NJIT
New Jersey's Science & Technology University
NEWARK COLLEGE OF ENGINEERING

Senior Design Showcase

A University-Industry Partnership Initiative of the Helen & John C. Hartmann Department of Electrical and Computer Engineering

Wednesday, December 14, 2022
CKB Agile Strategy Lab (NJII L-70)

Sponsored by Brian Kiernan

NJIT New Jersey's Science & Technology University

HELEN and JOHN C. HARTMANN DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

UNIVERSITY HEIGHTS
NEWARK, NJ 07102-1982

Message from the Chair

The mission of the Department of Electrical and Computer Engineering at NJIT is to provide outstanding academic and research experience to students to prepare them to meet the needs and challenges of the 21st Century in electrical and computer engineering. The mission includes providing state-of-the-art interactive education through innovation, cutting-edge research, real-world experience, and promoting industry-university partnerships.

The ECE Department faculty and staff are committed to providing an outstanding educational experience to our students to prepare them for personal and professional achievements. The Department continues to take new synergistic initiatives to bring experts from leading industries in mentoring and advising students for Senior Design projects.

This ECE Senior Design Showcase brings a synergy among students, faculty, and industry experts to help students gain an exciting and valuable experience in engineering project design and management that is closer to real-world situations while attending to budgets, deadlines, teamwork, and professionalism. It further provides industry participants an opportunity to get to know students for future recruiting and enhancement of public relations.

We have been fortunate to have many industry partners and we would like to extend our appreciation to all judges and their strong support for our students and programs.

Sincerely,

Durgamadhab Misra, PhD
Fellow of IEEE & Fellow of ECS
Professor and Department Chair
Helen and John C. Hartmann Department of
Electrical and Computer Engineering

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Senior Design Showcase
December 14, 2022
Program

All program events will take place in the CKB Agile Strategy Lab (NJII L-70)

9:00 a.m. to 9:30 a.m.	Coffee & Light Breakfast
9:30 a.m. to 10:00 a.m.	Projects on Display
10:00 a.m.	Opening Remarks *Moshe Kam, NCE Dean* *Durga Misra, ECE Chair* Project Presentations *Students*
12:00 p.m.	Lunch Showcase Awards Ceremony *Durga Misra, ECE Chair & Judges*

Judges Panel

Ahmed Mousa
Manager – Utility of the Future (UOF)
Futuristic Transmission, Distribution and Distributed Energy Resources (DERs)
Integrated Systems [TD&D]
Electric & Gas Asset Strategy, Asset Management & Centralized Service
Public Service Electric & Gas Company

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LB Electric Company, LLC

Shamoon Siddiqui ('04, 05)
Technology Consultant
Develop.IO

Senior Design Showcase
Presentation Roster

Group #	Presenter(s)	Project Title	Advisor(s)
1	Eric Eltringham (EE))	Automatic String Instrument Tuner	
2	Beck Gozdenovich (COE) Riley Schuster (COE)	Instantaneous Concussion Detector (ICD) for Impact Sports	Dr. Marek Sosnowski
3	Anthony Trentacost (COE) Dhruvi Patel (COE) Michael Zheng (COE) Mohamed Ali(COE)	Fire Fighting Drone	Dr. Marek Sosnowski
4	Fadi Abdulahad (CoE) Matthew Trzepla (CoE) Robert Sanchez (CoE))	Intuitively Programmed Robotic Arm	Dr. Marek Sosnowski
5	Cade Riegler (COE) Clayton Bernardi (EE)	Stovetop Safety Monitor and Emergency Shutoff	Dr. Marek Sosnowski
6	Brandon Knight (EE) Cameron Crosby (COE) Kyle Meth (COE)	Autonomous Mobile Robot for Transportation Tasks	

#1. Automatic String Instrument Tuner

Presented by

Eric Eltringham (EE)

The Automatic String Instrument Tuner is a device that captures the fundamental frequency of an attached string instrument and tunes each of its strings to a desired setpoint frequency via mechanical coupling to a servo motor. The system has several parts that coordinate together to achieve this goal: a piezo transducer that captures the analog signal of the instrument, an amplification and filtering circuit to prepare the signal for processing, a microcontroller which contains software to perform a Fourier transform and send corresponding pulse-train control signals to a motor, and a mechanical coupling component attached to the motor which physically adjusts the tuning pegs. The device is intended to automate the mundane and repetitive chore of tuning an instrument, as well as to minimize the effect of human error in the process through improved accuracy. Furthermore, the device aims to provide the user with the flexibility to determine their own unique frequency setpoints via mobile GUI and Bluetooth connectivity.

The intended user base of this device includes anyone that owns a stringed instrument (guitar, violin, piano, etc). This includes musicians of all levels as well as technicians at instrument repair shops.

After system testing, the device proved to be capable of tuning all six strings of an untuned guitar to a desired frequency range within +/- 1 Hz around a desired setpoint. It currently takes approximately 45 seconds to tune each string (roughly four minutes for a guitar). Further ongoing software refinement is needed to improve consistency of the results, accuracy, and speed.

#2. Instantaneous Concussion Detector (ICD) for Impact Sports

Presented by

Beck Gozdenovich (COE)
Riley Schuster (COE)

Advisor: Dr. Marek Sosnowski, ECE Department

Concussions, head trauma, and CTE have been at the forefront of sports medicine in recent years. While many large organizations, such as the NFL, have been putting millions of dollars in research to protect their players, there is a much larger demographic of youth athletes who do not have access to NFL-grade funding. Our objective is to create an affordable first line of defense against concussions and head trauma in the form of a wearable device that attaches to a player's helmet.

The ICD is a device that monitors the impacts taken to the head by a player and when the player experiences a potentially concussive impact to the head, an alert would be sent to a personal device, such as a phone. This personal device would be held by a trainer or coach that would consistently monitor for alerts throughout the competition or practice. The physical device will have three major components: Arduino Nano 33 BLE (bluetooth low-energy), triple-axis accelerometer, and a rechargeable battery. The device is programmed in ArduinoIDE and MIT AppInventor to read information from the accelerometer and send that to the phone for alerts.

The tests performed on this device provide a proof-of-concept for the ICD, showing that when an arbitrary threshold is reached, the ICD would send a string to the connected device, informing the trainer/coach that a potentially concussive impact has occurred. The ICD can stay connected for close to two hours on a battery charge, and send data over a distance up to 40m.

#3. Fire Fighting Drone

Presented by

Anthony Trentacost (COE)
Dhruvi Patel (COE)
Michael Zheng (COE)
Mohamed Ali(COE)

Advisers: Dr. Marek Sosnowski, ECE Department

According to the National Fire Protection Association, in 2020, the number of on-duty firefighter deaths per year had more than doubled, bringing the total to 140 firefighters. Our objective is to create a drone that would provide the firefighters with the necessary information prior to entering the scene of the fire, giving them a better idea of what to expect.

Our drone carries a payload consisting of two Raspberry Pi Zeros, a camera, a thermal camera, a temperature sensor, a flame sensor, and a smoke detector. The outputs of the sensors are seen in two different ways from a laptop, the regular camera is accessed through a web page, and the rest of the sensors are accessed through VNC Viewer, a remote access software for devices using Linux-based operating systems. Most of the drone's sensors were coded using Python and the Pygame set of modules, which was used to code cleaner-looking user interfaces.

The drone operator on the ground was able to view the outputs of the smoke and flame sensors and the cameras on a laptop screen. Using a scaled down approach to simulating a fire in an open field, we obtained the outputs expected from the drone operating near a large fire. Tests showed that the thermal camera has a range of 23 meters per one meter of fire diameter, similar to the flame sensor.

#4. Intuitively Programmed Robotic Arm

Presented by

Fadi Abdulahad (CoE)
Matthew Trzepla (CoE)
Robert Sanchez (CoE))

Advisor: Dr. Marek Sosnowski, ECE Department

Robotic arms are the most common robotic device used in industrial applications. Their speed and accuracy far outperform any human, but with this efficiency comes a great cost: learning how to program it. The typical methods for programming these cutting-edge devices are rather unintuitive; the most common method uses a bulky teach pendant to set waypoints. Some technicians choose to recreate the working environment in a 3D simulation, rendering every detail down to the dimensions of the work piece. The most modern method is called "teaching by demonstration" but requires the technician to be in direct contact with the work piece, which can be potentially unsafe when working with hazardous materials.

Our method is simple and effective: control the robot with a Bluetooth video game controller and record the robot's motion. The recording can then be played back at a later time at a much higher speed to optimize the operator's slow and careful movement. The software includes some useful features such as rewinding the recording in case a mistake was made, enabling precision mode to move the arm at a much slower speed, and a home button that moves the arm to a set position to increase repeatability. The robot arm is 3D printed and consists of an ESP32 microcontroller with Bluetooth capability, four digital servos with buck converters, an AC power adapter, and a DualShock 4 game controller for the operator's input. The robot arm can lift an object weighing up to 650 g and position it repeatedly within ±2mm.

#5. Stovetop Safety Monitor and Emergency Shutoff

Presented by

Cade Riegler (COE)
Clayton Bernardi (EE)

Advisor: Dr. Marek Sosnowski, ECE Department

Out of every room in the house, the kitchen is the most common place where a fire could start. Statistics show that between 2014 and 2018, 93% of all house fires started in the kitchen or cooking area, and these fires accounted for 92% of all fire-related deaths and 96% of all fire-related injuries. In 2018 alone, there were 170,100 household cooking fires, leading to 540 deaths and a total of 1.2 billion dollars in property damage. Due to the prevalence and severity of house fires in the United States, our team chose to look deeper into this problem in an attempt to try and reduce the number of house fires that occur every year.

The Stovetop Safety Monitor we have created contains a multitude of sensors, including thermal and regular cameras, a temperature and humidity sensor, and an IR fire sensor, that allows it to determine when the stove is being used, if it is left unattended, and if action should be taken in order to reduce the potential for a fire to start by alerting the user, shutting off the stove, or both. The system consists of a device hub containing a Raspberry Pi and its connected sensors, which process information and communicates with a server for data storage, device configuration, and user interfacing through our custom-built web application.

Our testing shows that the system is capable of identifying a wide variety of events with high confidence. The most important of these events are unattended cooking equipment (95% or greater detection confidence), fire detection within 5 seconds (90% or greater), and boil over detection within 1 minute (70% or greater). This device can be marketed to a wide variety of consumers as a safety device and can easily be adapted to suit a commercial kitchen.

#6. Autonomous Mobile Robot for Transportation Tasks

Presented by

Brandon Knight (EE)
Cameron Crosby (COE)
Kyle Meth (COE)

Out of every room in the house, the kitchen is the most common place where a fire could start. Statistics show that between 2014 and 2018, 93% of all house fires started in the kitchen or cooking area, and these fires accounted for 92% of all fire-related deaths and 96% of all fire-related injuries. In 2018 alone, there were 170,100 household cooking fires, leading to 540 deaths and a total of 1.2 billion dollars in property damage. Due to the prevalence and severity of house fires in the United States, our team chose to look deeper into this problem in an attempt to try and reduce the number of house fires that occur every year.

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The Department would like to thank the members of the ECE Industry Advisory Board for their generous dedication and contributions to improving the quality of the ECE academic and research programs.

Brian Kiernan ('70)
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Swatee Singh as Chief Data
and AI Officer
TIAA

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World Class Telecommunications

Rakesh Kabra
Entrepreneur, Investor.

Ahmed Mousa
Manager – Utility of the Future (UOF)
Futuristic Transmission, Distribution and
Distributed Energy Resources (DERs)
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