E/CE DEPARTMENT
THE COLLEGE OF NEW JERSEY
SPRING 2021

ELC 496/495 - Senior Project

FINAL DESIGN REVIEW (FDR)
May 5th from 9:00 am to 2:10 pm

PRESENTATION SCHEDULE:

9:00 am Wireless Driveway Security System by Alex Benasutti and Sarah Fontana. Adviser: Larry Pearlstein.

The home security system market has been growing at a tremendous rate over the past few years, which has stemmed from increased demand for home security and homeowner peace of mind. Current advancements in older technologies have greatly increased the effectiveness and efficiency of this sector, but only in systems that are immediately or relatively near the user's home. Homeowners who have an indirect line of sight or a long driveway may benefit from having surveillance located at the end of their driveway. However, current devices that supply this need lack logs and details on who has entered their property and thus are very susceptible to false alarms. To address this problem, we designed an easily-portable system which will detect and generate a user notification for when any large object, animal, or vehicle has entered a homeowner's driveway. The device uses a PIR motion sensor and NoIR camera system in tandem with image processing techniques to pinpoint and extract the object. All computations are accomplished using a Raspberry Pi Zero board, which will transmit an image of said object to the user via their phone by 4G/LTE cellular HAT. The user will also be able to interact with the security system by SMS message commands, with various functionalities such as pinging for an image and pausing/unpausing notifications. The device is powered by a battery connected with a solar charging system, which removes the need for an external connection to AC grid power.

9:20 am TCNJ Parking Lot Live Web Monitor by Jonathan Brito, Connor Dick, Caleb McKinney and Charles Richardson, advisors Orlando Hernandez and Larry Pearlstein.

The lots at TCNJ are always quite busy. Students, faculty and visitors are constantly having troubles with finding parking spots, especially at certain rush hours of the day or during days where big campus events are taking place. Multiple cars entering a full parking lot and searching for one empty spot increases the likelihood of a fender bender, and ultimately, increases the consumption of gas and time. A solution to this problem is to let users know whether a lot has available parking before entering to reduce traffic flow and gas emission. This can be accomplished by using PIR and ultrasonic sensors to monitor traffic flow and determine remaining parking spots. An ultrasonic sensor detects the presence of an object, while the PIR sensor determines thermal signatures of a car.

Therefore the amount of spots available recorded by this IoT device will be wirelessly transmitted to a user friendly website where the users can select a specific lot to see if it has slots available. Our project values sustainability, which is why our IoT device will be powered by a solar panel responsible for charging a lead acid battery. The circuit for this project shall be done via 4-Layer PCB.

9:50 am Handheld Oscilloscope by Brian Worts, Chris Jenson and Shannon Chapter, Advisor: Dr. Larry Pearlstein.

As a result of the abrupt shift to remote learning in higher education, many engineering courses have had to cut out hands-on learning with electrical hardware in exchange for simulation. To address this problem, this project aimed to create a portable, handheld oscilloscope that could be used by students to conduct hands-on learning with electrical hardware while away from campus. This project utilizes a custom printed circuit board to sample incoming signals, an FPGA to interpret and control data flow, and a microcontroller unit with a touchscreen interface to allow a person to visually interpret data and change control values in the FPGA. Each component presents challenges in various fields of embedded systems such as PCB design, EAGLE CAD, Verilog, hardware interfacing (SPI), and PSoC. Through the team's extensive work, it has been proven that this project serves as both a viable product and a comprehensive learning experience.

10:15 am NB-IoT for the Structural Health Monitoring of Bridges by Erik Hayes, Linh Ngo, Josh Tobia and Sarem Shalforoosh. Advisor: Ambrose Adegbege

The deterioration of bridge infrastructure has become a major global concern within recent history. In general, bridge collapses are mainly the result of natural disasters, poor design and construction, or neglected maintenance. This project focuses on how to better inspect the condition of bridges in order to maintain the health of the aging infrastructures. For structural health monitoring, engineers have been using either a visual inspection method or wired sensor systems, neither of which are adequate nor secure ways to inspect a bridge. This project focuses on developing a wireless sensor network (WSN) using narrowband internet of things (NB-IoT) communication to create an automated system that more accurately assesses damages in a cost effective and proactive manner. The system is designed to be used as universal infrastructure for ensuring the structural health of all types of bridges. It also is designed to run on low power, which is expected to have a system operational life of 5 years between maintenance. The project consists of designing the sensor nodes to collect the data and a central database to analyze and store all the information gathered by the system. This data includes strain data from a strain gauge operating at ultra-low power, and accelerometer data used to capture vibration information as the bridge is loaded. This data would be used to estimate the structural health of the bridge, which can then be uploaded to a web application for the benefit of users.

10:45 am Break

10:55 am Search Online Tutors on Demand by Andre Le, Advisor: Anthony Deese.

In the era of COVID-19, many students are not able to access tutoring resources on campus. Online tutoring resources are decentralized, and it can be difficult to find tutors for specific subjects. The Online Tutors on Demand Web Application will allow students to instantly search and schedule tutoring sessions via Zoom in one place. Tutors can set availability times, and students are able to search for tutors by subject and availability. This application is designed using a progressive app framework to work on both mobile and web browsers and is implemented using Ruby on Rails. It uses a model-view-controller architecture and organizes data through a PostgreSQL database. During this time of uncertainty, students will be able to find the academic help that they need.

11:10 am Photovoltaic Water Purification System by Louis White and Ria Sharma, Advisor: Wudyalew Wondmagegn.

The mission of this project is to create a proptype of a photovoltaic solar water purification system that is functional and able to purify water as required. This system takes DC energy from the sun rays and then converts it to AC energy to have usable energy in order to purify any water, in any area. The first semester goal for our group was to demonstrate the water level sensors that are using the arduino software program. The water level sensors have three specific levels that are indicated by the sensor to determine if the sensor is dry, partially submerged, and fully submerged. The sensors will be implemented in two tanks, which will help us cut off electricity supply to prevent overflow of the system. Then, for the second semester our group's goal is to implement the PV cell and demonstrate the system functioning as a whole to purify the water. Overall, it is important for our team to make this system as efficient as possible for areas that do not have readily available water.

11:30 am Autonomous Drone Package Delivery System by Saad Ahmad, Joshua Annandsingh, Parker Revier and Cedric Noel, Adviser: Dr. Ambrose Adegbege.

Everyday Drones are becoming more prominent. A prime example being Amazon, who has recently begun to implement drone delivery as a component in their business model. The Autonomous Drone Delivery System senior project aims to create an adaptation of the system down-scaled to fit a smaller college campus. Our drone will have the ability to deliver packages with a payload of up to 5 pounds, autonomously navigate the campus from the mail room to it's final destination and back, and provide a web based application for ease of use in requesting a delivery.

12:00 noon Teleoperation of Humanoid Robot via Exoskeleton Control Scheme, by Jordan Sinoway, Brian Dawson, Advisor: Seung-yun Kim.

The goal of this project is to create a novel exoskeleton apparatus that captures the movements of the wearer, and then translates these movements to a humanoid robot, granting approximately real-time teleoperation. The robot utilized for this project is Aldebaran Robotics' Nao, a ⅓ scale humanoid robot. Teleoperation has many practical applications, including hazardous waste disposal, robotics surgery, and tasks in the military, space, sea, and medical sectors. Potentiometers are integrated into the mechanical design at key joints in the wrist, elbow, and shoulder of the exoskeleton. These sensors vary their voltage depending on the joint angle and these values are

passed to the Teensy 3.5 microcontroller via a 13-bit ADC. The microcontroller then converts the data into usable angle measurements and passes them to a Python layer, via a serial data line, which in turn converts the angle measurements into commands the robot can interpret. The embedded code in the microcontroller is written in C++ and the Python intermediary layer utilizes Python 2.7 and the NaoQI SDK to control the robot.

12:20 pm Break

12:30 pm Electric Excursion by Keith Garcia and Nick DePaolis, Advisor: Allen Katz.

Personal transport vehicles have emerged throughout college campuses and urban areas over the past couple of years. These “Micro Vehicles” are used for both recreation and commuting while providing a clean and simple propulsion (or ride) from destination to destination. Our team chose to create an electric skateboard because of storage and weight advantages as well as the ability to modify the individual components to allow for increased customization to a wide variety of user requirements. Using a wireless controller, the rider will have control in the palm of his or her hand; this will provide the electronic speed controller, the brain, with information to determine the speed, braking and power consumption of the board during the trip. Sensors and interchangeable wheel sizes will give the user a custom experience to cater the board according to the terrain. The vehicle’s main components will consist of: a Lithium-Ion battery, electronic speed controller, belt drivetrain configuration and a brushless motor; mainly concealed on the underside of the board. Our team's goal is to create a portable vehicle of lightweight design capable of holding a maximum of 200 lbs and traveling approximately 15 miles, while being able to reach speeds of 12-20 mph.

12:50 am Macro Keypad for Content Creation by Luke Zambella, Advisor: Orlando Hernandez.

This project’s goal was to create a hardware device that interfaces with a PC to provide customizable input via rotary knobs and key switches. The idea was to create a low-cost alternative to current market offerings but still have the features of them. The main feature of this device is its use of rotary knobs that allow for faster repeated input as opposed to repeatedly pressing a switch. This is especially useful for actions such as video tracking, painting brush size, canvas rotation.
The system has a software and hardware portion. The hardware is how the user inputs commands via the twelve key switches and six rotary knobs. The software listens for commands from the hardware and translates into operating system virtual keystroke events. The user can define what button maps to what event. The hardware acts wirelessly over Bluetooth and uses a rechargeable battery for power.

1:05 pm Social Distancing with a Bluetooth Beacon by Dylan Novick and Nick Smith, Adviser: Allen Katz.

Within the modern context of COVID 19, and the social and behavioral restrictions in place to try to mitigate exposure, the need for smart solutions becomes ever more necessary. Our project attempts to, within the application of a high foot traffic business setting, solve the issue of ensuring a safe distance of 6 feet is met, as specified by the

CDC. Using beacon technology as our foundation, our system will use received signal strength indication (RSSI) as a method of reading distance between two interacting devices. Our components involve using the nRF51 DK beacon, capable of RSSI recording with BLE implementation. Using the respective software development kits, the embedded system will perform central and peripheral based tasks to both receive and transmit data simultaneously between established devices. The intention is to alert the user that the perimeter has been breached by using methods of visual and vibration-based indications, in the hopes that safe distance is re-established and exposure is kept to a minimum.

FIRST SEMESTER DESIGN REVIEWS (EFSDR)

1:25 pm Variable Bandpass Filter by Dan Poracki, Adviser: Anthony Deese.

1:40 pm RF Nonlinear Component Analyzer by Krupa Tishbi and Michael Ralea, Advisers Allen Katz and Larry Pearlstine.

1:55 pm Solar Powered Rechargeable Battery by Justin Cruz, Adviser Anthony Deese.