and Matlab would handle the post processing in order to maximize the

signal-to-noise ratio and interpret the data to create a graphical representation of the detected motion and position. This post-processed data would then be used to create and train the network. This basic form of detection once developed, can be used for anything from virtual reality gaming, to applications in the fitness industry for exercise form analysis.

Background of mmWave Technology

- mmWave Technology is a new technology which can provide highly detailed radar imaging
- Refers to frequencies of the radio wave spectrum from 30GHz-300GHz
- Known for its high accuracy (due to small wavelengths) and the sensor's small size
  - Ability to penetrate materials such as drywall, plastic, clothing, etc.
  - Ability to detect through rain, fog, snow, and dust
- Very few developed platforms allowing developers to leverage the technology in applications
- There is an issue of noise

TI AWR1642 Evaluation Module

S20-22

Title: *Smart Calendar & Schedule Assistant*

Members: *Sasan Hakimzadeh, Joseph Gordon, Dunbar Birnie, Umer Qazi, and Ashish Motyala*

Advisor(s): *Dr. Hana Godrich*

Keywords Scheduling, Database management, .NET Application Development, IOT (Alexa Capability)

Abstract

The motivation behind our project is to help individuals (particularly students) be able to plan their schedules more effectively and avoid last minute time crunches on assignments, studying for exams, preparing for interviews, etc. As students ourselves, we have found this to be one of the largest problem areas for college students who no longer have the guidance that they once had in high school yet have much more on their schedules than ever before. The basic idea of our multi-platform application is for students to be able to input tasks and events into their calendar as well as the estimated time expected to finish, and have the application create an optimal schedule for the user. Events in our project are categorized as static blocks on the schedule which never move. These may include classes that happen at the same time every week, bedtime, lunchtime, etc. Tasks on the other hand are things that show up in everyone's schedules, whether it is an exam coming up, a project deadline, or an essay deadline. For tasks like this, in order for the user to not be overwhelmed in scheduling time to tackle these things, the user must input a due date as well as an estimated amount of time that it will take to complete. Our algorithm will then take into account all parameters of the users' specific schedule in order to block off free time on the days before the due date.

While it may sound like the algorithm does all the work, it will actually also be listening to the user, as it will remember if a user canceled an auto-scheduled task multiple times on a specific day or time of day. Eventually, it will learn from trial and error to create the most optimal schedule which fits your lifestyle. Amazon Alexa will also be able to integrate with our design in order to tell us what we have planned for that day, week, etc. Our goal for this project is to allow a seamless mode of scheduling that removes the headache and forgetfulness that college students may deal with throughout their lives.

S20-23

Title: *Color Energy View*

Members: *Timothy Petersen, Darian Greenfield, Nathaniel Guevara, and Andrew Russomagno*

Advisor(s): *Dr. Jorge Ortiz*

Keywords Data Analytics, Green Energy, Energy Monitoring, Smart Device, Plug & Play

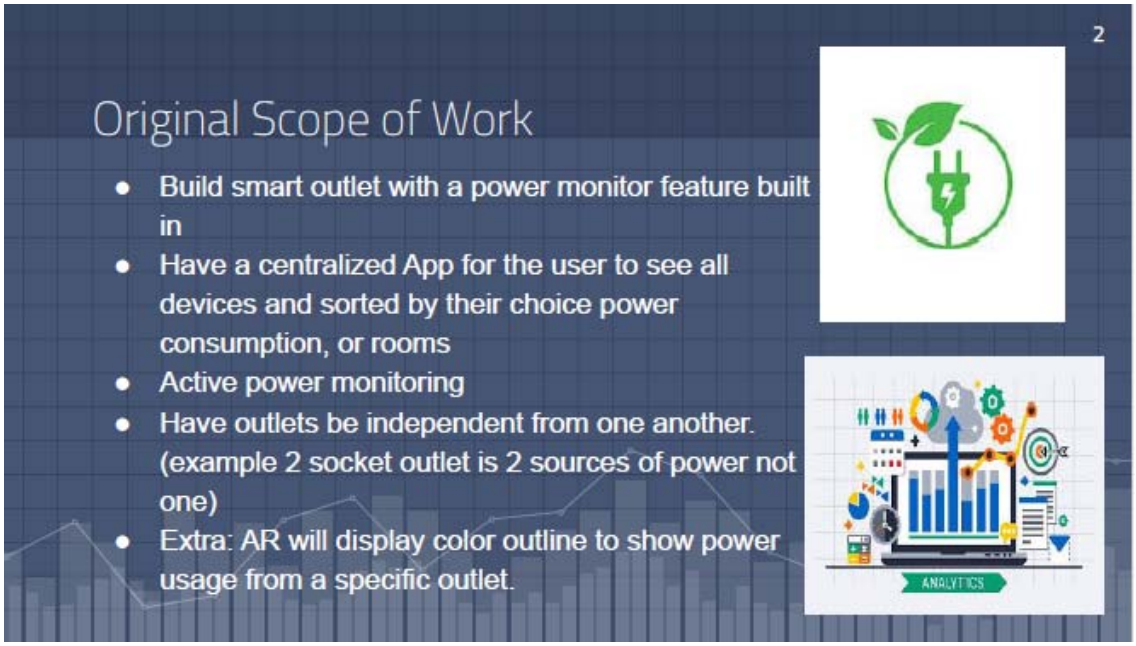
Abstract

With energy consumption awareness and "Go Green" efforts on the rise, many people are looking for solutions to reduce their energy consumption. According to the U.S. Energy Information Agency (EIA), residential energy consumption accounted for 40% of total U.S. energy consumption in 2018. In addition to this increased focus on the sustainability effort, attention is being drawn to the Internet of Things (IoT) and Smart Devices that have the capability to turn devices on and off with the tap of a screen. Our project plans on combining the two endeavors.

We are seeking to create a Smart Plug with energy consumption monitoring capabilities while also making recommendations to reduce user's carbon footprint. We intend to configure our device to fit within the wall's outlet box instead of sitting on the exterior plug. Consistency is a huge problem currently that we plan to remedy through multiple trials. Moreover, we plan to issue alerts to the user for sudden power drops, which for example can be used for

washer/dryer messages.

Our device is different from those currently on the market in that our device will implement power monitoring and smart controls through a carefully crafted UI. The user will have complete control over their switch from anywhere with internet access and will be able to see sudden spikes or drops in power. We intend to catapult the market towards the future of reliable smart controlled devices.



S20-24 *Title: Open Source SLA Printer*

Members: Taras Tysovskyi, Arushi Tandon, Jack Dulin, Robert Riso, and Jikun Pan

Advisor(s): Dr. Maria Striki

Keywords Lase control, 3D printing

Abstract

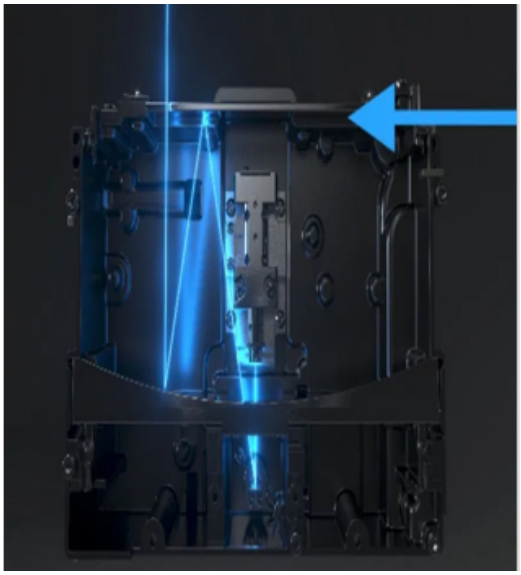
The Smoothieware project aims to create open source hardware (Smoothieboard) and open source software (Smoothieware) for controlling FDM 3D printers and CNC machines. The board is based on a 32-bit Cortex-M3 CPU, which is significantly more powerful than other popular controller boards that are usually based on Arduino Mega running 8 bit Atmel Atmega2560 CPU. This allows Smoothieware to have cleaner code base because there is no need to hyper optimize the code to run on hardware where each clock cycle of the CPU and each kilobyte of memory matters. Additionally, the permissive license of the project lead to many manufacturers making their own versions of the Smoothie board, which means a board capable of running Smoothieware can be purchased for under 20 dollars on amazon.

Mirror galvanometers can be purchased fairly cheaply from Chinese website such as Ali-express or JD online shopping for under 100 dollars. The position of the mirror is determined by the input voltage fed into the galvanometer. Generally the accepted input can be between -15V and 15V where each voltage value corresponds to a distinct orientation of the mirror. We would need to build a DAC capable of receiving an input via SPI from the Smoothie board and outputting the correct voltage to the galvanometer. (Also, we will invite professors or instructors to help us monitor the range of our voltage and make sure it is in the reasonable range.). On the reprocessing side, we aim for 100% compatibility with the existing slicers. Slicers are software that take an input 3D object, usually in STL or OBJ format, and turn it into a g-code file, which contains the sequence of steps (in G-CODE format), the 3D printer needs to take to print the model. We plan to modify the movement planning part of Smoothieware to seamlessly translate the g-code to movement of the laser beam, with minimum changes necessary to the slicer configure.

Being able to control the laser beam has plenty of applications beyond just SLA 3D printing. It is also in the heart of selective laser sintering (SLS), another 3D printing technology, as well as laser etching, laser cutting and more

Mirror galvanometers

- Reflects laser beam
- They deflect lasers by using the controlling signals inside the printer system



S20-25 *Title: Object Imaging Using Millimeter-Wave Sensors*

Members: Soo Min Kwon, Mathew Varghese, Pradyumna Rao, and Thomas Tran

Advisor(s): Dr. Yingying Chen

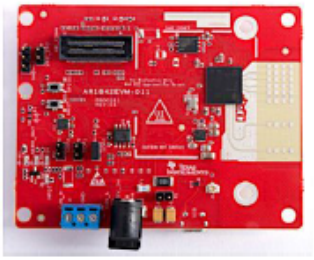
Keywords Imaging, wireless, detection, sensors

Abstract

Driven by a vast range of autonomous applications, object detection and imaging has been a widely explored field. Existing approaches, such as metal detectors, are simply too expensive or require cumbersome manpower, causing public areas such as schools to lack security measures. Moreover, other proposed wireless techniques have been deemed to be inaccurate and less resilient to noise. In this project, we propose a framework using millimeter-wave sensors to detect and image different types of objects. Millimeter-wave sensors use high frequencies which can be maneuvered for accuracy and efficiency. We propose to leverage the sensor data for machine learning algorithms for detection and computer vision techniques for imaging. Our methodology is twofold: (1) detect the object being sensed, (2) create a sketch of the image being classified upon sensing.

Methodology

- Utilizing millimeter-wave sensors allow us to use the angle calculations more efficiently
- Theoretically more robust to noise than other wireless methods
  - Can use these sensors in multiple settings (e.g. indoors, outdoors)



mmWave Sensor

S20-26

Title: *Parking spots finder*

Members: *Mingming Pei, Dazhi Li, Ziheng Wang, and Yuxiang Song*

Advisor(s): *Dr. Bo Yuan*

Keywords Gait Recognition, Machine Learning, Classification, Desktop Application, User Interface

Abstract

Parking is always been an annoying problem when comes to rush hour. For example, parking in campus even though you have purchased the parking permit.

In an open parking lot there always lacks effective way to demonstrate how many parking spots are available, which makes people waste their time on driving round and round to find a spot. Also, in a crowded open space parking lot, people have a hard time finding where they parked. We want to address the wasteful finding spots time and gives the information for parking conditions in advance and help people find where they parked.

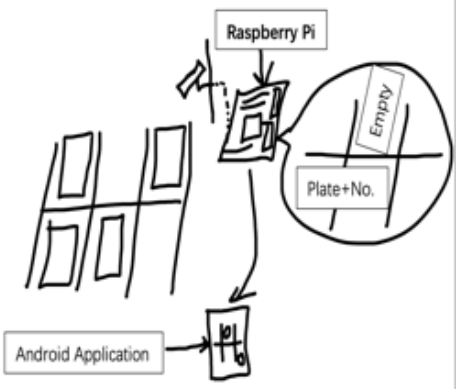
Review of conceptual design

Our goal is to achieve a system that

Can demonstrate the condition about

The parking lot and also help the end

User to find where they have parked



S20-27 *Title: Hierarchical detection system for violent behavior based on deep learning*

Members: Runlin Hou, Jin Xu, Donglin Gao, Sichao Wang, and Haole Wang

Advisor(s): Dr. Bo Yuan

Keywords Deep Learning, behavior detection, hierarchical, violence, video

Abstract

Our thought starts from the data we noticed on the internet. In the United States, more than seven people per hour die a violent death. The violence problem is a serious situation all over the world. And the even worse thing is that we may have the chance to save them. Cause, lots of these conflicts happened right in front of a camera. But we cannot set a person on the camera 24/7, so we are thinking why not have the camera to watch over for us?

We learn that there are a lot of approaches to detect violent behavior. Many of them were focused on the platform that carries the system like a drone-based detection system by Cambridge, also there are other directions of detecting the different behaviors.

What we want to do is to build an alarm system that can make the alarm process more efficient by having a hierarchical process to the detection result. Like if we detect a violent behavior with guns, the level would be serious and the crews to deal with it can be prepared for the upcoming dangerous if they got the information.

Our thought is that the upper-level system will detect the violent behavior and then the result will be partition by the identified weapon involved in the conflict. The basic logic would be the input video would be detected as violent behavior and then the system will keep looking for the weapon that involved in the conflict.

S20-28

Title: *Video Transcription App for the Hearing Impaired*

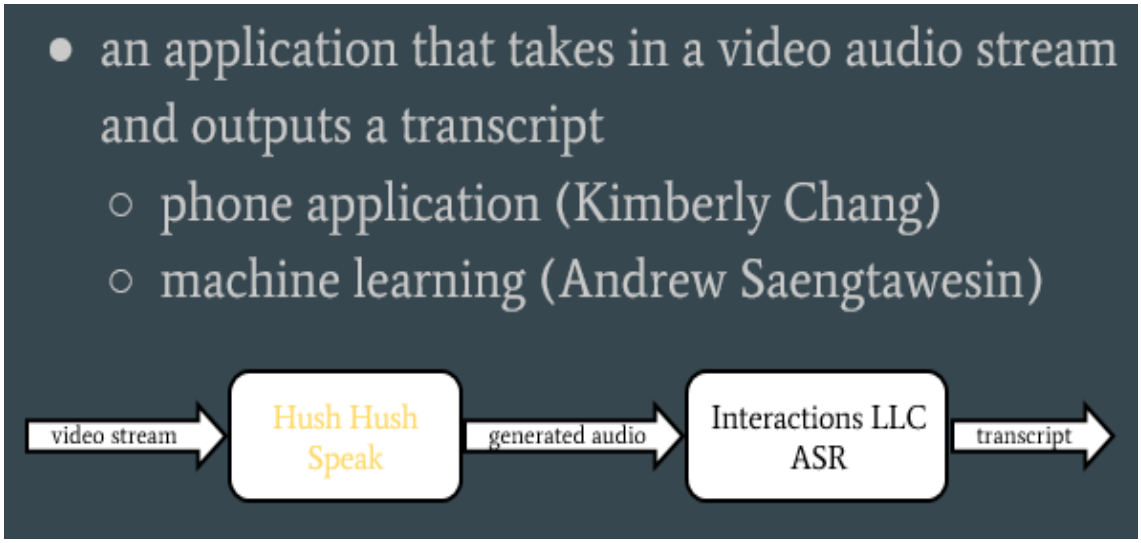
Members: *Kimberly Chang and Andrew Saengtawesin*

Advisor(s): *Dr. John Chen and Dr. Nick Ruiz (Interactions)*

Keywords Machine learning, transcription, automatic speech recognition, mobile application

Abstract

Automatic speech recognition (ASR), as found on some mobile phones, in YouTube's auto closed captioning and in other places, allows people with hearing impairments to more easily communicate and access media content. Problems with ASR arise if the input audio is noisy or if the environment precludes audio, such as in a library. Our project will mitigate these problems by using both audio and visual inputs in order to transcribe speech. In particular, our approach will be to adapt a lipreading audio-visual neural network model to transcribe videos. The model will be embedded in a mobile application that will be capable of transcribing a video. Because of the ubiquity of mobile devices, our model will be available on demand wherever it may be needed.



S20-29

Title: *Machine Comprehension with BERT*

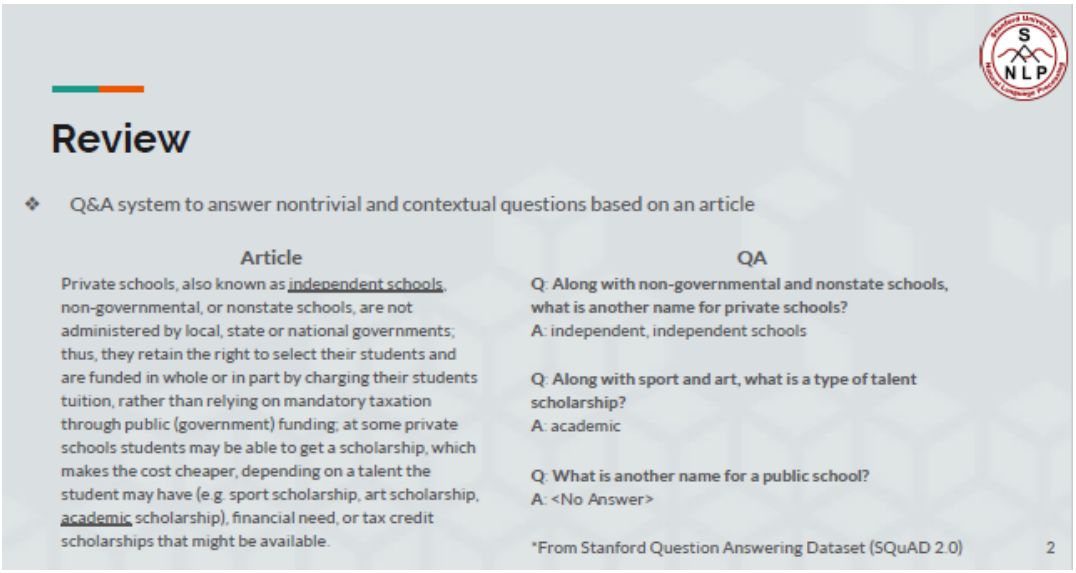
Members: *Ajeet Malhotra, Ping Lin, and Raffay Khan*

Advisor(s): *Dr. Kristin Dana*

Keywords Question answering, Deep learning, Natural language processing (NLP), Bidirectional Encoder Representations from Transformers (BERT), TensorFlow

Abstract

Imagine being able to ask an AI system about any piece of text, such as technical or legal documentation, to understand the relevant information. For our capstone project, we will be developing a machine comprehension system that leverages Bidirectional Encoder Representations from Transformers (BERT) to find the most relevant and succinct results to search queries. Traditional approaches in natural language processing (NLP) rely on long short-term memory (LSTM) networks that fail to capture long-term dependencies. We propose a model that inherently utilizes self-attention to improve performance on sentence-level comprehension. The project will utilize TensorFlow to develop an end-to-end platform that is deployable on a web application.



S20-30

Title: *Hear4U*

Members: *Manish Kewalramani, Andy Wang, and Varun Raghuraman*

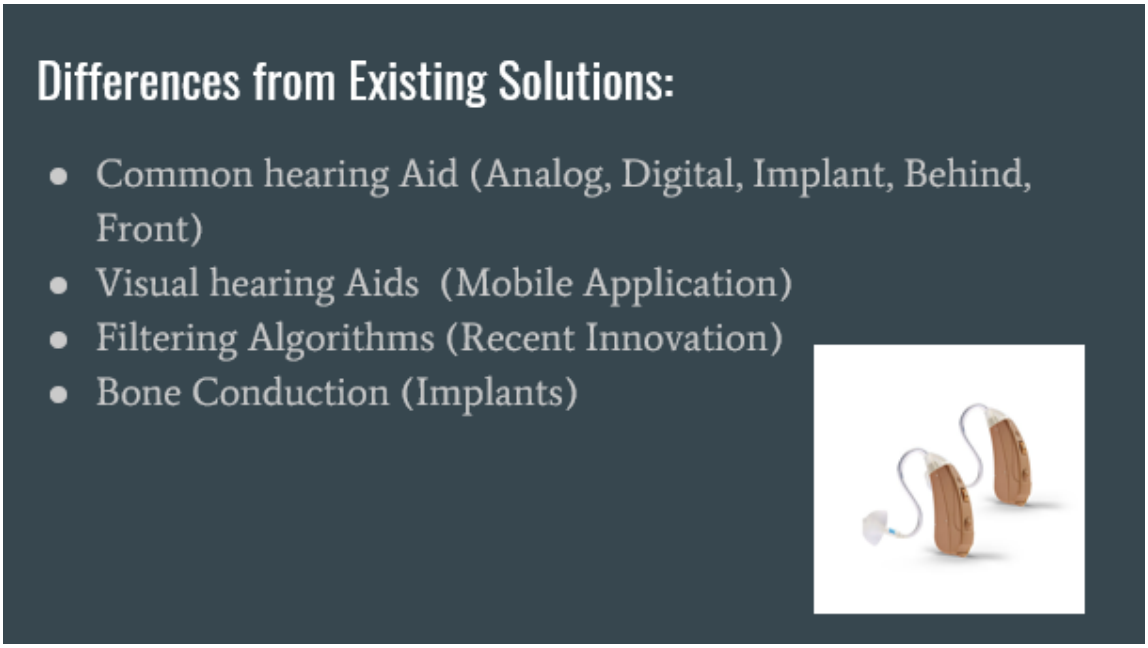
Advisor(s): *Dr. Anand Sarwate*

Keywords Machine Learning, Wearable Device, Concept Demo

Abstract

Hearing aids are an extremely useful way to help the hearing impaired. There is an inherent futility, however, in attempting to capture the entire experience of human hearing in a way that allows those who are unable to do it to experience it. A solution to this would be to add functionality to the hearing aids until the full hearing experience can be simulated. Our proposal is to create a device that will listen for noises of interest and vibrate to alert the user of these sounds to simulate the way in which

non-impaired people react to hearing keywords; specifically, in situations where the sounds of interest are quieter than other sounds. A machine learning algorithm will be trained to respond to the sound of a user's name. A buzzer will be used to simulate a tap on the arm, analogous to a manner in which someone would attempt to get someone else's attention. It is hoped that this demonstration would validate the usefulness of this device's functionality in a way that would make it desirable to integrate into existing devices, such as hearing aids or noise cancelling headphones. Additionally, it is thought that the concept can be applied to aid people with other issues apart from hearing loss, such as auditory processing disorders or inability to focus.



S20-31

Title: *Smart Home Camera*

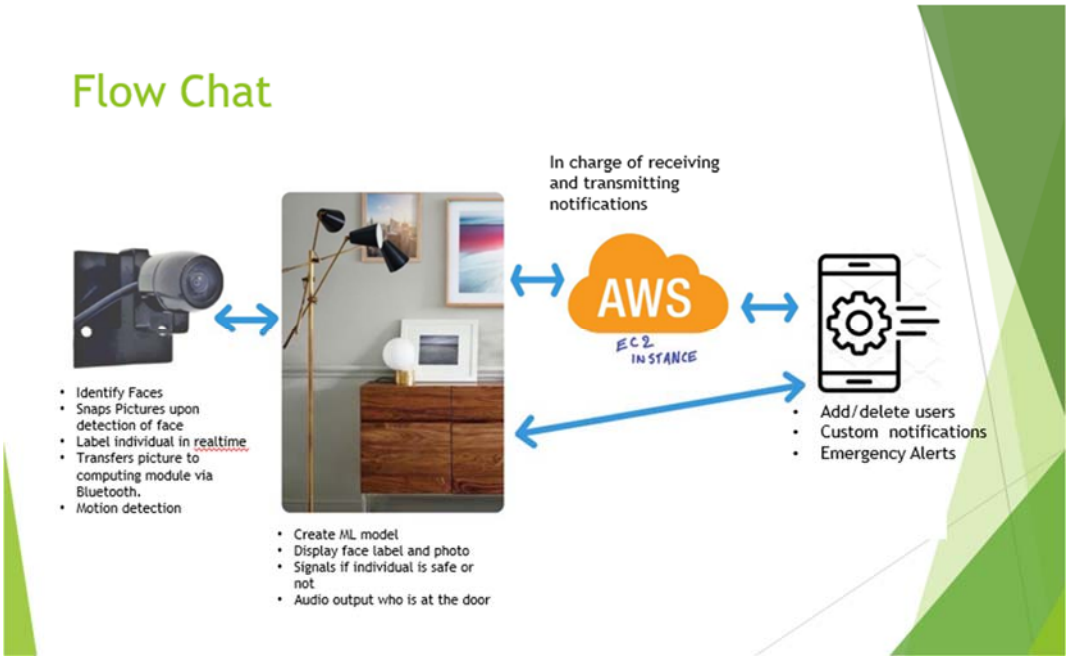
Members: *Shazidul Islam, Rahul Patel, and Parth Patel*

Advisor(s): *Dr. Maria Striki*

Keywords Machine Learning, Facial Recognition, Security

Abstract

In the 21st century, security is more important than anything. Companies such as Google created an Authentication app that constantly changes your account key's so no one can save your password one time and have access indefinitely. Security is a hot topic, yet some people forget to keep one very important thing safe, their home. In the united states alone, there is an attempted aggravated assault in a home every 45 seconds. Most intruders enter the home when individual household members open the door with out checking through the peep hole to see who is at the door. People truly take security that their front door offers for granted. Therefore our team has developed the AEGIS, the artificially enable guardian identification system. Our project will use Machine learning to intelligently label and announce to the house who is at their front door. Before training a model would take 8+ hours. With OpenCV we can train a model within a few minutes will little accuracy lost. Because of this our model will be able to continuously learn every time it detects a face. With AEGIS, if there is a stranger at the door step, out device will detect the stranger, take a picture, and display the name on the photo frame inside the home and announce "Stranger Alert" alerting the individual opening the door of the potential danger. With this implementation we expect to decrease home invasion and keep your loved ones safe and sound.



S20-32

Title: *A Multi-Dimensional Fleet of Intelligent Mobile Plants for Unknown Territory Exploration*

Members: *Albert Tran, Israel Jackson, Lawrence Chiang, Justin Raymundo, Hariharan Vijayakumar, Simon Zhou*

Advisor(s): *Dr. Qingze Zou (MAE)*

Keywords drone, robot, exploration, plants

Abstract

With the use of multiple drones and robots carrying plants, unknown territory can be explored in order to find resources for relocation. As the search for extraterrestrial land begins to be more urgent, there is a need for a way to explore these unknown territories without the need of sending humans. With the use of ground robots and drones, it is possible to search these territories for signs of resources that plants thrive in. Using this method, plants can be transported to locations of these resources in hopes of possibly being able to terraform these locations. Multiple ground robots will search for resources while carrying and monitoring a plant with the use of multiple sensors. A drone will be used as a central command center to search for resource locations as well as hold all resource locations to direct ground bots to requested resources. With this system, autonomous exploration as well as the transportation of plants can be combined in an efficient manner. This can be later be extended to the idea of transporting other lifeforms throughout unknown territory.

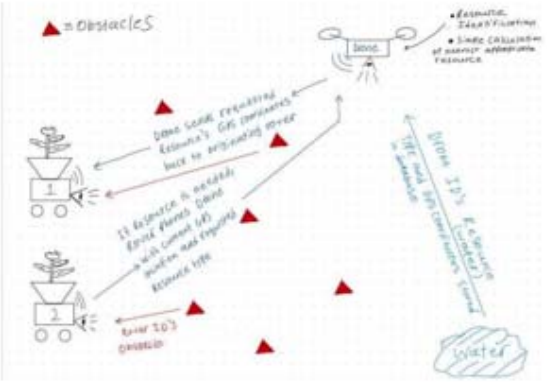
Selected Design:

Symbiotic Fleet of Ground Robots and Drones, sharing task load

- Ground Robots tasked w/ plant maintenance (Payload-heavy Tasks)
- Drone tasked w/ resource identification and Ground Robot coordination (Payload-light Tasks)
- Wireless Mesh Communication between Ground Robots and Drones for large area coverage

1. Ground Robot notices its plant needs water.
2. Ground Robot pings the Drone with its current location and desired resource.
3. Drone responds with nearest water source's location.
4. Ground Robot autonomously navigates obstacles to reach target.

Symbiotic Fleet



Drone is continuously detecting and recording resource types and location

S20-33

Title: AutoGard: Automated Garden using PIP Tag sensors and Arduino (or Raspberry Pi)

Members: Vincent Cheng, Kartik Garg, Matthew Jackson, Paul Stanik, and David Wang

Advisor(s): Dr. Yingying Chen

Keywords Garden, Arduino, Android Application, Sensors, Bluetooth

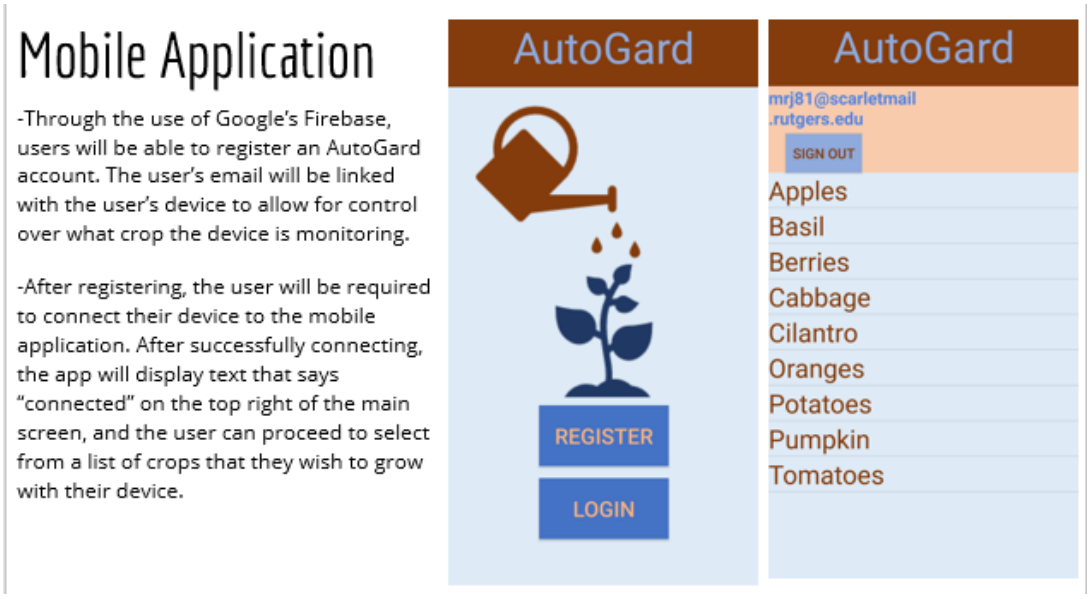
Abstract

Our initial plan is to use a watertight enclosure so that users can grow plants not typically grown in their environment. Therefore, our design goal is to have the plant be exposed to the least number of external elements as possible. Using PIP Tags and a soil moisture sensor, the device will monitor characteristics of the plant in order to assist it to grow. Based on the data collected by the sensors, the device will adjust the water, light, and temperature accordingly. If there is not enough light, the light will increase in intensity. If the moisture is too low, water will be sprayed. There will be a website where users can view data related to the crop or crops that they are growing. There will also be an android application so that this same data can be accessed through a mobile device.

We will develop a website in addition to the android application. The purpose of the website is to provide a visual user interface for AutoGard that users can access through the use of a computer.

Integrate an arduino into our automatic gardening system. An Arduino is easier to program and implement, and so if it can successfully perform all the functionalities our device needs, it would be preferable. The problem is that since the Arduino is mainly used for simple, repetitive tasks, it is likely that we will have to switch over to a Raspberry Pi. The Raspberry Pi is better suited for performing multiple, more complicated tasks which, in our case, would be controlling light, temperature, and water release.

We will also control soil moisture in AutoGard by using resistors. This will then give rise to a temperature reading or observation, so there might be a circuit to control temperature as well, since research in fine particles has shown that temperature determines moisture content on the micro level.



S20-34 *Title: Artificial Emotion Recognition*

Members: Devvrat Patel, Andy Lee, Nathan Silva, Jahidul Islam, and Shivani Sunil

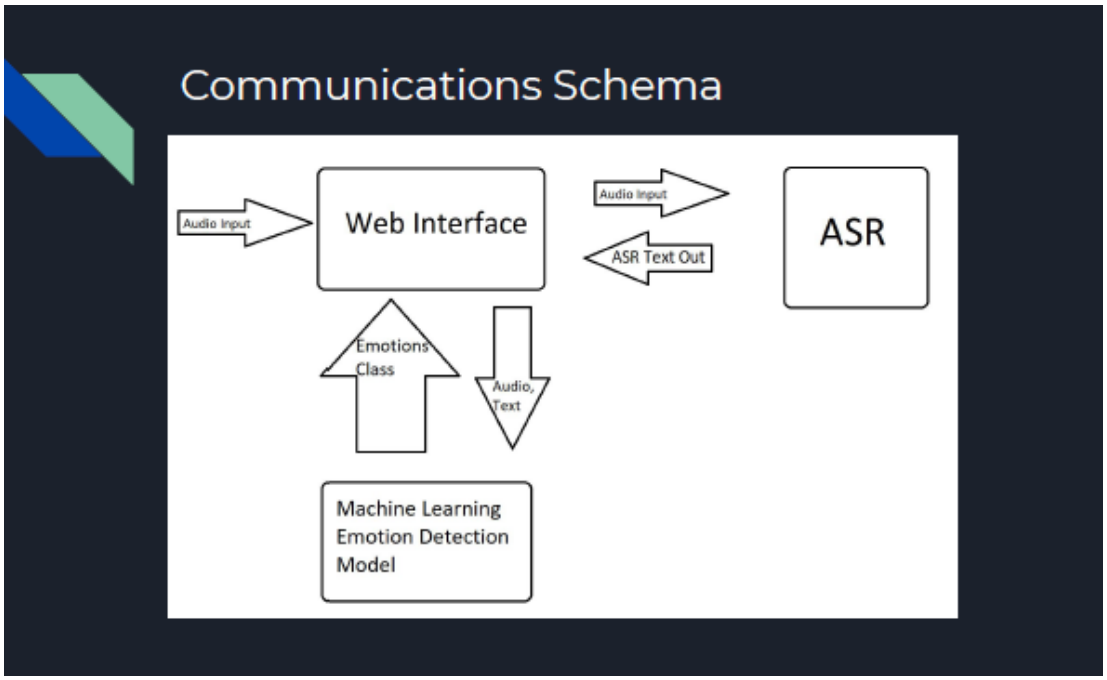
Advisor(s): Dr. Shahab Javalvand and Yeon-Jun Kim (Interactions)

Keywords AI, Emotion Recognition, Web Application

Abstract

Automated customer feedback systems can be frustrating to users thus allowing the inefficient system of direct human interaction to predominate the customer service field. Emotion sensitive systems are necessary in order to handle the larger volume of customers to meet the increasing demand. By managing customer interaction based on emotion, a human-like flow of communication can be established to meet customer needs. Some projects already exist in the emotion detection realm of machine learning such as real time emotion recognition through signals of speech and language. Our goal is to improve upon the current models using emotion detections by creating easily accessible interfaces and systems to analyze a user's state.

Part 1 of our project is the Web Interface, this will involve: developing a method of capturing audio, establishing a communication with ASR engine, developing method to receive hypothesis from ASR and passing it to Machine Learning Algorithms, and displaying analyzed emotion as an output to the user. Part 2 of our project is Machine Learning, this will involve: collecting a variety of applicable data, building models based on collected data that can be effectively analyzed to detect emotions, testing models to ensure proper emotional response, and output to the web interface. Our primary objective is to better understand and analyze user emotions to provide proper feedback and appropriate responses. We will be detecting emotions in real time and processing the information from input via web interface and communication to ASR engine.



S20-35

Title: *Eagle Eye – Multi UAV Reconnaissance*

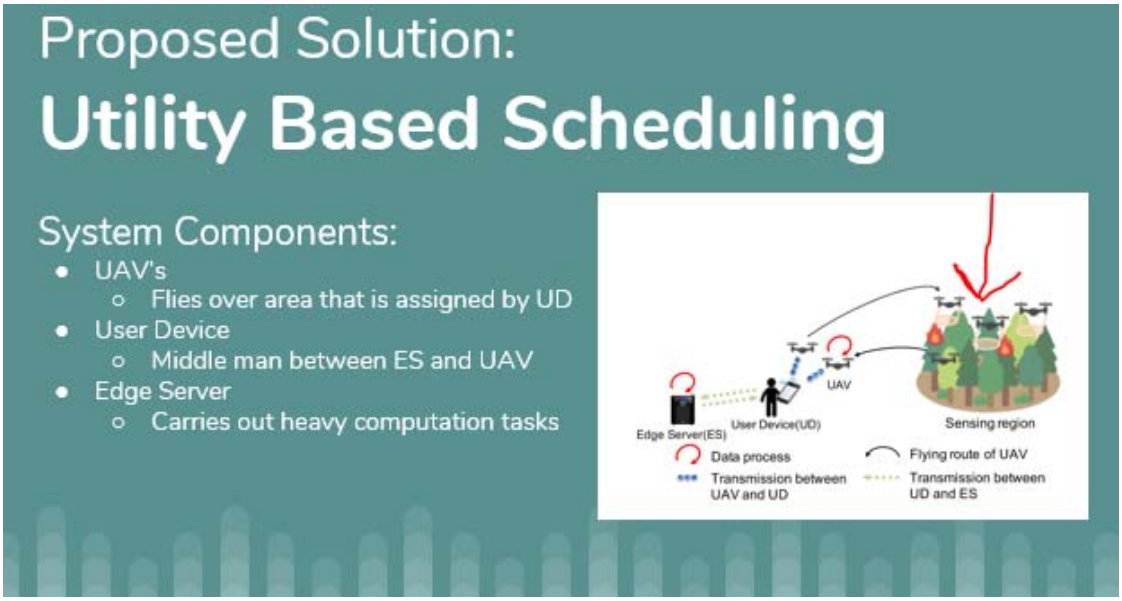
Members: *Kaavya Krishna-Kumar, Sagar Shah, Harmit Badyal, and Abhishek Kondila*

Advisor(s): *Dr. Narayan Mandayam*

Keywords Drone Surveillance, Human Identification, Disaster Relief, Multi-UAV Scheduling, Offline Network Communication

Abstract

From 2006 to 2015 there have been approximately 70,000 deaths and missing people due to natural disasters occurring worldwide. As a result, the need for a safer and faster way to find humans in disaster relief zones is necessary. Using small unmanned aerial vehicles (UAVs) is a possible solution to aid in search and rescue of missing people. With UAVs, we have the ability to scan the disaster zones and take images of the land. Then, using machine learning models we can process images to help identify humans that may be in stuck in disaster zones. In real situations however, this task might be more difficult due to drone limitations in flight times and processing power needed to classify images. In addition, network connectivity and transmission may be compromised during the disaster making it difficult to transmit images from the drones to the servers for processing. We suggest a utility-based formula that minimizes flight time and battery energy used to make sure that all images are continuously being updated and classified while maintaining a drone's flight power. Here, the drone's battery life will only be used for flight time and image capturing while an edge server will be used to process the images through image classification algorithms. We will be using a user device as a middle man between the edge server and the drones. The user device will be able to control the drone flights and transmit images to the edge server using Bluetooth.



S20-36

Title: *In-Baggage Object Classification with Wi-Fi*

Members: *Jiger Prajapati, Eric Lin, Tahmid Chowdhury, and Mohammad Nadeem*

Advisor(s): *Dr. Yingying Chen*

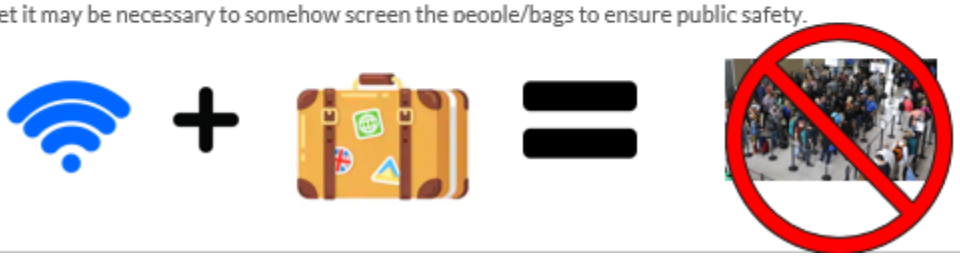
Keywords Wi-Fi, Object Classification, Machine Learning, Signal Processing, Security

Abstract

In recent decades, the need for increased security has arisen. Current methods to ensure public safety include screening of bags and people using costly X-rays, metal detectors, and human labor. However, these methods are currently very expensive and a lower-cost method would allow for more accessible security. Current research for economical alternatives include using 60 GHz radios and radar to perform object detection and imaging, which require specialized hardware that may not be widely available. However, we plan on having the same functionality using commodity Wi-Fi. Wi-Fi has emerged as a prevalent wireless networking method using radio waves to communicate between devices. Each data frame sent by a WiFi card is associated with a property called Channel State Information (CSI) which describes the properties of the Radio Frequency wave, including signal strength and phase. The CSI of a signal changes as it propagates through different kinds of materials. Thus, CSI can be used to classify objects based on their material composition. We can apply this to detect different objects in bags for security related reasons allowing a low-cost alternative to current in bag detection methods. In order to do this, we will obtain data related to each material, perform signal processing, and extract features of the processed signal. Afterwards, we will use machine learning to perform classification of the objects' material and shape.

Background

- Safety is a big concern nowadays
- Many measures are taken to ensure safety, especially when going into venues and flights, such as X-ray screenings
- But, traditional baggage checking/people screening requires bulky expensive x-ray machines, is time consuming, and impractical at large events.
- Yet it may be necessary to somehow screen the people/bags to ensure public safety.



S20-37

Title: *Custom Legal Advisor*

Members: *Andrew Sengupta, Amandip Kaler, Jeffrey Lu, and Aditya Mehta*

Advisor(s): *Dr. Ivan Marsic*

Keywords NLP, US, Code, Public, Advisor

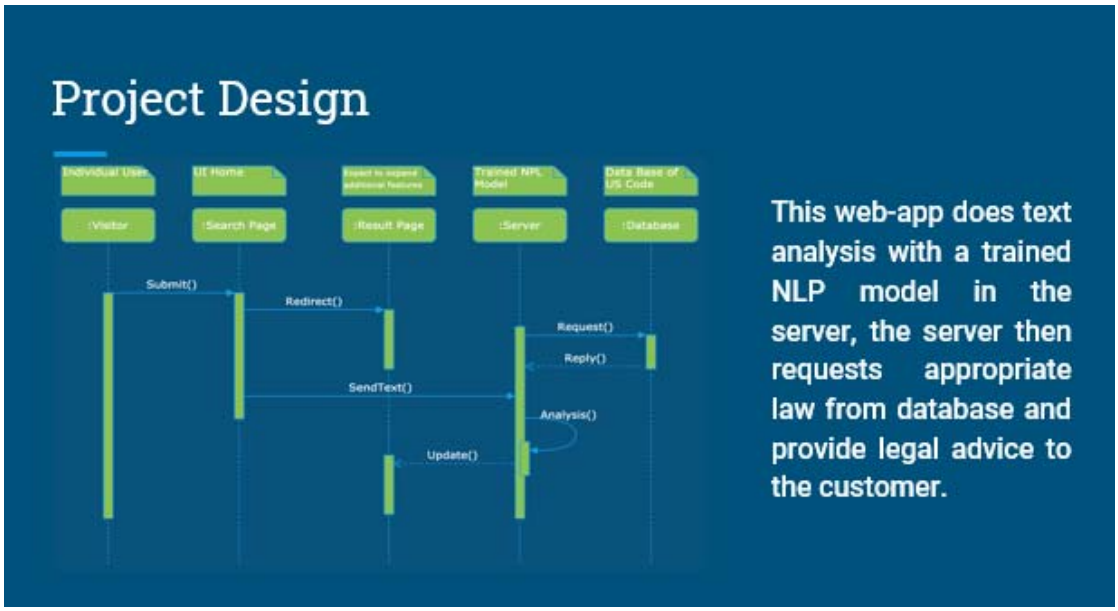
Abstract

The field of NLP started in 1950 when Alan Turing published "Computing Machinery and Intelligence", today, although no machine can pass the Turing test, over 70 years we made breakthroughs in language training models.

The number of United States citizens needing legal guidance is growing by the day, and it is extremely expensive to hire a lawyer. The average cost of a defense attorney is $150 - $700 per hour, and it is not uncommon for bills to reach tens of thousands. Unfortunately, it is quite hard for the average person to learn anything about the legal system because legal language is tricky, wordy, and hard to decipher without any prior knowledge.

The objective of our project is to create an intelligent research tool that employs natural language processing to search relevant United States code from the given brief of a case. This would make it much simpler for the average citizen to be able to simply look up a law and what it entails.

The approach to accomplishing this task is to implement natural language processing using PyTorch, specifically training convolutional neural network classifying applicable titles of the US code to the given scenario.



S20-38

Title: *Gesture Based Panic Button*

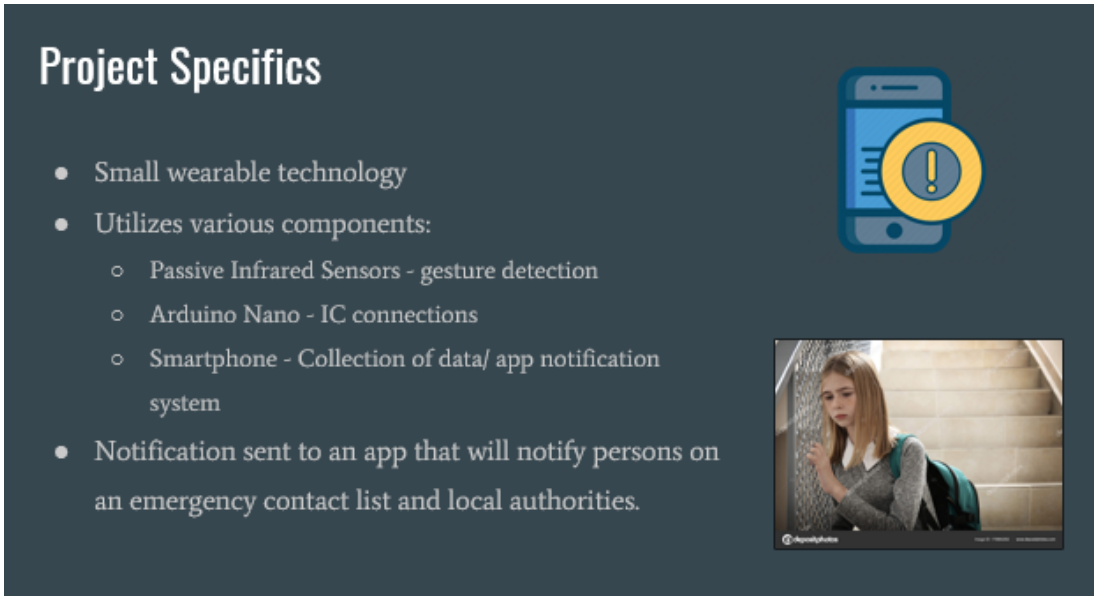
Members: *Daniel Chan, Allyana Dela Rosa, Priyanka George, and Michael Edwin*

Advisor(s): *Dr. Chung-Tse Michael Wu*

Keywords Discreet, Wearable, Gesture, Infrared, App

Abstract

In today's world, crime is an inevitable situation and although it is on the verge of being regulated, there is still the presence of potential threats. Under the stress and fear of these situations, victims can tend to freeze up and may not have ready access to their phones. As a solution, we aim to develop a small and cost-effective gesture initiated detection sensor that allows a person to discreetly notify an emergency contact. Using a passive infrared sensor, we will build a hardware device that will detect a specific motion and send inputs to a phone application that will then notify a person on the wearer's emergency contact list. In situations where the wearer might make the specified gesture by accident or misidentified a threat, we plan to create a failsafe operation on the app that will warn the wearer prior to sending the emergency notification. This way, the wearer can have the option to cancel the notification on their phone or proceed if they choose not to.



S20-39 *Title: Finger-Code security system*

Members: Chuang Zhao, Khandaker Hossain, and Linzhang Wu

Advisor(s): Dr. Chung-Tse Michael Wu

Keywords Hardware security, biometrics, multiple inputs, combinational circuit

Abstract

The passcode unlock method has matured in the modern-day hardware security system. The method for building these devices has changed as it's now more reliant on biometric components. In the past unlocking via fingerprint was used heavily by the industry and many devices implemented it as the go to method for securing a device. Before we look towards other methods in biometric security such as facial recognition or voice recognition there still exists room for improvement regarding fingerprint security systems.

The standard method for password authentication is limited when it comes to the protection of a user's privacy. Fingerprints can be recreated, and passwords are prone to being figured out. Current security systems are unlocked with a single fingerprint, and most systems only store one fingerprint.

We seek to alleviate this dilemma by combining both the fingerprint with the password component. This model is superior to previous single component security systems because it has 2 layers of defensive measures. 3 fingerprints inputs plus passcode unlock enhance the security in the hardware level. Furthermore, we will implement alternative fingerprint inputs stored in the system to avoid unavailable fingertips due to injury or stain.

This system can be implemented with a vault, home or a banking security system. This device would be a potential product for those who are looking to implement a security system to protect a precious commodity (gold bars, cash, gun etc).

Adjustments

We intend to use the optical fingerprint scanner as the adjustment. This will allow us to code in Arduino UNO.

Capacitive Fingerprint Scanner - UART (AD-013)

S20-40

Title: *Personal Multi-Channel Cloud Server*

Members: *Samuel Cho and Christopher Cheng*

Advisor(s): *Dr. Predrag Spasojevic*

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

Abstract

In this age of information, there is an ever-growing concern about the privacy and usage of personal data. With the advent of cloud storage, many people are entrusting their data to a third party entity in order to avoid maintenance costs. However, we feel that this control should be given back to the individual. This problem seems like a relevant issue for us to work on as it very closely relates to our previous coursework in utilizing both hardware and software technologies together in order to achieve this goal.

The goal of our project is to create an automatic backup/file-transfer system personally owned by the consumer, or in other words, a "personal cloud". By doing so, we will have learned more about integrating software and hardware, and about how wireless communication works at a more fundamental level.

We will need to determine what type of programmable circuit-board to use, how to make it communicate properly with bluetooth, wifi, and additional storage modules, and how to implement secure and automatic file syncing behavior using those modules.

Our project submission will be comprised of two parts: a wireless storage device capable of communicating through either bluetooth or over a wifi network to automatically sync your data and a device management app that allows the user to configure the system (how often it syncs, network credentials, etc.).

Hardware

- Raspberry Pi
  - Faster data transfer compared to Arduino
  - WiFi and Bluetooth functionality built-in
- SSD
  - File storage component
- Micro SD Card
  - Used for the purpose of storing the OS

S20-41 *Title: OutRecruit*

Members: Christopher Young, Jasjit Janda, Hersh Shrivastava, Jose Cuentas, and Mohit Khattar

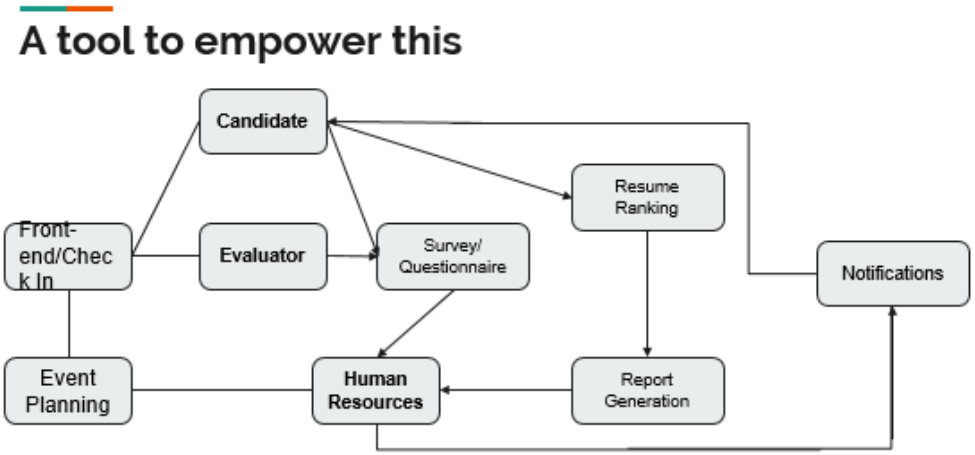
Advisor(s): Dr. Hana Godrich

Keywords Resume, Hackathon, Recruiting, Ranking.

Abstract

Hiring is a complicated and arduous task for every company. It is not easy to hire capable employees that are capable, ready to learn, and work well in teams. The current hiring process takes a lengthy time and offers low communication for the candidate, and for the company. Hiring involves reviewing resumes individually, calling for interviews, and administering exams before an offer is given. There is little ability to evaluate teamwork and skills. In addition, it can take weeks for interviews and weeks for decisions before offers are given. Not to mention, no real skill is presented for the company to verify what interviews claim or test results show. Extensive and tangible knowledge, adaptiveness, and teamwork are all vital skills that every company should assess, and hire based upon.

Our project aims to take pre-existing outreach events and hackathons to be able to draw ambitious candidates to apply, work, and receive feedback. We will be ranking and tracking candidates during recruiting events, by targeting keywords and phrases in their resumes. As candidates work alongside company employees during events such as Hackathons, valuable skills will be utilized. Input from company employees is stored in an extensive database. With all the information gathered, conclusive reports are generated and easily presented to the company. By targeting candidate skills and teamwork the hiring process becomes much more beneficial and significant. From there, the real interviews can begin as early as the day of the recruitment event.



S20-42

Title: *Capstone Management App*

Members: *Keya Patel, Mohammed Sapin, Shilp Shah, and Eric Zhang*

Advisor(s): *Dr. Hana Godrich and Diksha Prakash*

Keywords Capstone, Management System, Web Application, Team Management, Organization

Abstract

Currently, Rutgers Senior Design, or Capstone, is run primarily through Sakai, offering students an unintuitive option to register their teams and allowing faculty to post capstone-related resources such as past projects and general information. However, while this may be adequate for normal classes which are typically geared towards individual students, Sakai is not compatible for managing group projects- let alone the entirety of Capstone. These limitations become apparent when observing the lack of Capstone-oriented features that Sakai can provide such as an actual dedicated database for Capstone students and teams, and a solid team management tool that involves both advisors and judges and facilitates communication within the team. Furthermore, this process leaves most of the logistical work to Professor Hana Godrich and several other students to be manually managed through several excel spreadsheets, proving both tedious and potentially error-prone. In order to deal with these glaring issues, this Capstone Event Management System serves as a stand-alone web application away from Sakai that will provide students, faculty, and judges with tools that will facilitate the entire Senior Design process for all parties. Specific functionality includes the ability for students to create their own teams, pick their advisors, upload documents, and in the future- place orders for materials to be used in their projects to standardize the entire senior design process. To implement our solution, we used React for our frontend, Spring Boot and MySQL for our backend, and Spring Security and JSON Web Tokens (JWT) for our authentication and security protocols.

Main Problem

- No current system to automate project management of Capstone
- Most logistical aspects are done manually by Prof. Godrich and students

S20-43

Title: *QuikPark*

Members: *Yousef Aljallad, Harsha Dantuluri, Keith Kuchenbrod, and Liam Mccluskey*

Advisor(s): *Dr. Roy Yates*

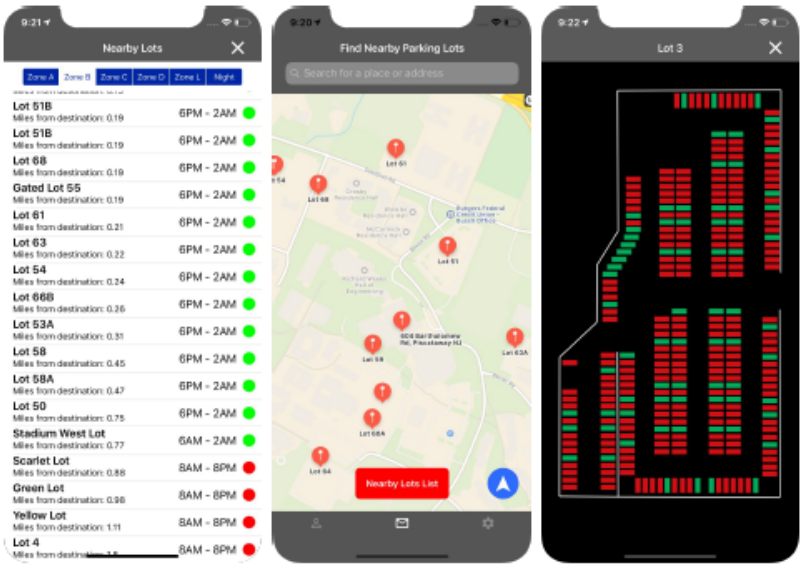
Keywords Cost-Effective, User-Centric, Image Recognition, Cloud Services, Internet of Things (IOT)

Abstract

Quikpark is a smart parking system designed to help drivers park easily and more efficiently. Through the use of cameras, the system analyzes video feed from cameras to keep track of occupied and unoccupied parking spots. These pictures are uploaded to an AWS server where the image processing is performed. This data is then sent to a mobile application that will present it to the user. Users will be able to see and choose open parking spots in real time. This will eliminate large amounts of time that drivers waste to find an empty spot in current parking lots. Furthermore, the mobile application will allow users to enter their final destination so that it can find the closest spot to avoid long walking times. Unlike other smart parking solutions, Quikpark does not require any sensors (sensor per spot). This allows for easy installation and is much cheaper when considering the number of sensors needed for commercial lots.

Mobile App

- Image 1: See the distance and availability of all rutgers lots to your desired location
- Image 2: Search for locations near Rutgers and see which Rutgers parking lots are closest
- Image 3: See occupancy of parking spots in real time. This image shows College Avenue Gym lot, and red spots are occupied and green ones are free



S20-44

Title: *Smart Office Access System*

Members: *Sudarshan Srinivasan, Shahnila Chowdhury, Sanjida Naser, and Ebad ullah Qureshi*

Advisor(s): *Dr. Roy Yates and Dr. Hubertus Franke (IBM)*

Keywords Access System, Facial-recognition, Microcontrollers, Cloud Services, Image Processing

Abstract

Access control systems allow employers to restrict access to certain areas of their building, setting varying levels of security depending on individual employees needs and clearances. This is where our Smart Office Access System comes into play. The proposed system will use an Arduino camera embedded in the lock which uses facial recognition to detect the person's face and allow office access to only authorized people. In case an unauthorized access is requested, an alert is sent to the administrator to prevent any suspicious activity. The administrator can review the request and can also unlock the door remotely if the request has been made by someone the user knows personally and needs to provide access to cope up with the fast-paced environment of the workplace. The biggest advantage of our proposed system over existing ones is that it is portable and easily installable.

S20-45 *Title: hARk - The Next Generation Hearing Aid?*

Members: Joshua Siegel, Aditya Verma, Shantanu Laghate, and Phurushotham Shekar

Advisor(s): Dr. Waheed Bajwa

Keywords Augmented reality (AR), hearing aid, sensor

Abstract

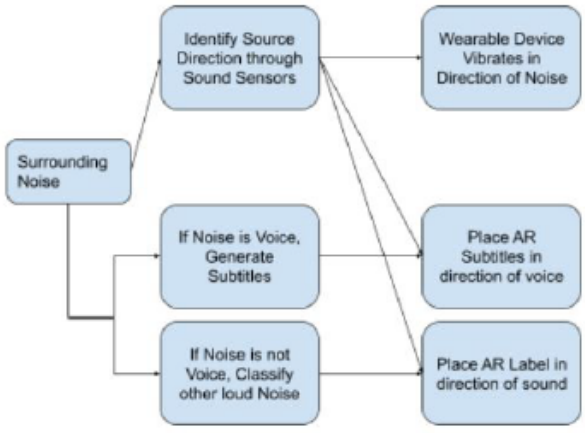
According to the World Health Organization, 1 in 20 people worldwide suffer from disabling hearing loss, hindering their interactions with the world around them and potentially putting them in life-threatening danger even in daily situations. We identify three specific problems that these people face and propose a solution that attempts to solve them.

1. Identifying the direction of incoming sound,

2. Hearing and understanding conversation in social interactions,

3. Identify life-threatening noises, such as cars while crossing roads and fire alarms

Our solution has two distinct portions that when used in conjunction attempt to resolve these three issues. The first component is a hat with microphones and four vibration motors, which vibrate in the direction of the incoming sound. The second component is an augmented reality headset which can perform real-time closed captioning of noises. For the purposes of demonstration, we use the Android ARCore functionality, but we imagine the target hardware for this application to be the Microsoft HoloLens is our target hardware. Our project combines signal processing, machine learning, and augmented reality for a seamless application and one that presents a valuable addition to the future of healthcare



Division of Work

(ORIGINAL)

- Hardware and Directionality team: Shantanu and Phuru
  - Setup Dragonboard 410c
  - Make MEMS mic array
  - Create directionality algorithm
  - Feed and process data
- Software and AR team: Josh and Aditya
  - Create ML classifiers to detect human voice
  - Detect several other environmental noises
  - Enable text-to-speech ability
  - Code Android-based AR app that places subtitles.

S20-46

Title: *Autonomous Underwater Diver Assisting Robot*

Members: *Nilay Patel, Syed Hussain, Dhanvin Patel, Smeet Kathiria, and Parthkumar Patel*

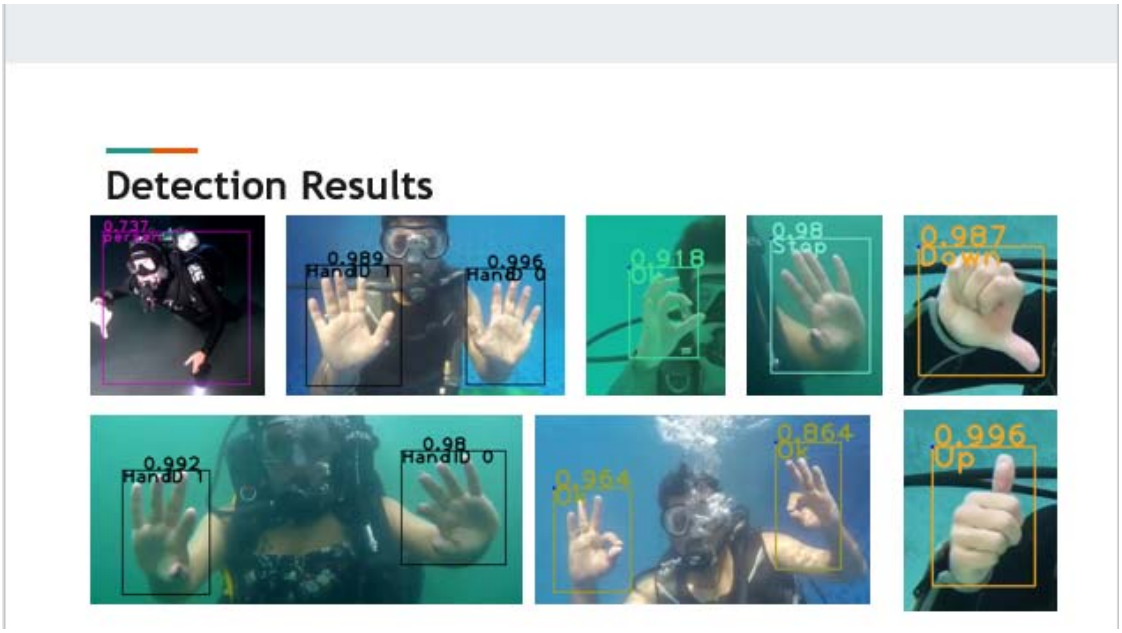
Advisor(s): *Dr. Dario Pompili*

Keywords Robot Operating System (ROS), BlueRov, Deep Learning, Object Detection, Nvidia Jetson TX2

Abstract

An autonomous underwater robot will be implemented using the BlueRov robot with capabilities of tracking, detecting hand gestures, and following the diver. We will develop tracking and detecting algorithms such that they will operate with the Robot Operating System (ROS). ROS allows us to control and automate the BlueRov sensors, motors, and the camera. The detection and tracking algorithms will be processed on the Nvidia Jetson TX2 GPU, mounted on a buoy connected through a router. Automation of the BlueRov and tracking algorithms will be tested in the swimming pool to shape the accuracy and speed.

The application of our project includes assisting scuba divers while they explore the underwater environment and discover new marine life that settles within it. The aquatic world is one of the most colorful and attractive places that are still to be fully discovered. Scuba diving is a popular way of exploring the underwater world, but with it comes diving fatalities. Due to the fact that it is an unexplored environment, danger from marine creatures, unexpected diving injuries and potentially life-threatening hazards may occur. The robot will assist the diver and prevent such issues from occurring by detecting hand signals and marine life around the diver.



S20-47

Title: *Low-Cost Ion-Selective Sensing for Hydroponics Solutions*

Members: *Jacob Battipaglia, Andrew Cecil, Krishna Gotur, and Einar Magnusson*

Advisor(s): *Dr. Richard Howard*

Keywords Hydroponics, Ion-Selective Sensing, Computer Vision, Control Systems, Internet of Things, Controlled Agricultural Systems

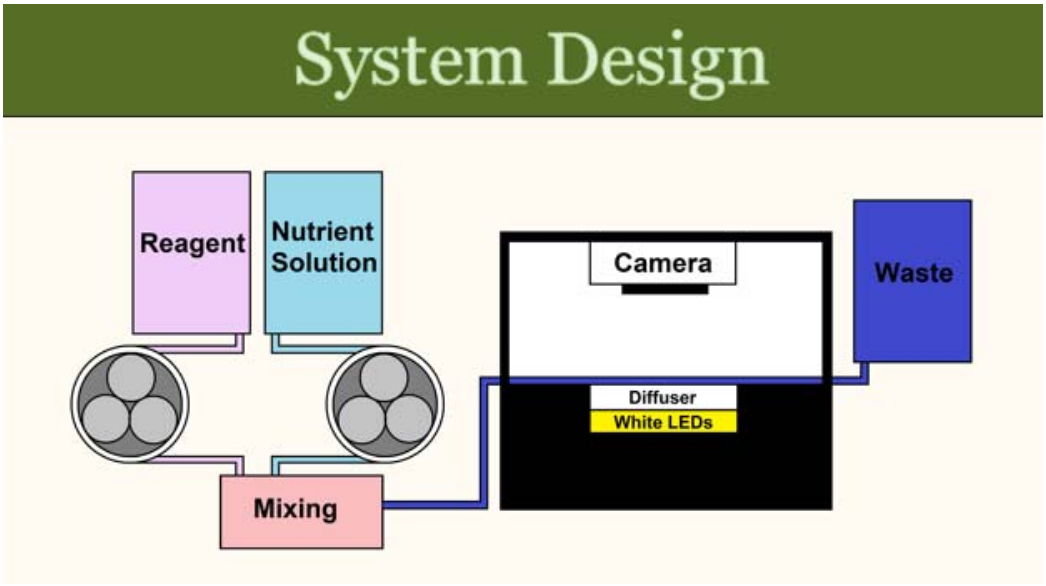
Abstract

Hydroponics is an agricultural technique where water is used instead of soil as the primary mechanism for nutrient delivery to crops. Water is used as a solvent for mineral and nutrient solutions, which are supplied to the crop's root systems. The roots are supported structurally by some inert substrate, such as perlite or gravel.

Successful management of hydroponic systems involves containing all fertilizers, pesticides, and agrichemicals within the system. Thus, many growers opt to recycle nutrient solutions. Before being recycled, it is necessary to verify that the concentration of all essential nutrients in the solution are within the optimal range for the particular crop being grown. Current standard approaches to testing nutrient solution concentration involve sensing pH and electrical conductivity, but these only offer general readings that are not specific to the concentrations of particular nutrients.

Ion-selective electrodes have offered a potential approach to nutrient-specific solution management, but they have some disadvantages. In addition to being costly, the electrodes are subject to chemical interference from other ions, and experience drift due to biofilm accumulation.

Our aim is to develop a low-cost ion-selective sensor for managing hydroponics solutions using color chemistry and computer vision. Many standardized colorimetric procedures exist for determining the concentrations of hydroponics macronutrients, such as nitrites, nitrates, ammonia, ammonium, orthophosphates, and potassium ions. These chemical reactions produce color changes that vary visibly based on the concentration of the desired ion. We aim to automate these color-chemical procedures and use computer vision to precisely quantify the results.



S20-48

Title: Robo-Buddy

Members: Joshua Olazo, Brian Ma, and Andrew Lu

Advisor(s): Dr. Kristin Dana

Keywords Computer Vision, Robotics, MediaPipe (Google), Hand-Tracking, Gesture-Recognition

Abstract

Common home robots of today such as iRobot Roomba are mostly focused on industrial tasks like vacuuming the floor. Recently, a renewed focus is being made toward robots for primarily social interaction. At CES 2020, Samsung debuted Ballie, a 'life companion' robot. Ballie is a robot centered around AI and will automatically perform tasks to help you around the house. However, we believe there was a missed opportunity to create an even further interactive experience for the user. Robo-buddy seeks to have more interaction with users through hand gesture controls. Our project will use an iRobot Create 2 controlled by a Raspberry Pi 3 using the robot operating system (ROS). Using a basic camera mounted on the robot and Google's MediaPipe (OpenCV, TensorFlow), we will implement the hand gesture controls. All computation will be handled on board the Raspberry Pi without the need for another computer. This project aims to showcase the potential of interactive social aspects in home robots

S20-49 *Title: Revised Degree Navigator*

Members: William Barron, Kyle Won Seok Chang, and Gabriel Shen

Advisor(s): Dr. Wade Trappe

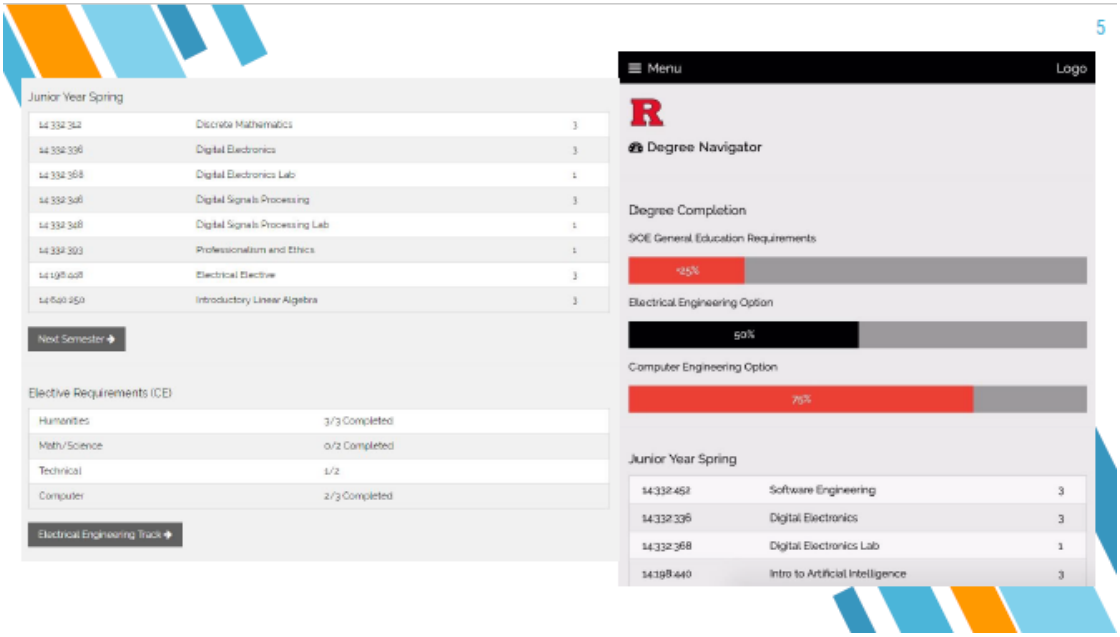
Keywords Revamp, Schedule, Requirements, Software, Customization

Abstract

Degree planning for a student attending college is very essential to them. Being able to understand the courses needed and when to complete it is very important to keep the student organized and ready for the years ahead of them.

The current Degree Navigator system according to the general student body as surveyed by our team appears out of date, visually unappealing, and functionally lacking in customization. Students don't have the option to swap a class from one requirement field to another. At this time, they can also only see the requirements for each semester but can't plan out which classes they intend on filling those requirements with. The closest draft or possible plan students can look at now is drawn up in the ECE student handbook, but here again the students lack the customization they would like.

Our plan is to create a new website where students will easily be able to plan out their entire college career before they even step on campus if they so wish. We will base our design off of the current planner shown in the handbook where one can see each of their semesters in front of them. Like in the handbook we will show the proposed classes in the schedule but allow students to click on the classes that aren't required and be able to see alternative courses offered. For those that are required we will lock them in so then they will not be able to be removed. In our website we will allow students to draw up several "draft" schedules so then they may see what classes they like and may satisfy the Electrical path or the Computer path.



S20-50 *Title: Smart Home Assistant*

Members: Rob Brokaw, Tom Murphy, Tom Wray, Brian Ogbebor, and Nitin Ragavan

Advisor(s): Kien Nguyen and Ryan Price (Interactions)

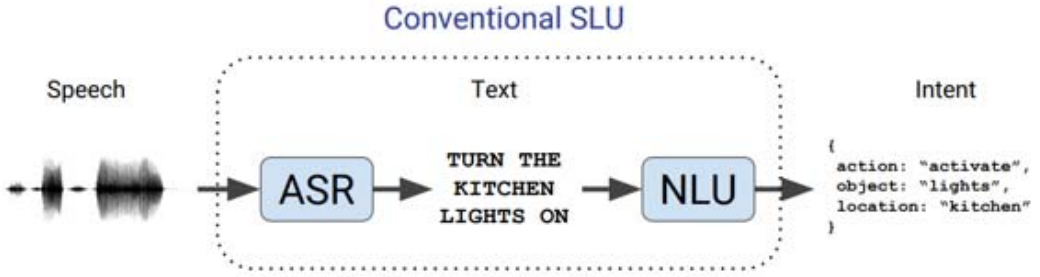
Keywords Smart Home, Open Source, ASR, NLU, Raspberry Pi

Abstract

Smart home devices that utilize systems such as machine learning have offered dynamic solutions that are customizable and adaptable to aspects of everyday life. Those devices include Amazon's Alexa, Google Home, and Samsung's SmartThings. Normally these devices rely on a central device that will capture audio from the user and then process this audio into text on a server which translates it to a command. That command is sent back to the origin device so that it can control other smart devices that are connected to it.

Our approach aims to implement an open source, modular system that can interact with a smart home device such as a Philips Hue Smart Bulb. The system will consist of a Spoken Language Unit (SLU) which contains two different modules. The Automatic Speech Recognition (ASR) Unit will be able to capture audio in .wav files and then convert the audio into text using different models like the Librispeech or ASpIRE model. The Natural Language Understanding (NLU) Unit will handle the the text recovered from the ASR and use keywords from the text in order to carry out commands. Those commands will be sent back to the Raspberry Pi that the SLU is hosted on in order to control the Philips Hue Light Bulb. The components on the Raspberry Pi will include a speaker and either a USB or Bluetooth Microphone. We hope to ultimately add to the range of open source end to end smart home devices that anyone can be able to use and program!

Methodology



"Speech Model Pre-training for End-to-End Spoken Language Understanding" by Lugosch et. al. https://arxiv.org/pdf/1904.03670.pdf

S20-51

Title: *Nephroto: Kidney Modeling App*

Members: *Christopher Basilio, Andrea Dumalagan, Parker Fisher, and Christian Remolado*

Advisor(s): *Dr. Deborah Silver*

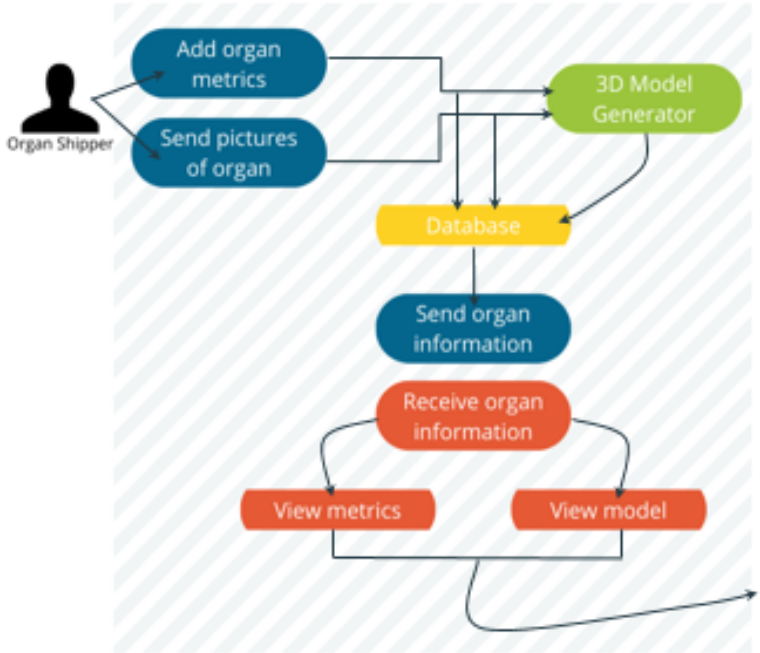
Keywords Android development, 3D-modeling, 3D reconstruction, medical field

Abstract

An issue prevalent amongst transplant surgeons is that organ specifications are unavailable until the arrival of the physical organ. Our project aims to combine the convenience of accessibility from mobile applications and the details of visualization from 3D printed organs: our group is currently designing a mobile application that renders a 3D model of an organ from pictures for use by transplant surgeons while awaiting the arrival of the actual organ.

Our mobile application will be developed using Android Studios and it will cater to two user models--the organ transporter and the transplant surgeon. The organ transporter is responsible for specifying key components and taking pictures of organ where it will then be stored in a database; the information will be used to construct a 3D model of the organ, and the model, along with the organ specifications, will be transmitted to the transplant surgeon for initial pre-operative planning. Not only will surgeons be able to spot nuances from one organ to another, but this application will also create a more direct line of communication between an organ's transporter and a surgeon.

Project Scope



S20-52

Title: *Grade Crossing State Machine*

Members: *Kyle Smith, Fatima Mir, Ryan Martin, and Josh Logiudice*

Advisor(s): *Dr. Michael Caggiano*

Keywords Digital Logic, Power Electronics, Control System, Energy conversion

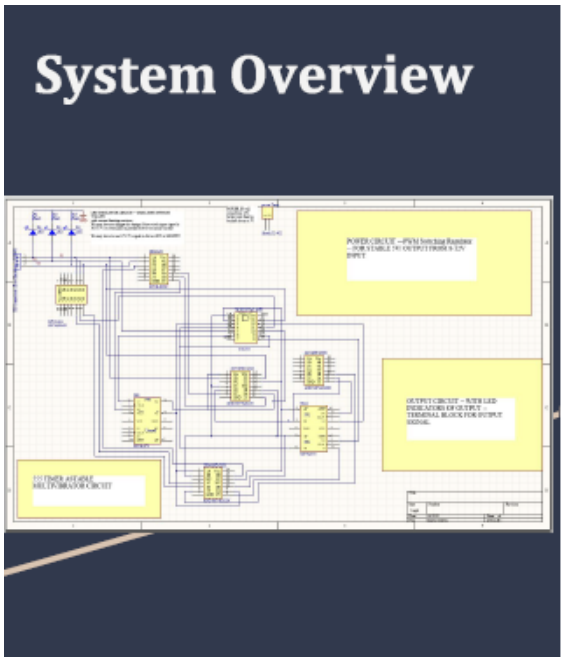
Abstract

Trains are one of the vital means of transportation in our country between shipping freight and moving people. The locations where railroad tracks crossroads are called grade crossings. Currently there is a control system in place to identify when a train is coming which then alerts people at the intersection by flashing lights and lowering gates.

Problems - The current control system is outdated and archaic, it uses large relays for the control logic of the crossing. These relays are expensive to replace and in many cases the railways are underfunded. The control system is tied to the power grid if power is lost so is the crossing's functionality. If these systems fail it could lead to people being unaware of incoming trains and potentially someone getting injured or worse.

Our objective is to design and build a control system for train grade crossings using digital logic and state machines. This system will be smaller, less expensive and easier to install and repair than the existing relay logic systems that are currently in use. In addition to this we will attempt to design the system to run independently of the power grid. The system will be an effective solution to update the many deteriorating and underfunded railways in our country.

The approach to this problem's solution that our team will take is; to first design the state machine that will govern how the system will function and then design the logic circuit using J-K Flip Flops and logic gates. Our approach will also involve designing the power system for the logic circuit and any other components necessary for the functionality of the system.



- We had originally planned to use a solar panel, but we achieved being able to make a Voltage Regulator
  - To save power by saving energy.
  - Saves power over time, Generation/storage at site.
- Design Power (Input) Circuit
  - A battery of 12VDC is used to get 5VDC with the help of voltage regulation circuit (using a 5.1V Zener diode)

S20-53

Title: *Inspired Parking Lot System*

Members: *Tingcong Jiang, Zhuohuan Li, Buyuan Lin, Shijie Xu, and Yiran Tan*

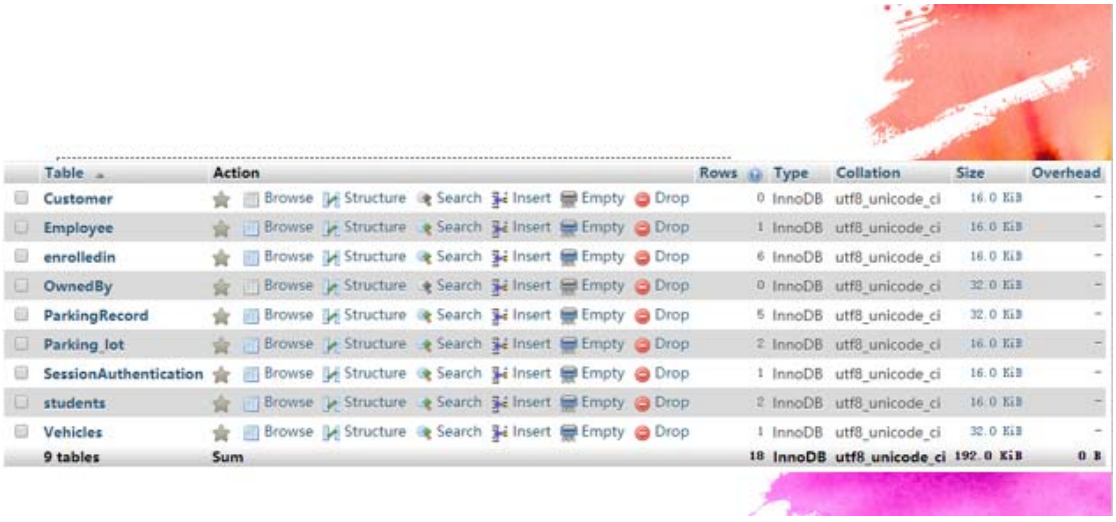
Advisor(s): *Dr. Maria Striki*

Keywords …

Abstract

Have you ever gotten into trouble finding a parking spot when you are driving to the school? Have you ever see an empty spot, but after you get closer, there is a mini, motorbike or a small car already parking there? After finishing your class, you forget where your car is parking and wasting lot of time trying to find your car.

As a group of engineers, we are dedicated to solve real-world problems. During the four years studying in Rutgers University, we find that the parking system in Rutgers University is not convenient. It is hard for students to find a suitable parking spots. So we came up with an idea to build an automatic system to help people to find a parking spot easier. Our project will save the time spending on finding a parking spot, help people to pay the parking fee in a more logical way and help people to find their car faster. There are cameras in the system to identify the car that is parking at a spot and put the information on a dedicated website. Once a user is logged into the website, the user can find where his or her car is parked. If a user has a reserved spot or need to find a vacant spot, the direction system will show a shortest path to the spot. The system also has a dedicate backend software for the manager to manage the whole parking lot. Furthermore, there are dedicated light on each spot to indicate whether a spot is vacant or not. We believe that if our system is implemented in a real parking lot, it will bring us a life changing experience of parking. We are Inspired Parking Lot Project Team.



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S20-54 *Title: Who R U? –Data Center Rack-level Security System*

Members: Zhuoran Liu, Mingju Liu, Miaomiao Xie, and Boyang Zhang

Advisor(s): Dr. Hana Godrich

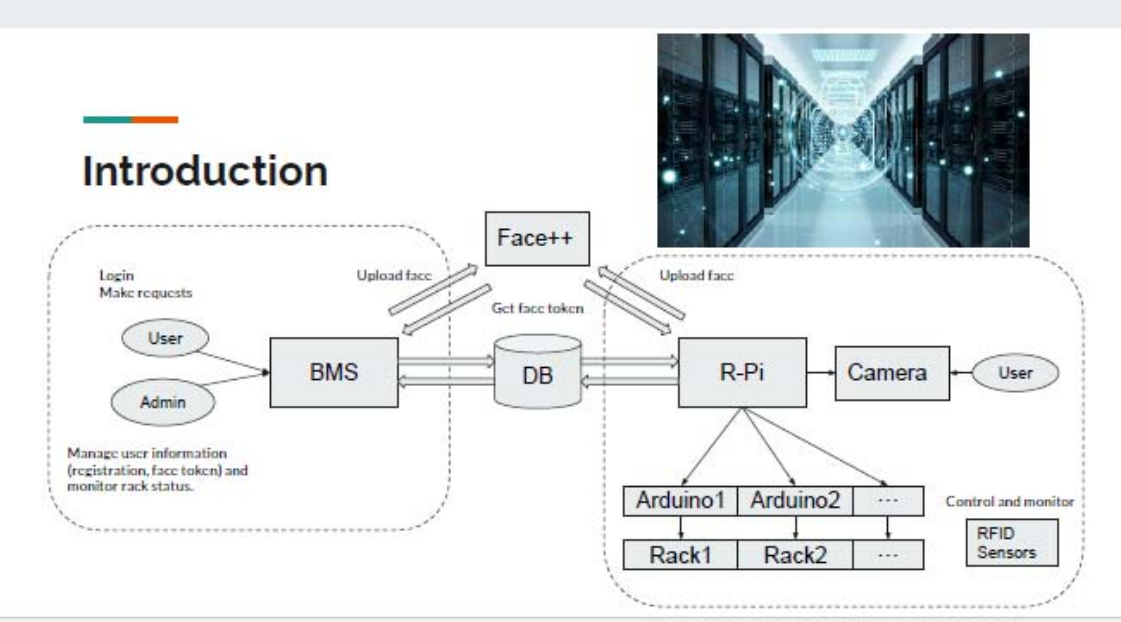
Keywords Rack-level, Low-cost, Easy-implementation, 2-factor security

Abstract

For data center security, once upon a time, it was enough to regulate access to the data center as a whole. As long as you could ensure that no unauthorized person has access to your data center, you'd be OK, you don't care about what happens inside.

But the remaining problem is that there are risks from within, especially for large data centers. They are mostly human errors, which is still one of the major causes of downtime in data centers. So, it's no longer enough to ensure that only authorized persons enter the data center. In our project, we mainly focus on rack-level security. We monitor users' access to specific systems and ensure they have the correct rights to a particular rack. Also, we would provide an audit trail regarding who touched those systems, and when and what they did each time.

We set two-factor security, which is facial recognition and RFID authentication. First, when someone approaches the entry, we will use the pi camera to do facial recognition. The authorized people can walk straight into the door, and specific rack door will open automatically. And for the non-authorized people (first time, info not in the database) then need to go to the manager to get the issued RFID card to get permit to access during the appointment time he or she made before. In our project, there are no physical keys, we will replace the physical keys into electromagnetic locks.



S20-55

Title: *Smart Stoplight*

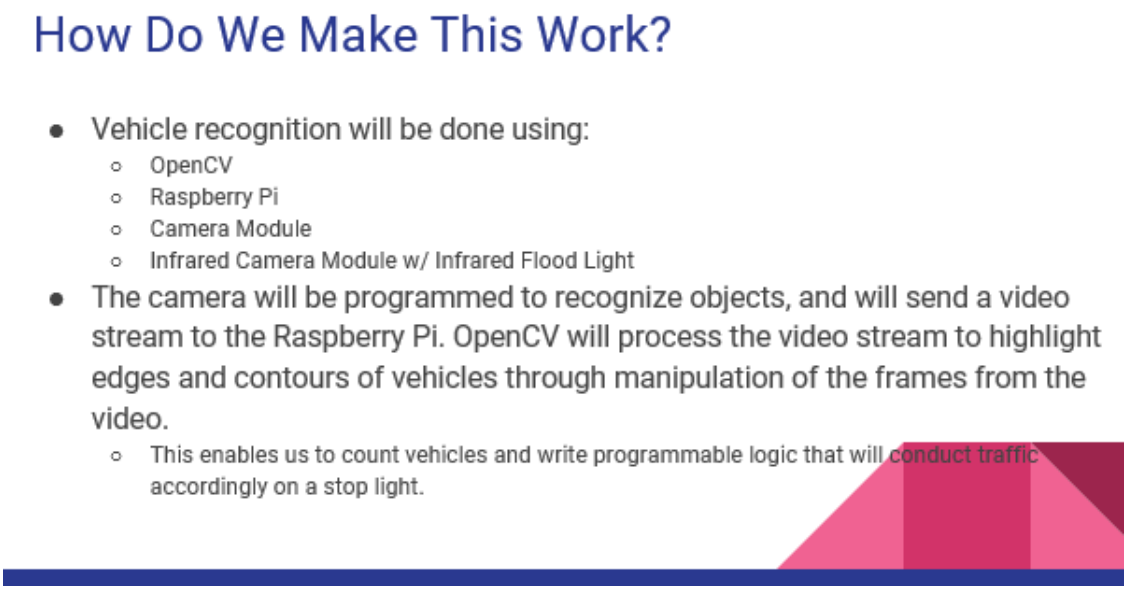
Members: *Harman Kailey, Daniel Anderson, Nick Han, and Denys Bengizu*

Advisor(s): *Dr. Michael Caggiano*

Keywords Computer Vision, AI, Machine Learning,

Abstract

A device that is easily attachable to existing traffic lights. Device will use cameras to detect traffic at intersection down to the detail of each lane. We are considering using thermal imaging cameras but they seem to cost too much to use for the purposes of this project. If there is a necessity to use a turn signal the device will conduct traffic accordingly. It will detect which lanes are most saturated with vehicles and take priority in the conduction of traffic. If there is a lane that has not received a green light in over three minutes and has some vehicles queued, device will conduct those vehicles to go. At some intersections, such as exits, a turning lane may begin backing up since the turn signal does not last long enough. This device can keep the turn signal on long enough to reduce congestion before allowing both sides of traffic to continue. If the device loses visibility, such as in a snow or rainstorm, it will enter a default mode in which it uses a timer based, turn based system as implemented in current traffic lights. This device will function using cameras with computer vision to view the intersection, an Arduino to act as the computer, and a hard shell and robust enclosure. This allows for further development of the software to include internet connectivity. When this device uses internet, it takes an IoT role.



S20-56 *Title: 2020Vision*

Members: Roshni Shah, Shruthi Sureshkrishnan, and Nithyasree Natarajan

Advisor(s): Dr. Kristin Dana

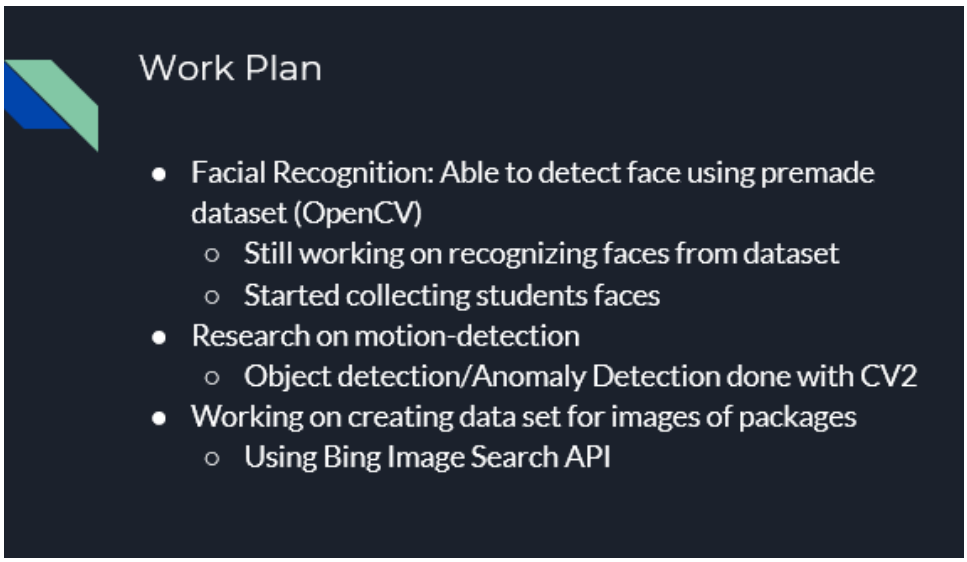
Keywords Computer Vision, Facial Recognition, Security, Accessibility

Abstract

The goal of 2020Vision is to utilize computer vision and facial recognition to help everyone, even those with visual impairments, feel safe and secure in their homes and out in public. Often, those with visual impairments are vulnerable to safety threats in the form of home attacks and burglaries. To prevent this, 2020Vision provides security by identifying if the person at the door is a known connection before alerting the homeowner to open the door.

To do this, we will extract the image of the person at the doorstep using a camera at the user's front door. After using facial recognition to identify the identity of the person at the door, the features of the identified person will be compared to those of the homeowner's predetermined list of friends. If the person at the door is a match, then the homeowner will get a notification of who it is. However, if the person is not recognized, then the homeowner will get a notification that the identity cannot be identified. 2020Vision will also send a notification to the user when he/she has received a package at the front door, using object classification.

As the safety of users is most important, 2020Vision also aims to send notifications to officials when it detects an anomaly. Recognizing unusual activities, such as kidnappings, in real time will allow for the police to get notifications right as these events occur and enable them to react faster to prevent further damage from occurring.



S20-57 *Title*: *Multi-Port Serial Communicator*

Members: *Bohdan Kryzh, Yanbo Jiang, Jacob Gehrig, and Adam Falkowski*

Advisor(s): *Dr. Athina Petropulu*

Keywords Serial Communication, Streamline, Python, Raspberry Pi, Arduino

Abstract

Chemical laboratories (pharmaceuticals, etc.) often use equipment that can be automated via serial communication by using commands in the form of strings of text. While these devices usually come with built-in interfaces on the device to control them or software to control each individual piece, it is advantageous to control all devices from one central location. In the control systems industry, this requires control software, programmable logic controllers, protocol converters, and extra hardware for power and other connections. The result is a large, slow, and expensive device that is not optimal for high speed data acquisition and control of the equipment. The multi-port serial communicator solves these issues by using a Raspberry Pi to host a user interface with every device's commands. The Raspberry Pi in turn controls an Arduino MEGA, which handles the serial communications to four devices by sending the actual command strings via RS232 or RS485. Since the Arduino can operate much faster than many PLCs used in the control systems industry, response time between selecting a command and the device receiving the command is much faster. Additionally, data can be acquired at a much higher rate, providing constant access to accurate data.

S20-58

Title: *Pedestrian-Friendly Traffic Algorithm Using Image Captioning*

Members: *Zihao Luo, Sui Huang, and Lieyang Chen*

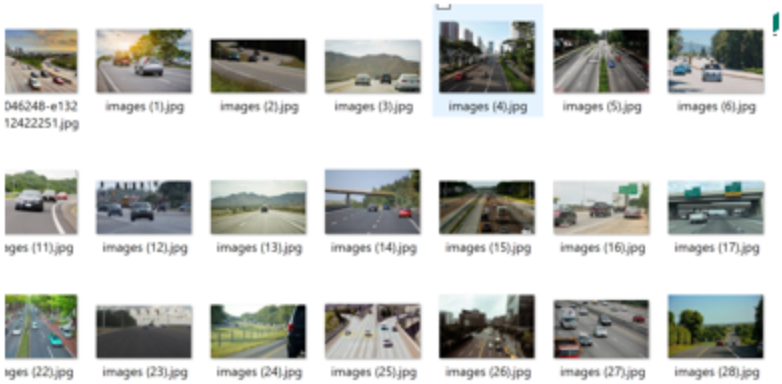
Advisor(s): *Dr. Kristin Dana*

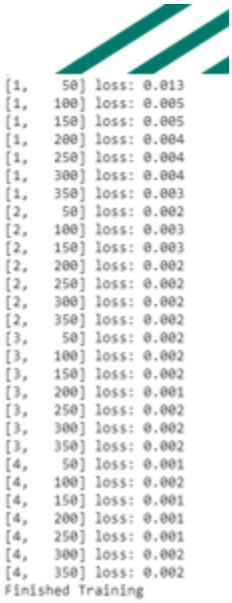
Keywords Computer Vision, Neural Network, Machine Learning, Image Captioning, Image Dataset

Abstract

Computer Vision has become one of the most popular topics recently. Among all the projects in computer vision, image captioning is a very prevalent project. It is able to transfer image data to other media, like sound, words, or even digital signals. In our Pedestrian-Friendly Traffic Algorithm, we hope that it could provide pedestrians' best experiences walking on the road. What we do is to use the neural networks to train the image data of the traffic and analyze to get what is happening on the road. With the help of image captioning, it could provide the English language of what is happening. We also applied some traditional computer vision way in our project, like calculating the speed of a vehicle by different frames of a video. By overcoming some difficulties, we had successfully come up with a way of getting the speed of every car on a video.

During this project, we get the data all by ourselves. We go the different roads with cameras and tripods to take videos on different weather conditions and different time. We download thousands of images online and label them ourselves. The research also has a potential goal for helping the blind. We recognize that it is very hard for blind people to walk on the road alone and even cross the road. Our algorithm is able to describe the real scenario of the traffic and provide the speed detection of the cars coming.





S20-59

Title: *FSAE Fatigue Tester*

Members: *Raymond Chiu, (MAE: Michael Fabiano, Madeline Bowne, Dennis Villani, Gil Rubio, Sefa Ocak, Michael Albacete*

Advisor(s): *Dr. Assimina Pelegri (MAE)*

Keywords Stress, Validation, Welds, Vibration, Racecar

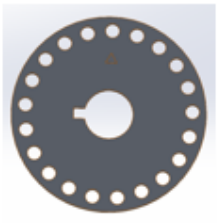
Abstract

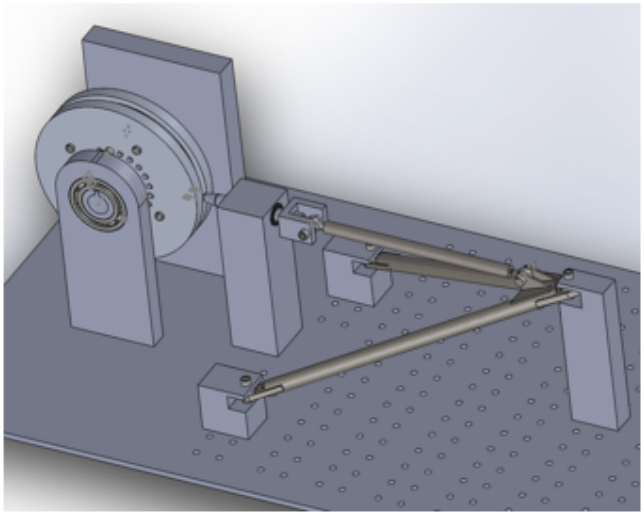
Industry fatigue testers are delivered at high prices and large footprints with small testing size, exceeding costs upwards of $5000 and often occupying spaces larger than 20 sq.ft. while testing small material samples. These are unaffordable by the Rutgers Formula Racing team here at Rutgers, where one of our design validations is to build and test components that are integral to our scratch-built formula-style racecar; some of these components are welded steel or aluminum that fatigue over time and eventually break, adding a risk of safety and cost. The fatigue tester we construct must simulate the test conditions we have observed in the past for these car components, utilizing a small footprint while being modular in fixture design to adapt other manufactured custom car components. Building this fatigue tester is achieved by adopting basic jig material that the team has and already uses, such as jig towers and a jig plate, while integrating a robust air compressor motor to turn an eccentric wheel. The cam wheel will displace a roller that will apply the load we designate in tension and compression, simulating the forces the welded components would see on a typical test and race day.

Scope of Work

Design

- CAD assembly including:
  - geometry of suspension components
  - cam roller
  - jig plate and fixtures





S20-60

Title: *Smart Goggles*

Members: *Tatsat Vyas, Max Davatelis, Zain Sayed, and Andrew Koskinen*

Advisor(s): *Dr. Kristin dana*

Keywords Smart Goggles, SLAM, Object recognition, Depth measurement, YOLO

Abstract

Our project focuses on utilizing the technologies available today to help people with mental illness such as prosopagnosia, Alzheimers and old age memory loss as well as people with complete vision loss. We are trying to develop a technique that can record the faces of the people that a person meets and informs the person who they are. In addition, it can also help the user navigate through the environment and alert them of any objects on their route. The goal of this device is to assist people with any type of vision or memory loss.

This project will consist of three major components: image capture glasses, accompanied android app, and cloud storage system. The glasses will be modeled using standard glasses frames, a microcontroller, and a camera compatible with the microcontroller. The microcontroller will be responsible for capturing facial data and further image processing.

The android app's main responsibility is to consolidate the image samples while providing an interface for the user to interact. This also ensures a consistent internet connection for the entire system.

Use previous data stored via cloud storage and cloud computing to match faces and return facial data to the app for the user to interact with. Further encounters with the same faces will strengthen the detection system.

Design

- Goggles with camera, microphone and earphone attached to it.
- A microcontroller with minimal storage
- A mobile application connecting to the goggles
- A remote server to hold the user data

S20-61

Title: *Agora VR: Virtual Reality Exposure Therapy of Agoraphobia & Social Anxiety Disorders*

Members: *Aryeh Ness, Daniel Nguyen, Michael Truong, and Ted Moseley*

Advisor(s): *Dr. Grigore Burdea*

Keywords Virtual Reality, Social Anxiety Disorder, Psychotherapy, Exposure Therapy, Metacognitive Interpersonal Therapy

Abstract

There are many types of social anxiety disorders. Agoraphobia is defined as "a type of anxiety disorder in which you fear and avoid places or situations that might cause you to panic and make you feel trapped, helpless or embarrassed". Some conventional treatment methods include self-help, therapy sessions, or medication. People who have these disorders find it difficult or impossible to go out for help and receive treatment and in other cases start to distrust the therapist.

State of the art virtual reality systems have emerged, presenting the average consumer with affordable, high-quality personal-use equipment. One such system is the Oculus Quest, a system capable of running virtual reality applications without external computing for the starting price of $399, comparable to that of a mid-range phone or video game console.

Utilizing the Oculus Quest, our solution will immerse the patient within a virtual environment that dynamically adapts to the stage of treatment, severity of the disorder, real time integrated biosensor readings, and external inputs from a clinician and caregiver. The system will integrate several conventional therapy methods such as psychotherapy, exposure therapy, and metacognitive interpersonal therapy (MIT). The option to use a low-cost, portable system in the safety of their home gives the patient with a low barrier of entry into exposure therapy. With our product, we plan to provide an alternative, more effective treatment option for those who suffer from Agoraphobia and social anxiety disorders.

AGORA VR

ORIGINAL SLIDES @

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S20-62

Title: *Visual Security*

Members: *Joel Cruz, Hyun Sik Kim, Keeyan Haghshenas, and Dakeen Daniels*

Advisor(s): *Dr. Jorge Ortiz and Dr. John McGarvey*

Keywords …

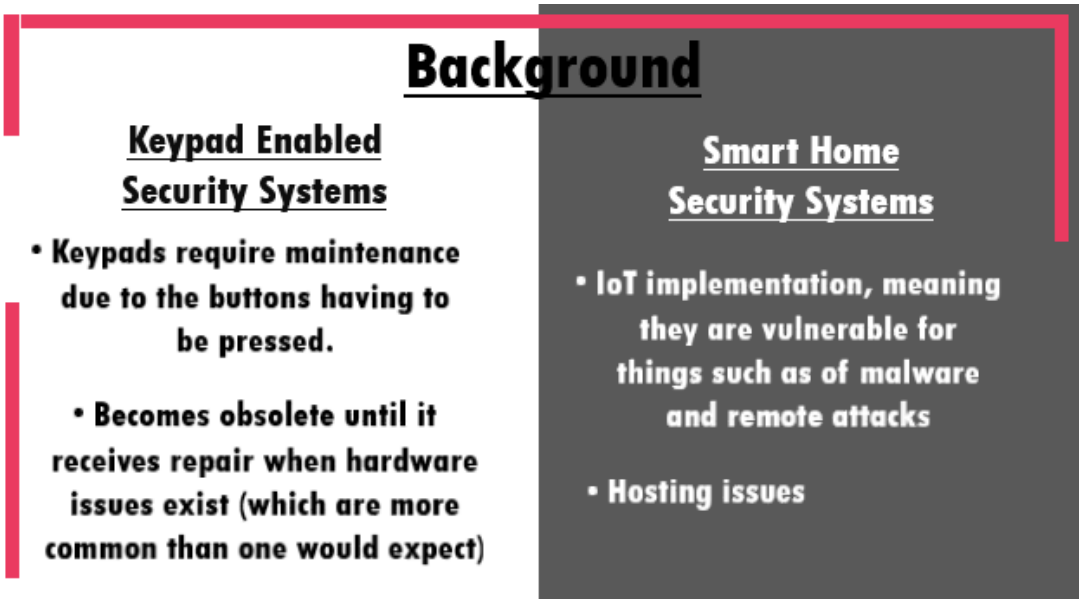
Abstract

Upon researching what issues exist today with technological implementations in security, two of the most prominent implementations are: keypads and IoT/smart homes. With those implementations came their respective complaints and issues amongst consumers.

With keypads, the continuous pressing of buttons would progressively create wear out the hardware, and customers would consistently experience malfunction with their machines. These malfunctions would create inconveniences for consumers, where they would have to wait for repairs [of the keypad] in order to gain access to the property using the keypad.

So, what type of system is as easy to use as a keypad, but as comprehensive and structured as a smart home security system? That's where the proposed "Visual Security", security system comes in. Visual Security would use computer vision and machine learning in order to allow users to submit a sequence of fingers gestures, as a password, into the camera of a device, in order to gain access into a property. How does this address the issues of keypads and smart homes?

When compared to keypads, Visual Systems will NOT use any technologies that will be susceptible to rapid mechanical or hardware issues, because the only way the user will be interacting with the system is the camera. "What about the wearing down of the device, that comes from the system being on being on all day waiting for the user to input a password?" That will not necessarily be the case with Visual Security; Visual Security will be implemented with proximity sensors to ensure that the device will ONLY be on when it's time for the user to input their password. This means that the device will be on for a couple seconds of the day, and the device will never have to be touched by the user.



S20-63

Title: *H.A.N.D. (Hand Augmented Narration Device)*

Members: *Hari Shetty, Louis Moccia, Darius Baboomian, and Sean Kearns*

Advisor(s): *Dr. Predrag Spasojevic*

Keywords Educational, enhancing, gesture-based, Raspberry Pi, IMUs

Abstract

The reality of the presentations today is that the technology we use to present in front of large crowds is counterintuitive attracting the attention of our audience. The usage of office presentation clickers or keyboards to help navigate through presentation slides disrupts the flow of presentations and has been proven to distract the audience from a presenter's main points. Our project addresses this problem by giving the presenter an avenue for a more fluid performance, giving them an attention-grabbing appearance during their presentations. Our solution will explore the usage of various sensors, such as Inertial Measurements Units (IMUs) and Force Sensitive Resistors (FSRs), on a Raspberry Pi to track a user's hand gestures and translate them to keyboard inputs. In our initial model, IMUs will be our primary method of extracting hand gesture data while FSRs allow for more combinations of hand gestures to key bindings. In doing so, we allow the presenter a variety of options to make their presentations more fluid. Furthermore, this type of device provides a variety of applications that can extend beyond the traditional presentation, such as allowing the presenter to switch to different applications, more fluidly switch to different presentations, or interact with their students using hand gestures. Finally, we intend to do this with cost in mind, since our primary competition can be a relatively cheap product. Our goal is to make a product will help revolutionize the way people interact with their audience and their technology.

State of Design

- Device is able to effectively calculate angle of the device and is also able to recognize basic movement
- Basic program on a laptop is able to take data sent from Pi and has currently been hard coded to translate to keyboard inputs
  - Final design will include a better UI that will allow customization for this
  - Data is transmitted through MQ Telemetry Transport (MQTT) protocol, which allows for quick, easy sending of data from Raspberry Pi to computer. This protocol also allows for future devices to simultaneously connect to a laptop, allowing for the potential of student interaction
- Overall cost of prototype totals to $82.31
  - This would decrease significantly with mass production due to overestimation in specifications (e.g. The Raspberry Pi Zero WH would have also likely worked, so a weaker microcontroller can be mass produced/purchased)

S20-64

Title: *Analog Joint Source Channel Coding*

Members: *Zhile Li and Linshen Ye*

Advisor(s): *Dr. Dario Pompili and Vidyasagar Sadhu*

Keywords Quantizaiton, AJSCC, Modulation, Matlab

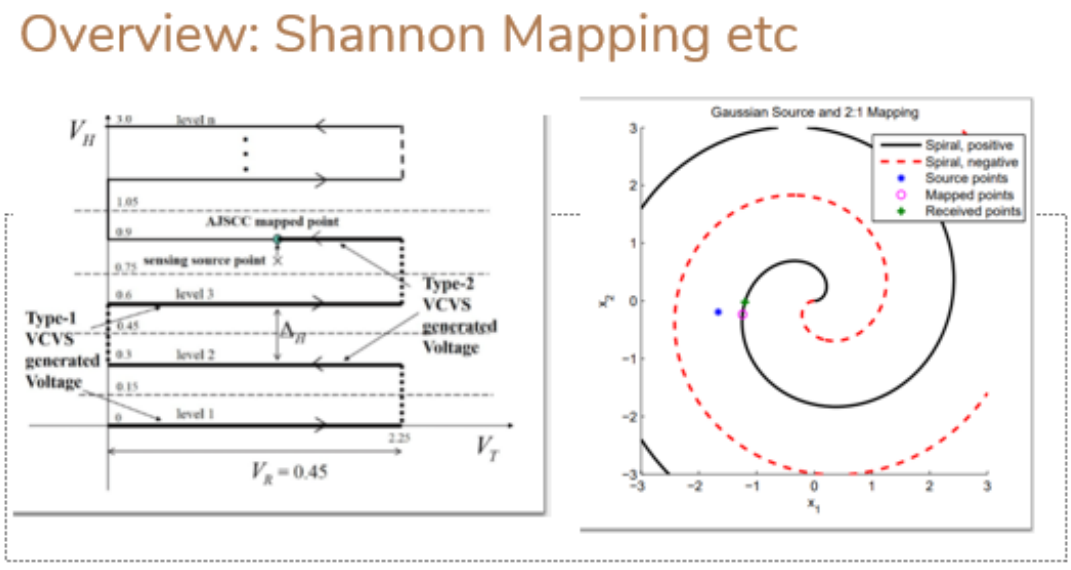
Abstract

We first introduce Analog Joint Source Channel Coding (AJSCC) and explain its benefits and goals. Also, we then show several past research projects in this area, along with some applications of AJSCC in other related fields, such as Wireless Communications, Information Theory, and Networking.

The problem we want to solve through the project is that (underwater) sensors need a huge amount of energy to transmit collected data, and we want to increase the efficiency and reduce the consumption.

We use AJSCC to increase the efficiency. Because digital devices need more power consumption, so our object is using all analog devices. Because JSCC can encode more groups of data into one group, so our object is using this coding method to reduce the amount of transmission signals.

First, we describe the combination of quantization circuit and AJSCC MOSFET and use the data to encode and do FM modulation with noise. In another word, we show our MATLAB simulations on AJSCC in a noisy channel, our quantization circuit, and experimental values of MOSFET constants. We then calculate the RMS and do the decoding process.



S20-65

Title: *Music Sheet Maker*

Members: *Sifan Yuan and Haocong Wang*

Advisor(s): *Dr. Yingying Chen and Dr. Yilin Yang*

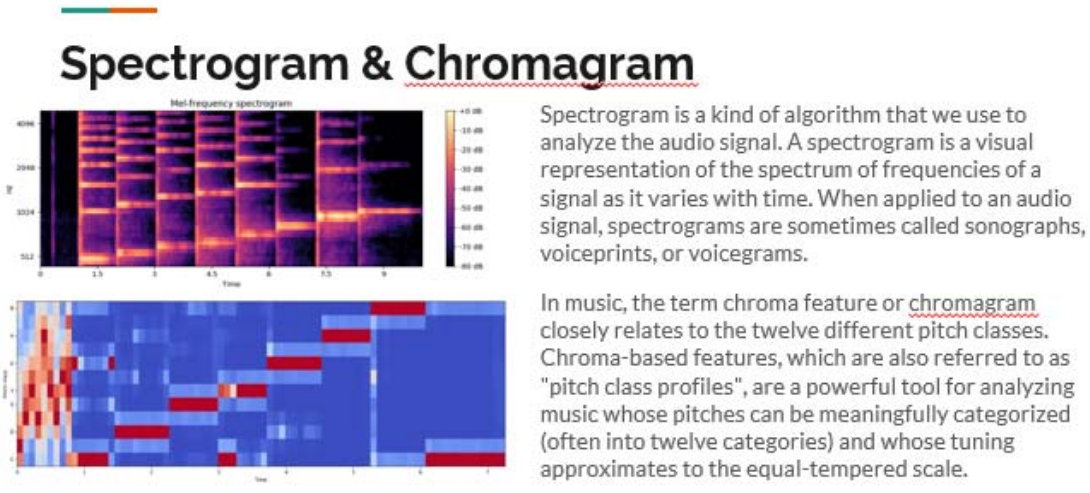
Keywords …

Abstract

The Transcription of music refers to the generating of the music note from a given part of music. The traditional music transcriptions have been written by hands. This is absolutely a time-consuming job, and, it also requires the people who do this has a very well musical knowledge base. What's more, it also has other requirement, for example, the place should not be very crowdy. These limitations of the traditional music transcription make people hard to write or record the music they want to. To let everyone be able to "write" music, we want to find a way to do music transcription automatically.

Our goal is to develop an application to write music sheet automatically with a given part of the audio on android platform.

The whole project can be probably divided into 3 main parts: the audio data fetching and preprocessing part, the music transcription part, and the output and presenting part. In the first part, we will focus on how to get the data from the device and to generate the dataset which will be used in the transcription part. In the second part, our goal is to finally output a MIDI file from the data we get from the first part. The last part is to transcript the MIDI file into a standard version of music sheet, which can be directly used by orchestra or chorus.



S20-66

Title: *Siyam – The Group Dieting App*

Members: *Wahhaj Zahedi, Salman Hashmi, Nada Ali, Omar Atieh, and Shazim Chaudhary*

Advisor(s): *Dr. Wade Trappe*

Keywords Health, Social, Mobile Application

Abstract

Currently as of 2020, there are hundreds of dieting applications on the market that all aim to help users control their diet by keeping track of what they eat. The top few market leaders incorporate a "social" aspect of being able to share what you eat and if you have reached your personal goals. The key that is missing from all the hundreds of mobile apps on the market, including the top market leaders, is the aspect of accountability. It is our hypothesis that if people are held accountable is a social setting for what they consume, then they are more likely to keep consistent throughout their personal dieting journeys. This is the problem with all those attempts at helping users keep a good diet. Alongside this, we believe that rewarding consistency and incentivizing users to continue their good dieting habits will play a huge part in transforming the current landscape of dieting apps. Our approach will be to allow users to create and join groups with whom they choose and meet a group streak depending on whether or not everyone in a group has met their goal for that day. Each personal goal is the typical goal you would see in any other app in terms of calories and micronutrition's. The core of our approach with group streaks and incentives is an innovative take on the dieting world, that we think will improve three aspects of dieting: consistency, motivation, and accountability.

S20-67

Title: *Heat Source Detector*

Members: *Yuan Cheng, Junsong Xing, Xiaotian Qiang, and Shiyuan Chen*

Advisor(s): *Dr. Michael Caggiano*

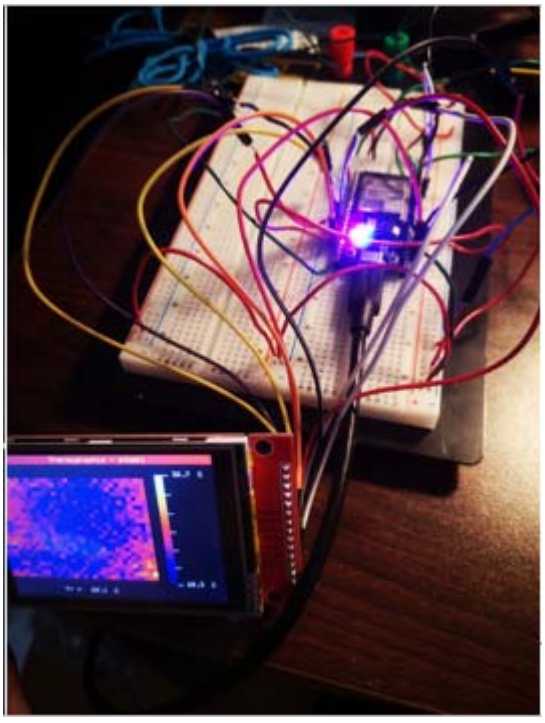
Keywords …

Abstract

The home fire is dangerous. In less than 30 seconds a small flame can turn into a major fire. It only takes minutes for thick black smoke to fill a house or for it to be engulfed in flames. It is hard for people to notice the fire when they do not know where the fire starts. Our capstone project is to design a heat

source-detector which helps to find the place with high temperature and measure the distance between the heat source and the detector and in addition, report to people where is the heat source.

The traditional way to prevent the home fire is the smoke detector. There are two types of the traditional smoke detector: photoelectric smoke detector and the ionizing smoke detector. The photoelectric smoke detector is sensitive to dust and insects, which means regular maintenance is needed. And the ionizing smoke detector is even more sensitive, which may lead to false alarms as the product of cooking. And our project is going to design a detector that is not so sensitive: it will only report when the temperature is unnormal. This will prevent the miss report from the cooking: when people cook there may be some smoke which is detected by those sensitive detectors. Also, our design will not make large noise, it will report to you on your mobile phone.



S20-68

Title: *Facial Recognition & Object Detection For Alzheimer's & Memory Impaired*

Members: *Ludwig Randazzo, Avnish Patel, Ernest Chiu, and David Santiago*

Advisor(s): *Dr. Hana Godrich*

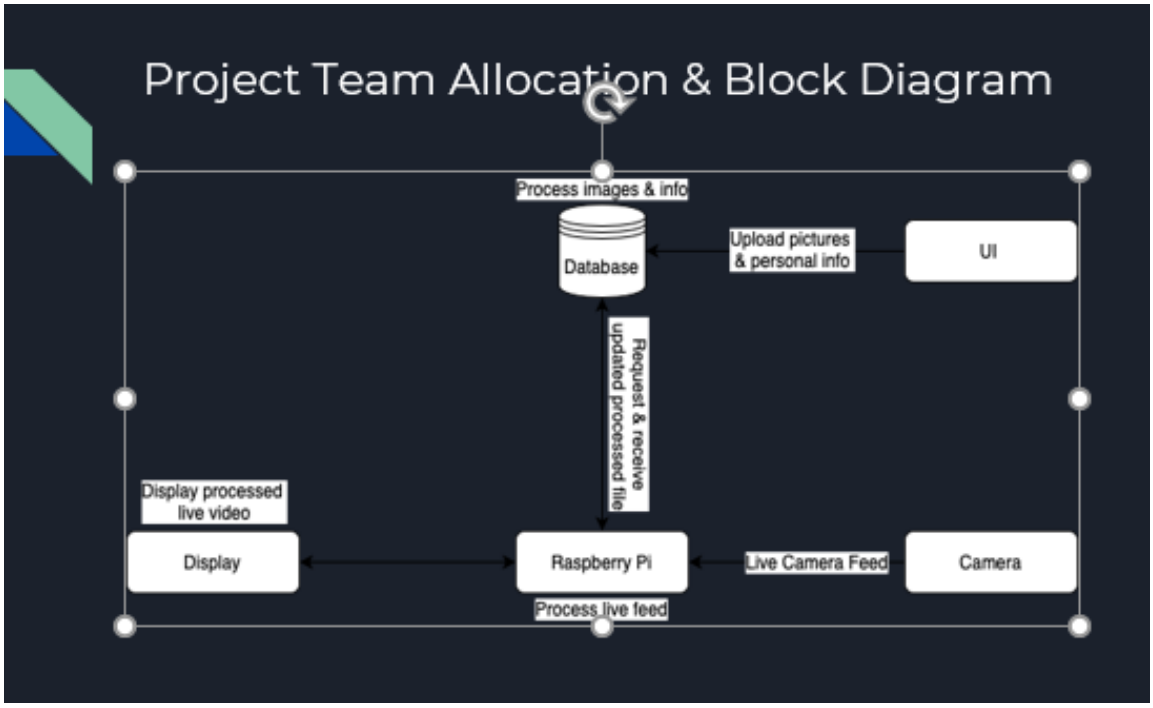
Keywords AI, facial recognition

Abstract

The goal of this project is to help people with memory issues to remember loved ones and objects to make their day to day lives easier

Primarily targeted at those who suffer from Alzheimer's and Dementia , or other memory impairing diseases. Inspiration for the project: Paul Baldasarre.

The main modules of this project: OpenCV / Tensorflow, Raspberry Pi, Screen, Android Phone Camera, Database. We plan on using Raspberry Pi for the camera and use the algorithm and database to decode pictures/live video feed. We plan on showing the name of the person and have the user click on the box surrounding the "object" and all the information regarding that will show up.



S20-69

Title: *Retrofit Garage Door Opener*

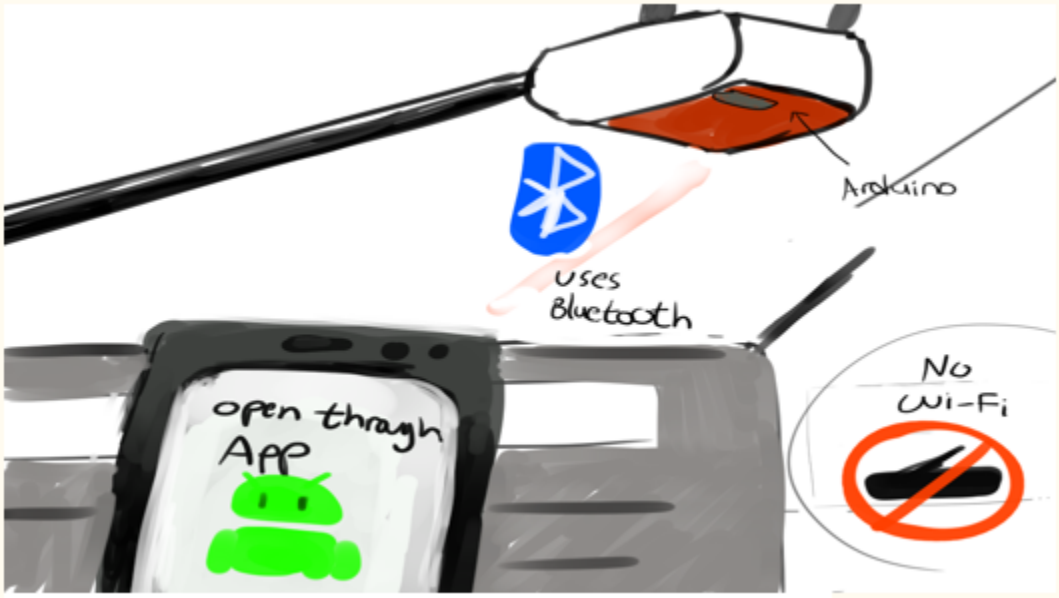
Members: *Andrew Schneeloch, Haoran Qin, Chris Gordon, Luis Camacho, and Sara Mirza*

Advisor(s): *Dr. Hana Godrich*

Keywords Sensor, retrofit, control

Abstract

When it comes to your average home garage system, you may find it hard to have easy access from anywhere in your home or just outside. Many systems require a separate remote, which is prone to being lost, in order to access your garage door. There may even be rare cases in which you may be required to have someone open the door for you. Overall, the issue is ease of use as well as ease of access. Our solution to this problem is that we are going to design an android app that will work hand in hand with an Arduino, or a soon to be retrofit device, to in turn synchronize with your current garage door opening system. This will allow for remote access via the android application disabling the requirement for a separate remote since typically everyone has their phone on them. In order for this to work we plan to have the android app connect to our retrofit device via a Bluetooth wireless connection to then grant access to control our retrofit device. On top of this, the Arduino will connect to the pre-positioned garage door opener via an RF connection since most openers use RF to work remotely. The app will be able to retain users and guests so that anyone who is allowed by the owner will have access to open or close the door. The applications connectivity will work through Bluetooth so that once the user is in range he or she will be able to open up the door because they will already be connected.



Our Schematic

S20-70

Title: *Smart Sweet Spot of Your Home Stereos*

Members: *ZHENZHOU (Tom) Qi*

Advisor(s): *Dr. Xiaoran Fan and Dr. Richard Howard*

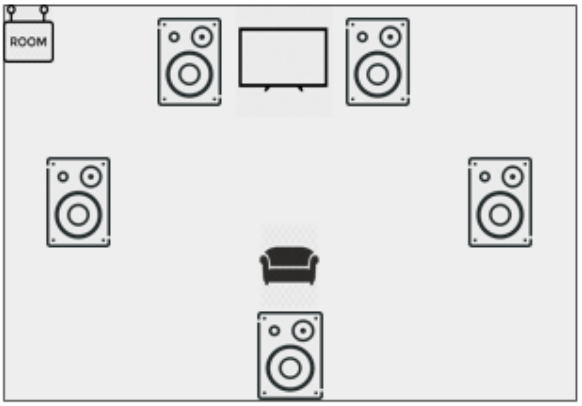
Keywords …

Abstract

Home stereos are common in most families. Either implemented in basements or living rooms, playing music, movies or even live concerts, it is a great way to relax. However, people may find that aligning the speakers in their home stereos tedious. What annoys them most is that even when they move around their furniture, the positions of the speakers have to move accordingly.

We came up with a novel way to solve this problem by using the technique of beamforming. Which we can make the speakers automatically adjust their positions so that the sweet spot is always around the person no matter where he stands. And the following will be our method and systems.

Background



- Takes a considerable time in adjusting the speakers.
- When new furnitures are added, all the work done previously have to be redone.