NJIT New Jersey Institute of Technology | 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 11, 2024
Campus Center Ballrooms

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 11, 2024
Program

All program events will take place in the Campus Center Ballrooms

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*
12:30 p.m.	Lunch Showcase Awards Ceremony *Durga Misra, ECE Chair & Judges*

Judges Panel

Arsalan Gilani ('89)
Vice President, Business Strategy
Smartiply, Inc.

Brian Kiernan ('70)
InterDigital Communications (Ret.)

Carol Benitez (Mendez) ('12)
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Vice President, World Wide Sales
Solid State Cooling Systems

Leon K. Baptiste ('91)
President/CEO
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	Daniel Sarzynski (CoE) Firezghi Araya (CoE) Michael Mittleman (CoE) Mohammad Shaker (CoE)	The SmartPack	Dr. Xuan Liu
2	Abdelrahman Awad (EE) Fred Bonda (CoE) Gustavo Aldas (EE) Ronald Almargo (EE)	Revolve	Dr. Macros Netto Dr. Xuan Liu
3	Christopher Biondi (EE) Dion Sapp (EE) Kevin Morales (EE) Luis Flores (EE)	Solar Power Station (SPS-CDLK)	Dr. Xuan Liu
4	Filip Roth Tronnes-Christensen (CoE) Jakub Klimkowski (CoE) Raul C. Falar (CoE)	M.I.R.O.R - Mirror Integrated Robot for Object Recognition	Dr. Jean Walker-Soler Dr. Xuan Liu
5	Emmanuel Mensah (EE)	Automatic String Tuner	Dr. Xuan Liu
6	Adrian Garcia-Pinoargote (EE) Joseph Hovick (EE) Joshua Barr (EE)	Smart Blinds	Dr. Xuan Liu
7	Alexander Bonfanti (EE) Jonathan Ventura (EE) Paras Jani (EE)	Solar Power Charger with Arduino Overcharge Protection	Dr. Xuan Liu
8	George Ibram CoE)	Smart Mirror	Dr. Xuan Liu
9	Edilson Beco (EE) Jeremy Camey (EE) Victor Melamed (EE)	DC to AC Inverter	Dr. Xuan Liu
10	Erisa Malaj (EE) Louis Handwerker (EE) Mike Wu (EE)	Smart Shopping System	Dr. Xuan Liu

#1. The SmartPack

Presented by

Daniel Sarzynski (CoE)
Firezghi Araya (CoE)
Michael Mittleman (CoE)
Mohammad Shaker (CoE)

Adviser: Dr. Xuan Liu

We propose to develop a self-charging smart travel-pack equipped with GPS and onboard power bank for charging mobile electronic devices. It will consist of four major interworking systems: the energy generation system, battery pack and battery management system (BMS), GPS and Bluetooth-enabled lock, and an affiliated mobile app for tracking the luggage. The device will also employ solar panels to provide independent charging capabilities, in addition to standard A/C outlet charging through USB-c.

The SmartPack aims to provide an additional layer of safety and convenience to all types of travelers and adventurers, including the everyday student or professional.

#2. Revolve

Presented by

Abdelrahman Awad (EE)
Fred Bonda (CoE)
Gustavo Aldas (EE)
Ronald Almargo (EE)

Advisors: Dr. Macros Netto
Dr. Xuan Liu

The people in the Arctic and Antarctic regions face consistent problems with energy generation. Diesel is very expensive due to transportation costs and is extremely polluting. Additionally, traditional renewable energy sources like solar and wind are unpredictable in these harsh climates due to limited daylight and freezing temperatures. To address this gap, we introduce Revolve, a versatile and innovative alternative to conventional green power solutions for extreme environments. Revolve can be kept indoors, making it less affected by harsh conditions compared to wind and solar energy systems. It is a renewable energy system powered by human effort, offering unlimited scalability. Revolve integrates seamlessly with any modern adult bicycle through a simple belt-driven mechanism that powers an attached generator. By combining the efforts of multiple bicycles, users can cooperatively generate power together, promoting a sense of community and teamwork while also encouraging individual health through aerobic exercise, which strengthens the heart, blood vessels, and lungs.

For an enjoyable user experience, Revolve includes a detachable interface that can be mounted on the bicycle. This interface displays real-time data, including WiFi connectivity, fitness tracking, and progress monitoring for individual users with unique login credentials. Key metrics, such as heart rate, maximum RPM, and distance traveled are just a handful of the metrics that are tracked, promoting exercise and encouraging healthy living, even in challenging environments.

#3. Solar Power Station (SPS-CDLK)

Presented by

Christopher Biondi (EE)
Dion Sapp (EE)
Kevin Morales (EE)
Luis Flores (EE)

Advisor: Dr. Xuan Liu

Our project presents a portable, solar-powered power station tailored for versatile off-grid applications, including emergency power backup and remote energy needs. The system is designed to ensure reliable and sustainable energy access, particularly during power outages or in areas without grid connectivity. It combines a 200W solar panel for efficient DC power generation with an AC input (wall outlet) for added versatility. Outputs include a 110V outlet and multiple USB ports (USB-A, USB 3.0, USB-C), accommodating a wide range of devices and appliances.

Key components include an integrated rectifier, inverter, and a high-capacity 10,050 mAh battery, enabling continuous operation. The design prioritizes user convenience, with a compact and space-efficient form factor that simplifies transportation and deployment. By addressing the challenges of accessibility and energy independence, this project aims to provide an innovative solution for emergency preparedness, outdoor activities, and sustainable living. The system underscores the potential of renewable energy technologies in transforming how we access and utilize power.

#4. M.I.R.O.R - Mirror Integrated Robot for Object Recognition

Presented by

Filip Roth Tronnes-Christensen (CoE)
Jakub Klimkowski (CoE)
Raul C. Falar (CoE)

Advisors: Dr. Jean Walker-Soler
Dr. Xuan Liu

Conventional object-tracking systems rely on motorized mounts that demand significant power and torque to operate effectively. M.I.R.O.R. is a sub-millisecond object-tracking system that achieves precise tracking of fast-moving targets using lightweight mirrors. By minimizing torque requirements, it efficiently maneuvers mirrors via stepper motors in a pan-tilt system similar to two-axis galvanometers, eliminating the need for a closed-loop feedback system.

A single-board computer (SBC) integrates all active components and performs complex computations internally. The system employs the open-source library OpenCV for image processing and object detection, generating positional data of the tracked object, which the SBC uses to control motor adjustments.

M.I.R.O.R. is versatile, with applications in sports analytics for ball trajectory tracking, wildlife photography for dynamic animal capture, and defense systems for target tracking and missile interception.

#5. Automatic String Tuner

Presented by

Emmanuel Mensah (EE)

Advisor: Dr. Xuan Liu

Traditional tuning methods can be difficult for beginners and individuals with motor impairments. This project aims to create an affordable, portable automatic string tuner that simplifies tuning for instruments such as guitars, violins, and ukuleles. Using a piezoelectric sensor, the system detects string vibrations, and through analog and digital signal processing, determines the current pitch. A stepper motor adjusts the tuning pegs in real time within a closed-loop system, ensuring precise alignment with the desired pitch.

The design features a user-friendly graphical interface that displays pitch deviation, tuning status, and allows for instrument and string selection, offering an accessible and efficient tuning solution.

#6. Smart Blinds

Presented by

Adrian Garcia-Pinoargote (EE)
Joseph Hovick (EE)
Joshua Barr (EE)

Advisor: Dr. Xuan Liu

We created a smart window blinds system with various functions. The automated system's main function is to open and close blinds depending on light and temperature intensity levels to help cool a house over the day. This action is autonomously completed using temperature and light sensors. It includes an Arduino-based motor system for the blinds, detection methods using sensors, and demonstrates additional capabilities such as being powered by solar energy.

The market for this system would be consumers who are interested in upgrading their homes with a convenient, environmentally-friendly product.

#7. Solar Power Charger with Arduino Overcharge Protection

Presented by

Alexander Bonfanti (EE)
Jonathan Ventura (EE)
Paras Jani (EE)

Advisor: Dr. Xuan Liu

Solar power is everywhere, with the sun being a constant part of our lives, hanging overhead. Every day people can harness the energy that comes from it, using it to power parts of a home or onto a specific machine. An individual can harness that same energy too, to charge an electrical device on the go.

Most popular examples would be hikers, who spend their day in the sun, and with no electrical outlets in nature, the sun is a great alternative. With the app, you can connect to it via a Bluetooth signal that gives the charger information about your battery, as well as manually turning on the charger to charge the phone or turning the charger off to let the internal rechargeable batteries to be charged. It would also automatically turn off when the battery percentage hits 100%.

#8. Smart Mirror

Presented by

George Ibram (CoE)

Adviser: Dr. Xuan Liu

The proposed mirror is a smart mirror that runs through a programmed Raspberry Pi 4. It will be a two-way mirror with an LCD screen attached from behind that will only allow light from the LCD to display different features. These features will be integrated into the system, providing time, weather, calendar, and an option to connect it to Google Assistant.

The target market will be all homeowners, and the Commercial industry (hotels, AIRBNB, public restrooms, malls, etc.) looking for a way to upgrade their Mirrors!

#9. DC to AC Inverter

Presented by

Edilson Beco (EE)
Jeremy Camey (EE)
Victor Melamed (EE)

Advisor: Dr. Xuan Liu

Our device will convert 24 volts of Direct Current (DC) into 12 volts of Alternating Current(AC) by using a microcontroller to drive two pairs of Insulated Gate Bipolar Transistors (IGBTs) and pass their output through a low- pass LC filter.

The controller's software, planned to be written in C, will continuously monitor this output, scaled with a voltage divider to be safely fed into the controller's Analog-to-Digital Converter (ADC), and accordingly adjust the duty cycle of the signal used to drive the transistors.

A potential market for the device's design may be among uninterruptible power supply (UPS) manufacturers for integration in miniature UPSs serving 12-volt devices such as personal computers.

#10. Smart Shopping System

Presented by

Erisa Malaj (EE)
Louis Handwerker (EE)
Mike Wu (EE)

Advisor: Dr. Xuan Liu

The Smart Shopping System is a retrofitting kit designed to seamlessly integrate on to any existing shopping cart, converting it into a "Smart shopping cart." This system features a handle-mounted enclosure that houses the electronics. The enclosure has a 4-inch touch screen so the user can interface with the cart. Additionally, there is a barcode scanner next to the screen and is used to scan items before placing them in the cart. A scale in the basket of the cart ensures the items that are scanned are also the items that are placed in the cart. It also ensures that if a user wants to remove an item, that they remove the correct one. There is also an item lookup feature that shows where items are located in the store. Store owners are able to add product information and store maps on a micro SD card.

The entire system is controlled by an Arduino Mega microcontroller. The battery system is designed to last between 18 and 21 hours, has a recharge time of 3 hours, and can be swapped out for a fully charged battery if needed.

When the user wants to check out, a QR code is generated and a cashier scans it, loading the cart information into the register where they can pay. This product is targeted at supermarkets and retail chains who aim to streamline operations and improve customer satisfaction, offering convenience and efficiency.

ACKNOWLEDGEMENT

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.

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