ELECTRICAL & COMPUTER ENGINEERING
UNIVERSITY of WASHINGTON

ENGINEERING

INNOVATION

ENTREPRENEURSHIP

MESSAGE FROM ***THE CHAIR***

Welcome to the seventh annual ENGineering INnovation and Entrepreneurship (ENGINE) Showcase at UW ECE. It's a delight to invite our industry and campus colleagues to join us as we feature and celebrate the hard work of our students, who will soon be graduating to become the next generation of electrical and computer engineers. This year's Showcase features 48 team projects representing 188 students and covering topics as diverse as digital health, cybersecurity, power systems, machine learning, communications and robotics.

The projects here arise from ENGINE — our engineering entrepreneurial capstone program. ENGINE was created to enable students to work in teams on industry-sponsored projects, and it is the culmination of a student's electrical and computer engineering education. This program, generously endowed by our alums Milton and Delia Zeutschel, is designed to develop students' skills in collaborative system engineering, innovation, entrepreneurship, project management and product development. It is also a way for our industry partners to benefit from the rich innovation culture at UW ECE.

ENGINE was developed in 2015, and with leadership from UW ECE Associate Professor Payman Arabshahi, our associate chair for education and industry liaison, it has grown from just four projects seven years ago to almost 50 this year. Milt has also spent significant time giving feedback and helping to shape the program. In addition, he has mentored our students and given several lectures to them over the years on career development, teamwork, entrepreneurship and leadership.

I wish to extend a special thanks to all our industry sponsors for their generous contributions, as well as their mentorship, flexibility and creativity. I would also like to thank ENGINE Program Director Payman Arabshahi, as well as College of Engineering Industry Capstone Director Jill Kaatz and Associate Director Dorian Varga. Together, they are responsible for establishing and coordinating industry partnerships that support the projects you will see today. Thanks goes as well to our ENGINE teaching assistants, Shruti Misra, Daniel King, Harsha Vardhan and Kelly Ho, for their excellent work and dedication to our students.

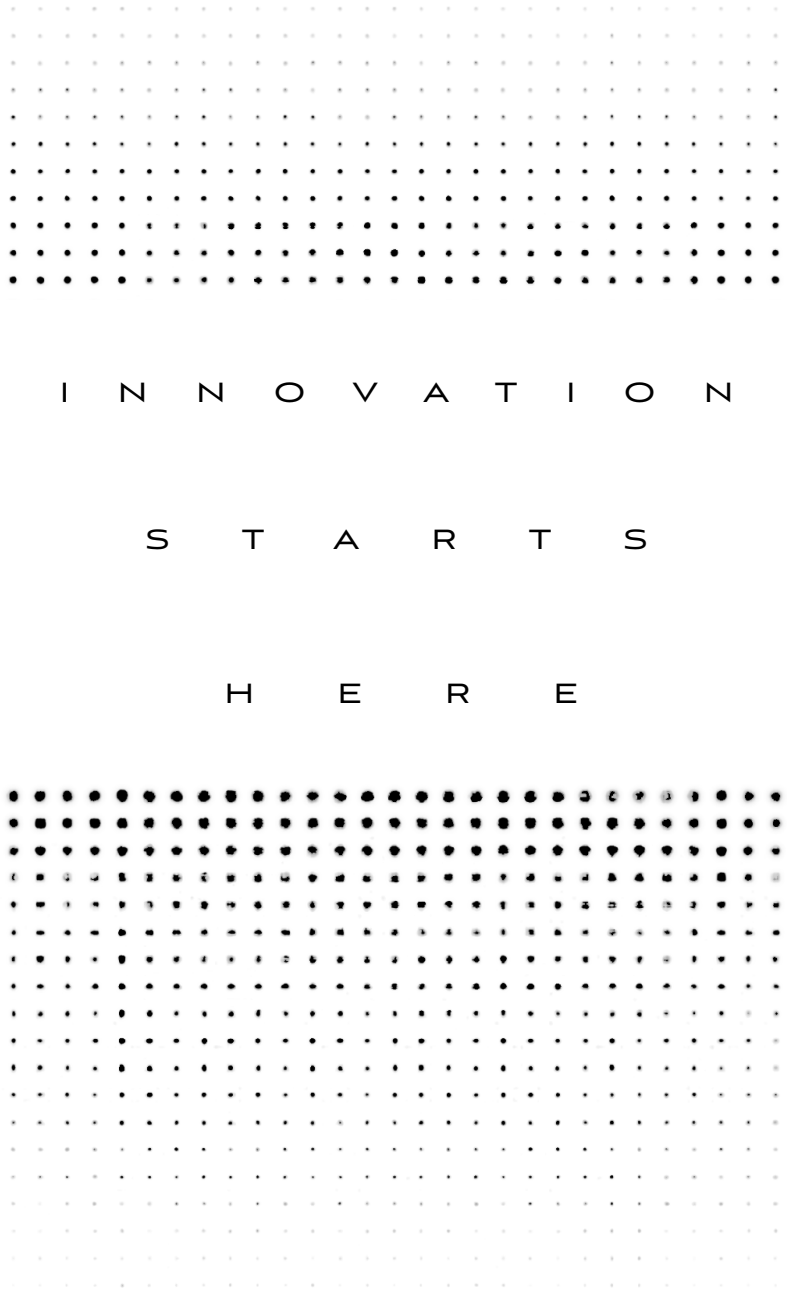
Congratulations to all students on the completion of your final capstone projects! The knowledge you have gained from this experience will serve you well in the coming years. I have no doubt that you will build successful and rewarding careers.

To our industry partners and campus colleagues, I look forward to having the chance to talk with you in-person about future collaborations. Enjoy the ENGINE Showcase!

Best to all,

Eric Klavins

UW ECE Professor and Chair



ENGINE SHOWCASE

2022 PROJECTS

01

Value Engineering

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SPONSOR
JOYLUX

The vFit Gold is a wellness device intended to alleviate the symptoms of menopause. This design team was tasked with adding an array of sensors for enhanced biofeedback to the user. The prototype shows the team's proof of concept in action, with pressure sensors to monitor the improved strength of the pelvic floor muscles, while also tracking and displaying the data through an updated smartphone app.

02

BOM Wire Tracer

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SPONSOR
PACCAR

Harness drawings show the schematic and layout of the electrical wires used in PACCAR's vehicle. Because there are several harness files not within the same system, it requires a lot of hand tracing to analyze the harnesses in the circuit. To solve this issue, this student team, sponsored by PACCAR, is working to design a software that takes in multiple BOM (bill of materials) and fuse map to auto-trace and analyze the risk level of each circuit in the BOM.

03

Web Tool for Testing Environmental Conditions and Procedures for Airborne Equipment

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ZEROAVIA

Aircraft equipment is subjected to a wide range of environmental conditions throughout the products' lifetime. The DO160g is a standard produced by RTCA (Radio Technical Commission for Aeronautics) that defines environmental test procedures and test conditions for aircraft hardware. The student team will develop a software program with a graphic user interface that provides test parameter metrics and test data validation based on specific equipment category and applicable test section.

04

Remote ID Solution for Unmanned Aircraft Systems

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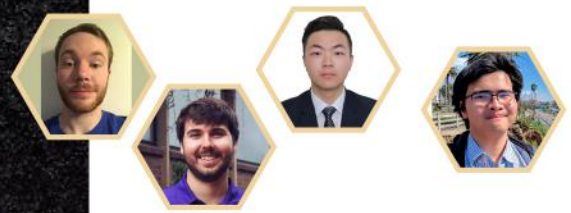
SPONSOR
SAGETECH AVIONICS

Unmanned Aircraft Systems (UAS) are now required to be equipped with a remote ID solution. This is a Bluetooth device that acts as a digital license plate and broadcasts Remote ID messages compliant with ASTM 19 standards. This student team worked to build and test a remote ID transceiver that can be attached to a drone and tracked by an accompanying android application at a range of 2 km.



05

Compact AM Broadcast Band Radiating Antenna

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SPONSOR
PACCAR

This project seeks to design and construct a portable, self supporting, compact radiating antenna that will efficiently cover the AM broadcast band and produce E fields at greater magnitudes than the electrically short dipole antenna currently used. The compact radiating antenna would be used as part of a testing practice utilized at PACCAR to evaluate on-vehicle sources of electromagnetic noise which may interfere with the radio receivers in the vehicle.

06

Automatic Load-pull Tuner

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SPONSOR
ACCESS LASER

This student team will work to build an automated load-pull tuner, a tool used for the RF engineers to characterize new transistors and test the performance of newly designed radio frequency (RF) Power-Amplifiers. The student team will work to design a circuit (delivering the PCBA) with a control firmware and a graphical user interface (GUI) to acquire the required data and save them in the computer. The combination of PCBA, firmware, and GUI will enable RF Engineers to deliver pulses, change the load to the amplifier, and acquire test data from an oscilloscope for their design analysis.

07

Security Attack and Defense Reasoning Framework

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SPONSOR
NUTANIX

The project focused on developing and testing a first-order logic expert system that can use existing knowledge, acquire new knowledge from user inputs, and provide answers to questions using known facts via deduction and explanations to the answers that it provides. This system will be used to model various cybersecurity domains and identify the potential pathways to accessing sensitive data.

08

Mosquito Flight Monitoring: Benchmarking Performance of a Stereo Vision System

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SPONSOR
PHOTONIC SENTRY

Photonic Sentry has developed the Photonic Fence Monitoring Device (PFMD) for entomologists to study the 3D flight behavior of insects with great accuracy. The goal of this capstone project is to benchmark the positional accuracy of the system. The results of this work will help Photonic Sentry develop updates to the software and data processing systems to improve data quality, as well as inform future clients of the limitations of the device.

09

Aircraft Modification Status App

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SPONSOR
HORIZON AIR

The maintenance of aircrafts is an important factor for airlines to have safe flights. Aircraft technicians need to have a consistent and reliable system that is able obtain data about specific aircrafts that they will work. This student team created an app that generates QR codes that take information from Horizon Air's database on aircrafts to be scannable on mobile devices and present aircraft technicians in the field with the information they need to perform aircraft maintenance.

10

Design and Development of a Wireless Mesh Network for Sound Transit Commuter Rail Trains

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SOUND TRANSIT

Sound Transit's current heavy rail commuter trains use carriages that are shuffled regularly to form a consist, but with no network to allow for consist-wide communication the various systems that exist on each carriage. As a result, tracking and finding information about entire consists is very difficult to do efficiently. The goal is to create a prototype of a consist-wide network for these preexisting systems to communicate through, while also allowing carriages to be rearranged and moved to different consists while automatically joining the network of their new consists with no human input.

11

Fluke ADC Testing Platform

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FLUKE CORPORATION

To make the process of testing analog to digital converters (ADC) efficient, our team designed a flexible ADC testing platform that can assess the performance of different ADCs. This system integrates three different hardware elements: PC, microprocessor, and ADC shield. The system provides a friendly user interface, such that users can adjust ADC parameters and interact directly with different ADC shields.

12

Wireless Airway Management System for Emergency Medical Applications

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STRYKER

Capnography is a non-invasive measurement of partial pressure of CO2 from the human airway. Existing capnography devices utilize side-stream technology, which is inconvenient, messy and bulky, and does not provide Emergency Medical Technicians (EMTs) with the most helpful, real-time feedback. We worked to create a portable main-stream capnography device that is capable of measuring End-Tidal CO2 from the exhaled breath of patient, as well as inspiratory and expiratory flow rate and airway pressure so that EMTs can know, real-time, whether they are ventilating a patient properly.

13

Point of Interest Deduplication

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TELENAV

A Point of Interest (POI) is a set of information about a place with details such as title, address, geo coordinates, and category of the place. Telenav has large POI datasets that are used to provide navigation services, however the datasets are at risk for containing complex duplicates of POIs due to data aggregation from various vendors. This team worked to design, develop, and test a Java API library that will be used by Telenav to determine whether two POI objects should be considered duplicates or not.

14

ATS Augmented Installation and Checkout

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SPONSOR
ATS AUTOMATION

ATS is a building automation company that designs and installs control systems that control various systems in a building. The project is an augmented reality application that can assist installers, electricians and field technicians during the installation phase of projects in identifying the incoming and outgoing wires on a building automation system, BAS, or controller.

15

Plugable Multiport USB-C Charger

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SPONSOR
PLUGABLE TECHNOLOGIES

USB-C is widely used these days for fast charging and other capabilities. Taking advantage of this, the project's goal is to design a 5V 4A power supply that charges up to 5 USB-C devices overnight, using Plugable's patented "priority charging" algorithm. This algorithm supports charging the highest priority port at up to 15W, with power dynamically shifting to the lower priority ports as each device completes charging in succession. The project deliverables include a prototype PCB board with fully analog components that follow the patented algorithms and the USB-C Power Delivery protocol.

16

Volansi NextGen Autopilot and Backplane

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SPONSOR
VOLANSI

Volansi logistics drones are currently used to support an initiative that is trying to provide healthcare (vaccines, medicine, etc.) to areas where it is needed most, such as rural areas and natural disaster areas. Current models of Volansi drones are not optimized for drone operators who are not trained engineers and rough operating conditions where heat and vibration are large factors. This student team developed modular backplane and autopilot boards to ease drone repair in the field and ensure the durability of drones in all environments.

17

High Frequency RF Phase Meter

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SPONSOR
UW MEDICAL CENTER

The UW Medical Center Cyclotron accelerates particles using two high frequency RF signals. The phase difference between the signals is a critical parameter in the acceleration inside the cyclotron and the extraction efficiency of the particles. This student team designed, built, and tested a new RF phase meter system which accurately detects this phase difference with improved components to replace an outdated and hard to maintain system while providing thorough and accurate documentation that can be further utilized by the UWMCF staff.

18

Neuropathy Patient Assistant

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NOVO NORDISK

The Neuropathy Patient Assistant App provides a user-friendly dashboard of the patient's glucose levels and their activities. Given that neuropathy patients undergo immense pain in the limbs, the app provides recommendations to alleviate pain in their hands and feet through exercises. The app also provides timely recommendations to patients to maintain a healthy lifestyle and keep their diabetes under control.

19

Real-Time SDR to HDR Up Conversion with Automatic Dynamic Mid-Level Tone

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SPONSOR
REALNETWORKS

Display technology has advanced over the past decade, providing consumers with smart TVs of higher resolution, frame rate, brightness and significantly more vibrant colors (HDR). However, Movies are still captured, encoded and rendered in a format that doesn't take advantage of colors available (SDR). This project aims to solve the problem of SDR to HDR conversion using a mix of color theory and AI rather than brute force machine learning only.

20

Wireless Blood Oxygenation Sensor III

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STRYKER

Wireless blood oximeter could measure the user's SpO2, SpCO and SpMET and transfer the data wirelessly to user's laptop. Because of this wireless design, we could make the oximeter more compact and portable. This team will continue the last year team's work to fix any issues and build a functional version product.

21

Data Insights Engine Tool

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NOVO NORDISK

Novo Nordisk is working to create a data insights engine that allows Novo Nordisk to incorporate predictive and prescriptive insights into their innovation process. Our team is working to design and create the UI/UX for this tool for internal Novo Nordisk teams to interact with the data, identify and understand previously undefined personas that can then be provided with novel and innovative healthcare solutions.

22

Intertidal Sensor Array for Monitoring Ocean Change Stressors in Oyster Farms

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SPONSOR
NOAA

This student team worked to develop an intertidal sensor array and remote data management system that could be deployed and used by shellfish growers, informing farmers of appropriate management strategies through measurement and analysis of water quality parameters such as pH and temperature. This sensor array integrates data management, battery power, and wireless communication in a robust package using off-the-shelf components, designed to function in harsh environments.

23

Ultrasonic Transducer System for Ice Melt Probe

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SPONSOR
UW APPLIED PHYSICS LABORATORY (APL)

The University of Washington Applied Physics Laboratory has been developing an ice melt probe to study subglacial lakes up to five kilometers beneath the surface of the ice. One limiting factor in the depth that the probe can reach is a lack of telemetry. Our goal is to design a system that uses ultrasonic acoustic pulses to measure the thickness of meltwater that forms around the probe as it makes its descent.

24

UW Human Powered Submarine (HPS) Autopilot Project - Test Phase 1

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SPONSORS
BOOZ ALLEN
UW APL

This student team built on the development of the prototype Autopilot module and developed a validation and verification test regimen and conducted bench testing in the simulated environment with the goal of providing the UW Human Powered Submarine (HPS) team with a fully bench-tested working prototype of the Autopilot module for incorporation into the current HPS design. The objective of the validation and verification testing is to ensure the autopilot sensor can tolerate off-axis installation in the actual vehicle and can tune control surface outputs based on actual control surface deflection areas and lever arms off the vehicle center of rotation.

25

Video Facial Recognition (Speed Matters)

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REALNETWORKS

Current Facial Recognition (FR) evaluations performed by NIST uses still photos, not from video. However, successive frames of a video stream can provide a single context of an individual's presence such that consecutive recognitions of the same individual could be made with increasing confidence. This project aims to redefine FR accuracy for real-time video and evaluate the hypothesis that accuracy compounds with successive frames of a live video feed or develop an alternate formula.

26

Energy Efficient Wireless Systems and Sustainability

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SPONSOR
AMAZON

Sustainability has become a key factor in engineering and design of modern electronics. One of the major contributors of carbon impact is wireless devices, during the production of integrated circuits and usage of wireless communication over the lifecycle of the product. Amazon seeks to reduce the carbon footprint of its products and processes, thus has created this project to research developments in energy-efficient wireless communication and summarize the findings in an extensive report and propose alternative strategies for energy-efficient wireless communication and applications.

27

Using VR to Model and Control Realistic Octopus Experience

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UW CSE

This project seeks to create a virtual reality experience to help increase the user's empathy for octopuses. With guidance from experts, our team is challenged to create an octopus model and implement AI that accurately replicates the behavior patterns of real octopuses. Our work culminates into a sandbox VR experience that highlights the functionality of our model and allows the user to experience the environment from the perspective of an octopus.

28

Smart Home Sensor for Diabetic Foot Ulcerations

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NOVO NORDISK

One-third of diabetics will experience diabetic foot ulcerations (DFUs) which can significantly diminish quality of life and even lead to amputations if not caught early. In order to help reduce the severity of DFUs, the student team has developed a system that uses a combination of sensors and a deep learning model to analyze the data and foot images. This information has all been incorporated into a smartphone app where the user can take daily surveys to evaluate the status of their feet, view past records of their feet, and receive recommendations for a course of action.

29

Quantifying Bias in AI: Detecting Bias Along the Machine-Learning Pipeline

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REALNETWORKS

While there are significant concerns around algorithmic bias in AI, this project aims to move the conversation along by objectively defining and quantifying bias. Our first goal was to define bias, specifically in facial recognition AI models. Secondly, our team created four different testing tools to measure the level of bias present in a training dataset and the resulting model once it is trained.

30

Intelligent Data Wizard

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SPONSOR
NINTEX

Nintex is building the next generation of the low and no-code intelligent platform to help companies in storing and managing their data. Our project aims to extend the existing Nintex platform by enabling customers to generate schemas capable of a wide range of data type conversion. We achieve this by building an intelligent data advisor with a universal intermediate model, which is more efficient and widely compatible compared to regular format converters.

31

OAK-D Drone Landing

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INSITU

The OAK-D Drone Landing project uses the capabilities of AI technology to help guide and land a UAV. In this project, the team has explored the application of DepthAI and object detection to recognize and guide a drone to land on a platform. The purpose of this project is to model a multirotor VTOL vehicle landing on a moving ship with the use of an AI camera.

32

Robotic Arm for Automating Tester Connection

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PACCAR

Robotic automation is a flourishing process that PACCAR wants to add to its Manufacturing Support Team. An automatic solution will free up test operators to use their time more efficiently and reduce the time required to test each dash, saving time and money for the plant and the company. Our team worked to incorporate a Kawasaki robotic arm capable of accurately connecting a plate containing multiple cable connectors to the plugs of the rear of a semi-truck dashboard.

33

Intelligent Interfaces for Remote Collaboration in VR

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SPONSOR
MOONBEAM

Moonbeam uses virtual reality and artificial intelligence to transform the future of remote creative collaboration. They build tools to help corporate innovation groups work more effectively with startups without the constraints of geography. Through this capstone, this student team worked to develop features leveraging conversational intelligence AI in order to support remote collaboration within VR.

34

ML Performance Drift Detection and Correction with Time Series and Active Learning

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SPONSOR
TUPL

ML models drift and show degradation in performance as the real-world data change over time. Therefore, these models need to be retrained with new data that reflects the new reality of the process. The students implemented an ML Drift Detection module to automate detecting and measuring drift, and an Active Learning module to retrain the model using new data in an effective way. The project is implemented as a microservices REST backend with an interactive UI for the user to input necessary parameters and to show the vital parameters of the ML model.

35

Degree Progress: Web app for Student Degree Planning

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UW ECE

This student team worked to design and develop a web based tool to simplify the degree planning process for undergraduate students. The application demonstrated a comprehensive list of degree requirements and career paths to make it simple for students to plan courses for future terms. Open-source technologies NGINX, Django, HTML, CSS were used to build and deployed the website.

36

Low-cost Perception System and Remote Management of an Autonomous Wheelchair

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CYBERWORKS ROBOTICS

Autonomous Wheelchairs increase freedom and ease of mobility for the most vulnerable peoples in society. This student group integrates sensors and develops a perception system for autonomous, campus-wide navigation, with the goal of reducing reliance on LiDAR based SLAM. The project also focuses on integrating system fault detection and a remote wheelchair management system into the Cyberworks Autonomous Navigation stack.

37

Autonomous Exploration through Heterogeneous Robotic Collaboration

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SPONSOR
NASA JPL

In this project, students are developing and demonstrating software algorithms capable of supporting collaborative heterogeneous multi-agent autonomous exploration of Mars' physical environment. The students' proposed system comprises one drone and one rover. While the drone can provide a broader view of the area, the rover can complement with detailed information for a smaller surrounding area. With each robot free to move independently, together they can perform distributed measurements that would be nearly impossible for a single robot to achieve.

38

Image Quality Control for Coupang Catalog

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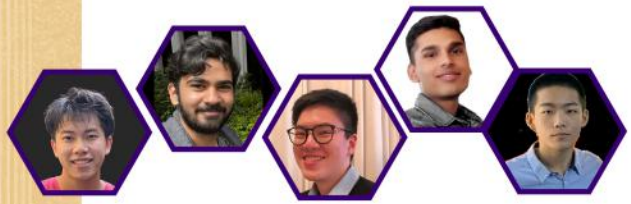
SPONSOR
COUPANG

Coupang is an international e-commerce platform that hosts billions of sellable items. Currently, human operators are performing quality control on only a small number of seller listings. But this process can not be scaled as the business grows rapidly. This team worked to create scalable models to improve image quality control for the Coupang marketplace. The objectives include detection of unwanted elements and image super resolution.



39

Rise of Web-based Computing Trend on the Client

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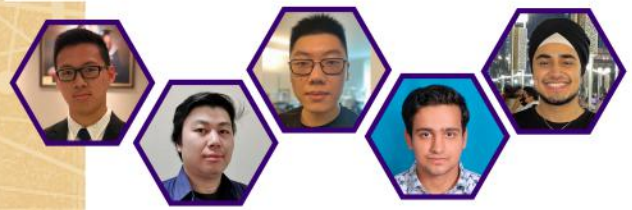
INTEL

Data of user activity and trends can help in improving future CPU development. We studied and compared the trends of native apps vs. web-based apps and the impact of client resource utilization based on user-web activity interaction matrix. It included looking into "(i) "progressive web apps", (ii) "hybrid web apps", and (iii) "pure web apps". We also analyzed the correlation of above trends in relation to processor metrics such as page faults, power consumption, browser and parent category usages, etc.



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Wireless Broadband Service Quality Prediction App

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T-MOBILE

This student team worked to design and test a system comprised of a simple, customer "do-it-yourself" tool embodied as an Android App. This app reads low and FDD mid-band signal quality being experienced in the home and, using an ML-based model, predicts service quality for the higher TDD mid-bands. Through this, the app can tell the internet speed the customer can expect from the T-Mobile Home Device before subscribing to it.

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Wyze Places: Android and iOS Apps for New Smart Home Interactions

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WYZE

Powered by Wyze — the Kirkland-based tech start-up specializing in innovative and accessible smart home products — the Wyze Places project presents a new alternative to smart home applications' conventional list-based depiction of devices. Instead, Wyze Places' map interface gives users a visual understanding of device locations and statuses within a space, providing visual context for improved usability. Through the design, development, and testing of both Android and iOS mobile applications, Wyze Places enables the enhancement of smart home user experiences and device interactions within the Internet of Things.

42

AI Video Captioning

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AI Video Captioning is a project that focuses on exploring technical solutions of video captioning for indoor home scenarios, video content understanding by bridging visual and language information and leveraging video data to generate captions to describe the semantic content in video recordings. The team worked to do in-depth research on academia-leading solutions on video captioning and apply state-of-the-art methods to build machine learning models to generate descriptions on Wyze device captured videos. The model and software developed will be used to create meaningful captions that help users monitor their daily events and identify situations that need their attention.

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JetRacer Soccer League

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LOCKHEED MARTIN

This student team sought to build a customizable soccer arena and four 10th scale RC cars, starting from the NVIDIA self-driving JetRacer design, which utilize artificial intelligence to play soccer competitively in the designed field.

44

Fine-Grain Object Recognition Using Wyze Cam

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Network cameras are used widely in both consumer and industrial applications, and some advanced features like Machine Learning tagging can help provide insights into the video streams. However, the current content-based tagging solutions can only generate high-level labels like a car, person, or pet instead of specific subordinate categories from these high-level labels. This project aims to provide a more informative image tagging solution by investigating the application of fine-grained object recognition for dog breeds in network cameras.

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Maker Robots for Autonomous Network Robot Systems Development

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NASA JPL

NASA's Cooperative Autonomous Distributed Robotic Explorers (CADRE) project is developing a network of mobile robots with the goal of cooperative autonomous exploration of the Moon, Mars, and beyond. Through the system design and collaboration of electrical hardware and robotics perceptions, the NASA JPL undergraduate team designed, built, and integrated a platform of software and devices in the form of an Open-Source Rover. The rover actively provides real-time data from an Inertial Measurement Unit (IMU), GPS, RealSense Camera, and wheel speed sensors using Wi-Fi to store valuable information and navigate autonomously.

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Synthetic Network for the Alaska "RailBelt" Electric Power System

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ALASKAN CENTER FOR ENERGY AND POWER

The student team designed a detailed synthetic electric grid model for combined transmission and distribution systems for the Alaska Railbelt Cooperative. Due to Alaska's extreme climate, this model would need to take into account the seasonality of power usage. This model will be used to represent load and generation data for seasonable and futuristic scenarios.

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Analysis of Bus Dwelling Time Pattern in King County

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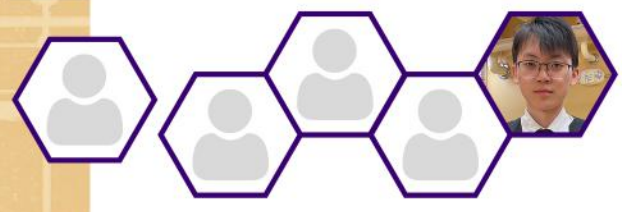
KING COUNTY METRO

Optimizing dwelling and idling times of King County Metro buses reduces operational costs, minimizes air pollutants in Greater Seattle Area, and improves environmental sustainability. The student team performs the analysis, estimation, and visualization of the bus dwelling time pattern from March 2019 to February 2022 using various statistical techniques which gives an insight into routes having high dwelling times. This assists King County Metro in route planning, and transition to electric buses.



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Airframe Health Monitoring System

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AMAZON PRIME AIR

This student team worked to design a system to determine unmanned aerial systems (UAS) airframe health, predict maintenance intervals, and diagnose off nominal airframe behavior. The project was broken into three parts: examine the existing sensing capability of a drone to determine potential benefits of health monitoring, explore additional sensing capabilities and the added capability of a monitoring system, and down-select and develop a system capable of tracking the performance of an airframe component through one lifecycle.

NOTES

2022 ENGINEERING INNOVATION ENTREPRENEURSHIP

ELECTRICAL & COMPUTER ENGINEERING

UNIVERSITY of WASHINGTON

program design: Ryan Hoover