ENGINE Pitch Day

UW ECE Innovation & Entrepreneurship Program

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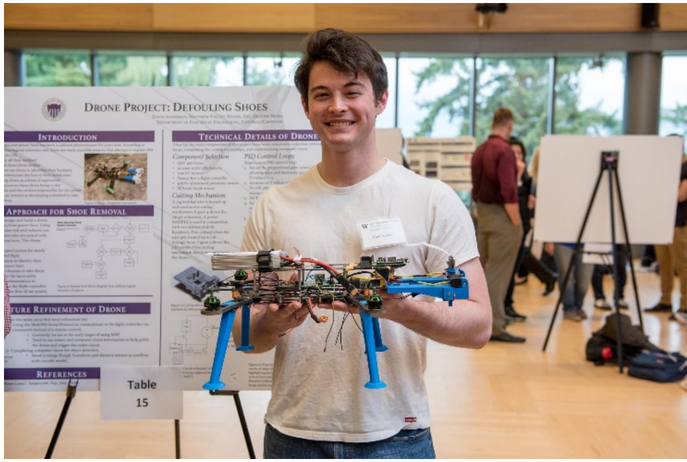
Eric Klavins

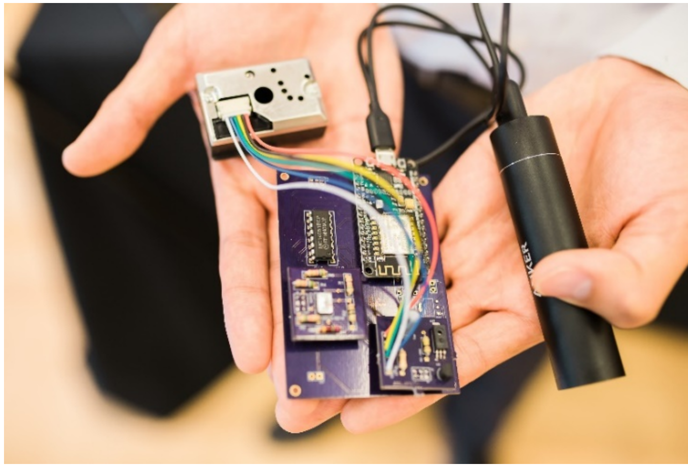
ECE Professor and Chair

ELECTRICAL & COMPUTER ENGINEERING

Engineering Entrepreneurial Capstone (ENGINE)

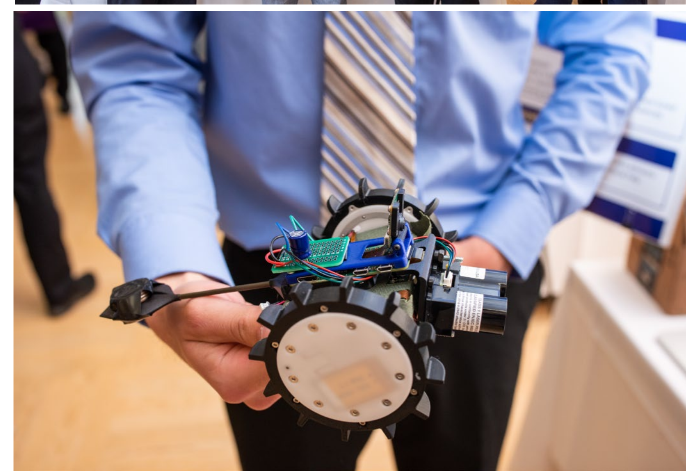
- 3-4 person student teams work with UW faculty and industry mentors on industry-sponsored projects over two quarters, 1,100 – 1,500 hours per project.
- $15,000 project fee (for sponsors/companies).
- 130+ students; 40+ projects per year; cross-departmental across the College of Engineering.
- Superb breadth of projects, from machine learning/AI to genomics, robotics, energy, sensing, networks, security, and more.
- Example sponsors: Uber, Oculus, Intel, Amazon, Microsoft, Alaska Airlines, Fluke, NOAA, NASA JPL, US Navy, BMW, Axon, T-Mobile, Booz Allen Hamilton, Boeing, Airbus, Lockheed Martin, Offerup, Volvo, Paccar, Stryker, and many local startups.





Engineering Entrepreneurial Capstone (ENGINE)

What will you do and learn?



- Deliver design projects to success from start to finish.
- Work in multidisciplinary teams, learn project management, ethics, oral and written communication, design reviews, risk and liability, intellectual property, cost and economics, regulatory compliance, societal impact, environmental impact.
- Work on projects using industry best practices and industry tools (from project management and reviews to cloud computing and sourcing manufacturing).
- Direct industry mentoring on projects + Direct faculty advising on projects.
- Poster presentation event at annual ENGINE Day in June; Design awards.
  - *https://ece.uw.edu/ENGINE*
  - *https://engr.washington.edu/industry/capstone*

Engineering Entrepreneurial Capstone (ENGINE)

Timeline

- **EE 496 / 598**, Fall: 2 credit course on systems engineering, patents and IP, project management
  - Recommended course – not a prerequisite.
  - Companies present projects to class (Nov. 10).
  - Students submit resumes/transcripts and fill out a technical questionnaire (Nov. 17).
  - Teams and projects are assigned (Nov. 30).
  - Teams define scope and vision of projects and produce a requirements document (Dec.).
- **EE 497 + 498 / 598**, Winter and Spring: 4 credits each, project work, design/system integration/operational readiness reviews, deliverables.

Engineering Entrepreneurial Capstone (ENGINE)

Projects for 2021-2022

- Mix of industry, non-profit, government, and faculty led projects

A special shout out this year to veterans among our students, faculty, staff, and industry mentors – thank you for your service!

Join us in developing the next generation of engineering leaders!

Data Insights Engine Platform Design

Vanessa Roknic
vnro@novonordisk.com
Novo Nordisk Inc.

Project Description

- Our team is working to create a **data insights engine** that allows NNI to incorporate predictive and prescriptive insights into our innovation process and disruptive solution creation
- The vision is for this tool use clinical, commercial and social determinant data to understand the **patient as a person** to identify and understand previously undefined personas that we can then provide novel and innovative healthcare solutions
- We need your help in defining, designing and developing the optimal UI/UX for such a solution

Desired Outcomes and Deliverables

- Working prototype, end-user platform for our data insights engine
- Solution is accessible from desktop, tablet and smartphone
- Name and branding for tool
- Reporting/visualization output designs

Design Parameters, Scope, & Performance Criteria

- Define breadth of NNI business problems to solve; value to end users; who are the end-users (technical or non-tech)
- Determine how will the insights derived from this tool / solution fit into the broader innovation process
- Provide recommendations for reporting or visualization; the data being used; static or dynamic data; state-based or stateless models; granularity and quality of the data being collected

Extensions and Stretch Goals

- Explore at least one unique use case to develop predictive model combing clinical, commercial and SDoH datasets (use case TBD)

Required Disciplinary Skill Sets

- UI/UX Design
- Wireframing
- Prototyping
- Market research/testing
- Data Engineering/Data Science
- Data analytics

Neuropathy Patient Assistant

John Canevari
jcev@novonordisk.com
Novo Nordisk Inc.

ELECTRICAL & COMPUTER ENGINEERING

Project Description

- Develop a personalized tracking/recommendation tool for people living with diabetic neuropathy that can help them manage their condition
- Device that can measure changes in a persons physical limitations and algorithmically adjust recommendations to their individualized abilities
- Should also be linked to existing device engaged by the consumer to receive outputs (e.g. smart phone/tablet, voice activated devices, etc.)

Desired Outcomes and Deliverables

- Wearable device/s which deliver appropriate data to smartphone application
- Software which displays the appropriately modified information and diagnostic recommendations (personalized to their capability/level of ability) in a usable (accessible - UX standards) visual format (easy to use dashboard and navigation)
- Demonstrated successful real-world use - patients can easily access the wearable devices and smartphone app with the follow-on understanding of the appropriate course of action through the dashboard/interface/bot

Design Parameters, Scope, & Performance Criteria

- Wearable (Smartwatch) integrated (combined input) with smartphone app for measuring key indicators
- Software (algorithm) to translate inputs into recommendations or diagnosis personalized to patient's ability and their specific need - what is the reasonable equivalent of treatment/care each patient can access and act upon
- Interface/dashboard designed to UX and accessibility standards
- **Performance:** ability of the integrated data inputs (wearables, etc.) and smartphone application to capture adequate information and provide, through the interface, an understanding of appropriate (personalized) recommendations.

Extensions and Stretch Goals

- Add-on ability for remote engagement with HCP or care partner
- Add-on ability for e-HR integration

Required Disciplinary Skill Sets

- Accessibility and UCD requirements
- Full suite of wearable and mobile application design (Information Arch, UX, Graphic, Content, Frontend/backend tech development)

Smart Home Sensor for Diabetic Foot Ulcerations (DFUs)

John Canevari
jcev@novonordisk.com
Novo Nordisk Inc.

Project Description

- Develop a sensing and/or visual tool to help patients with difficulty accessing healthcare identify potential established or emerging DFUs
- Sensor linked to backend AI software capabilities to analyze data, determine risk and recommend action/intervention
- Should also be linked to existing device engaged by the consumer to receive outputs (e.g. smart phone/tablet, voice activated devices, etc.)

Desired Outcomes and Deliverables

- Usable/workable sensor and hardware which deliver appropriate data as well as appropriate physical usability
- Middleware (API- software) which completes the translation of data into prognostic/diagnostic understandings
- Software which displays the information for decision making recommendations in a usable (accessible - UX standards) visual manner
- Demonstrated successful real-world use - patients can easily apply/use the sensors as well as understand appropriate course of action through an existing dashboard/interface

Design Parameters, Scope, & Performance Criteria

- Sensors as smartphone plug-in/wearable for measuring muscle activity, plantar pressure and blood-flow, etc.
- Camera to capture images of foot (plantar) - perhaps enhanced PPG sensors
- Software (algorithm) to translate inputs into recommendations or diagnosis
- Appropriate hardware to accommodate sensors, camera, device (e.g. smartphone) for limited physical ability patients
- **Performance:** ability of this tool to capture adequate information and provide an understanding of DFU status for both patient and provider to react to and apply recommended prognosis/treatments.

Extensions and Stretch Goals

- Add-on ability for remote engagement with HCP or care partner
- Add-on ability for e-HR integration

Required Disciplinary Skill Sets

- Accessibility and UCD requirements knowledge
- Mobile application design (Information Arch, UX, Graphic, Content, Frontend/backend tech development)
- Middleware (API) development, programming and backend coding.
- Knowledge of sensor ability and application
- Hardware design - materials design

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ELECTRICAL AND COMPUTER ENGINEERING (ECE)
SENIOR CAPSTONE PROJECT 2021-22

Human Powered Submarine Autopilot Project

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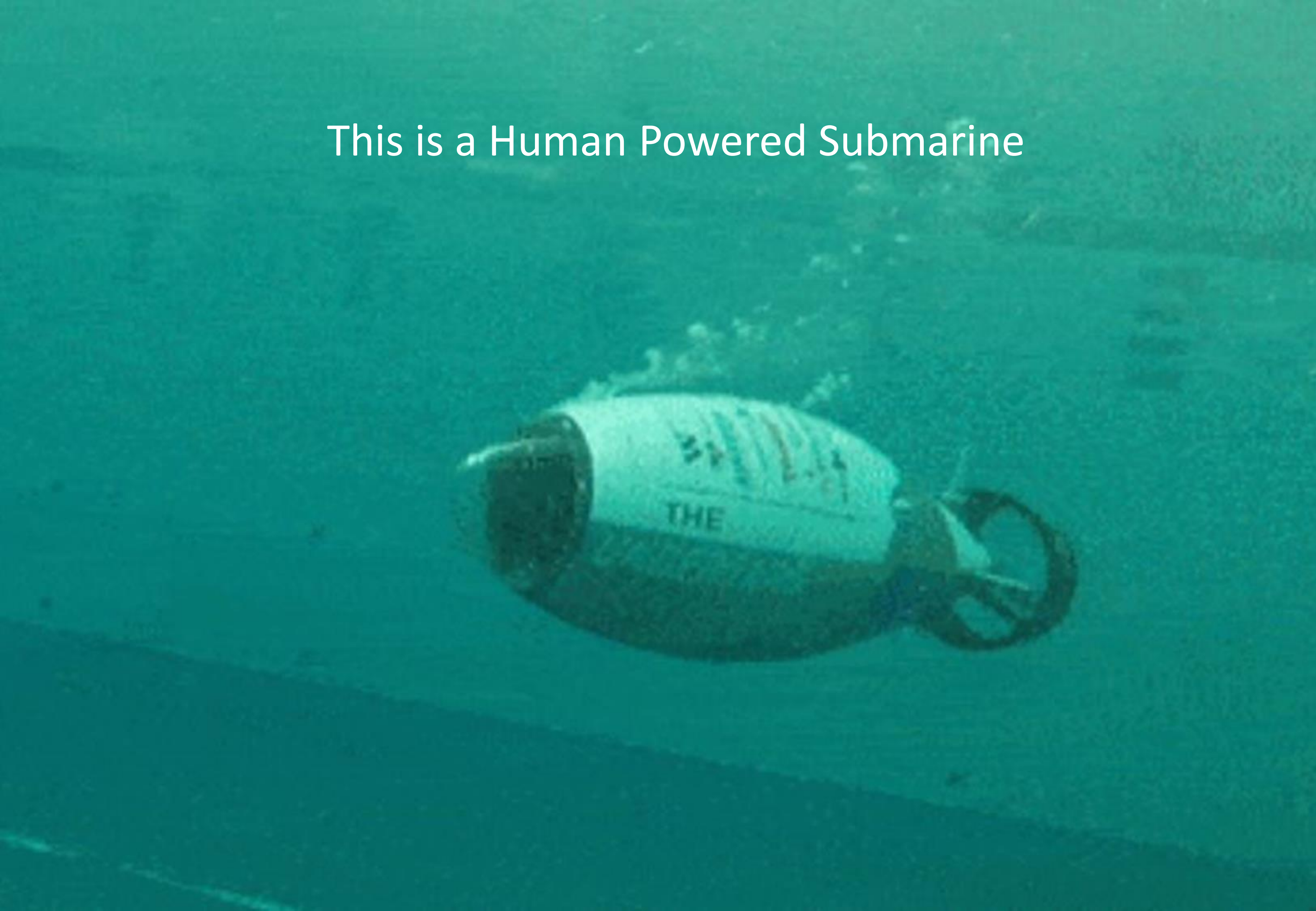
NOVEMBER 2021

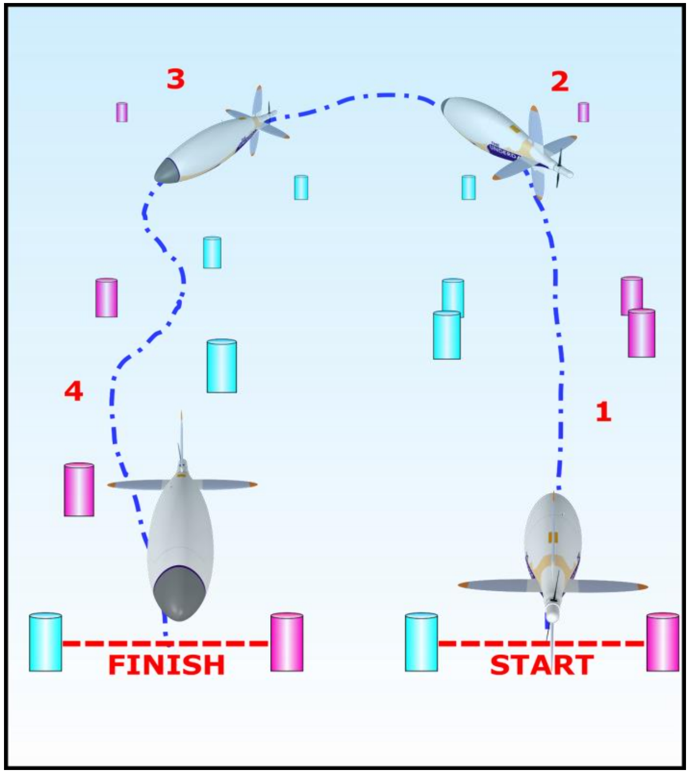

This is a Human Powered Submarine
THE

This is a University of Washington HPS Race Team

PROBLEM: Unintended/Uncontrollable Submarine Roll
GOAL: Autonomous Roll Control - Faster Race Runs

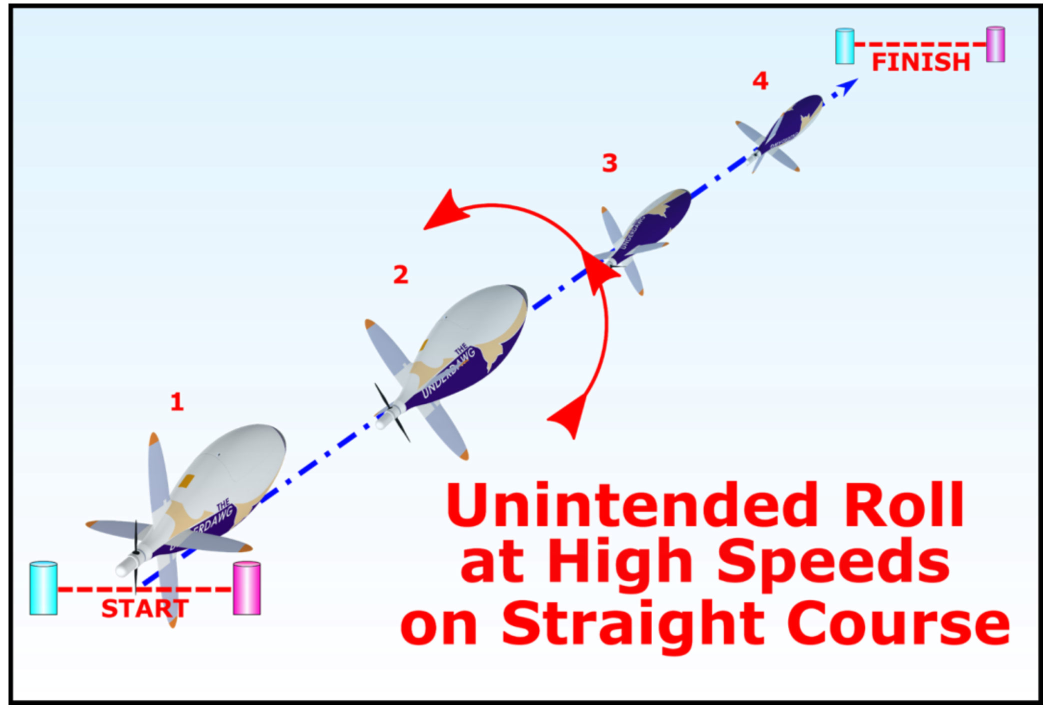
Applied Physics Laboratory
UNIVERSITY of WASHINGTON

European Course



Planned JUN 2022

U.S. Course



Planned JUN 2023

PROGRESS TO DATE - 2021 SUMMARY

Applied Physics Laboratory
UNIVERSITY of WASHINGTON

System Integration Engineering (COMPLETE)

Component selection:
- Pugh matrix for microcontroller and sensor solution that fit CPU, RAM, cost, complexity and dimensional requirements
- Chose Arduino Nano 33 BLE with 9 Degrees of Freedom (DoF) Inertial Measurement Unit (IMU) (*Figure 6*)

Unmanned Maritime Autonomy Architecture:
- Standardized functional framework (*Figure 4*)

Sensor Fusion:
- Accurate roll, pitch, and yaw (*Figure 5*)

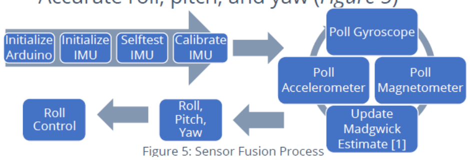


Figure 5: Sensor Fusion Process

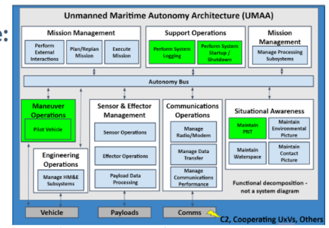
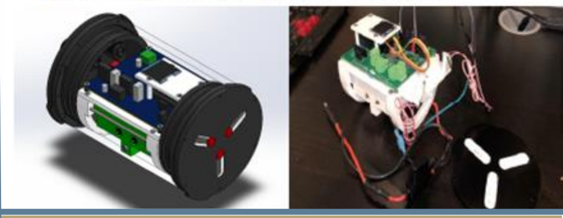


Figure 4: Supported UMAA Functions [2]

Mechanical Design Engineering (COMPLETE)

Waterproof Module:
- Developed & designed final module assembly in Solidworks (*Figure 11* top-left)
- Designed & 3-D printed internal frame and mounting fixtures (*Figure 11* bottom)
- Machined multiple components necessary for physical assembly (*Figure 11* top-right)



Control Engineering (COMPLETE)

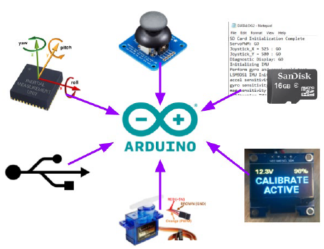


Figure 7: System

Control Modeling:
- Modeled submarine roll equation
- Designed a stable PID Controller (*Figure 8*)
- Validated stability of controller gains

Hardware Implementation:
- Implemented PID controller on an Arduino
- Integrated peripheral components (*Figure 7*)

In Figure 7, above, all components of the design were integrated through Arduino. These include SD diagnostics, internal display, servo PWM, IMU sensor fusion, serial USB diagnostics, and pilot joystick passthrough.

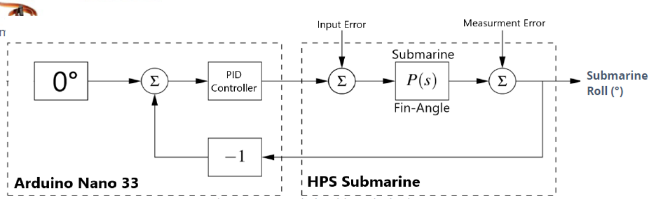


Figure 8: Control Algorithm Block Diagram

Power Engineering (COMPLETE)

- Custom PCB integrates: Arduino microcontroller, 12V DC power source, and autopilot peripherals (*Figure 6*)
- PCB features include: TPS54331 Buck ICs, Safety Fuses, Voltage Monitoring

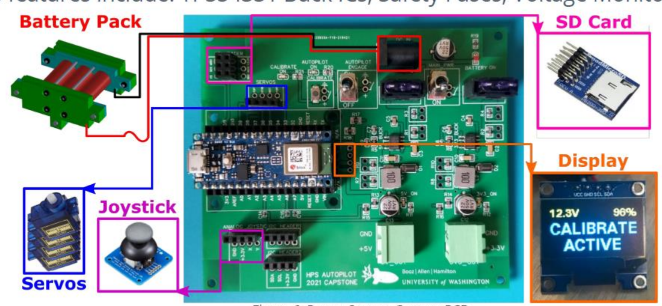


Figure 6: Power System Custom PCB

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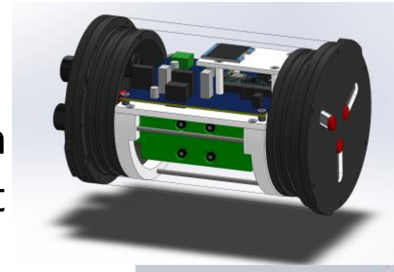
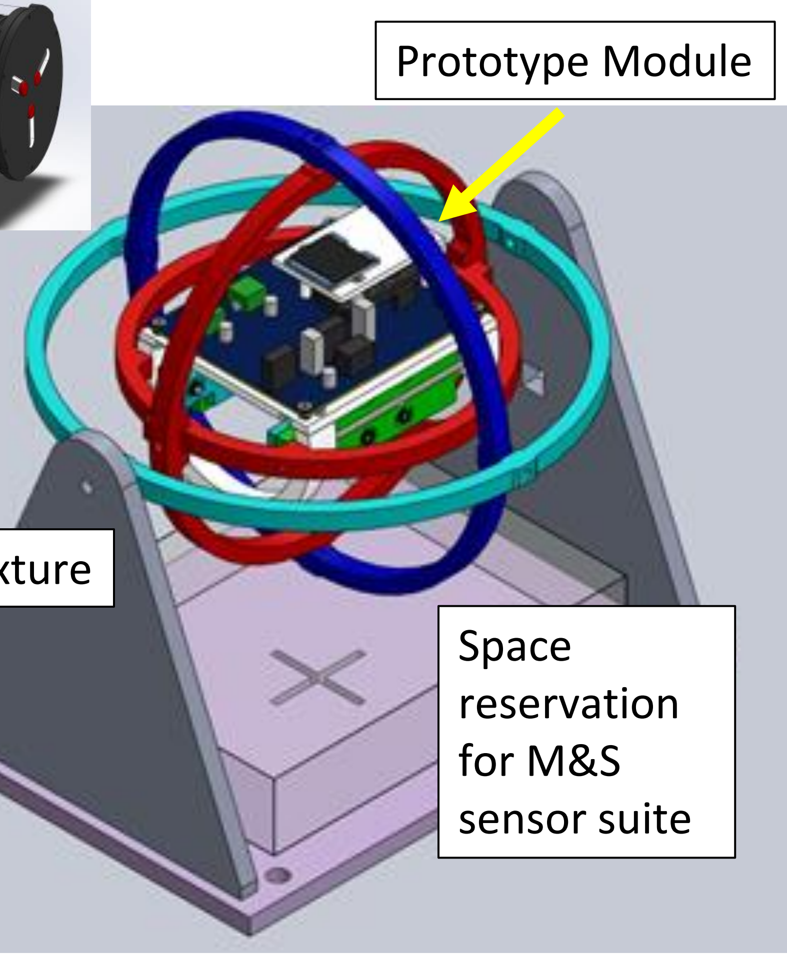
THIS YEAR'S PROJECT - PHASE 3 2022

Applied Physics Laboratory
UNIVERSITY *of* WASHINGTON

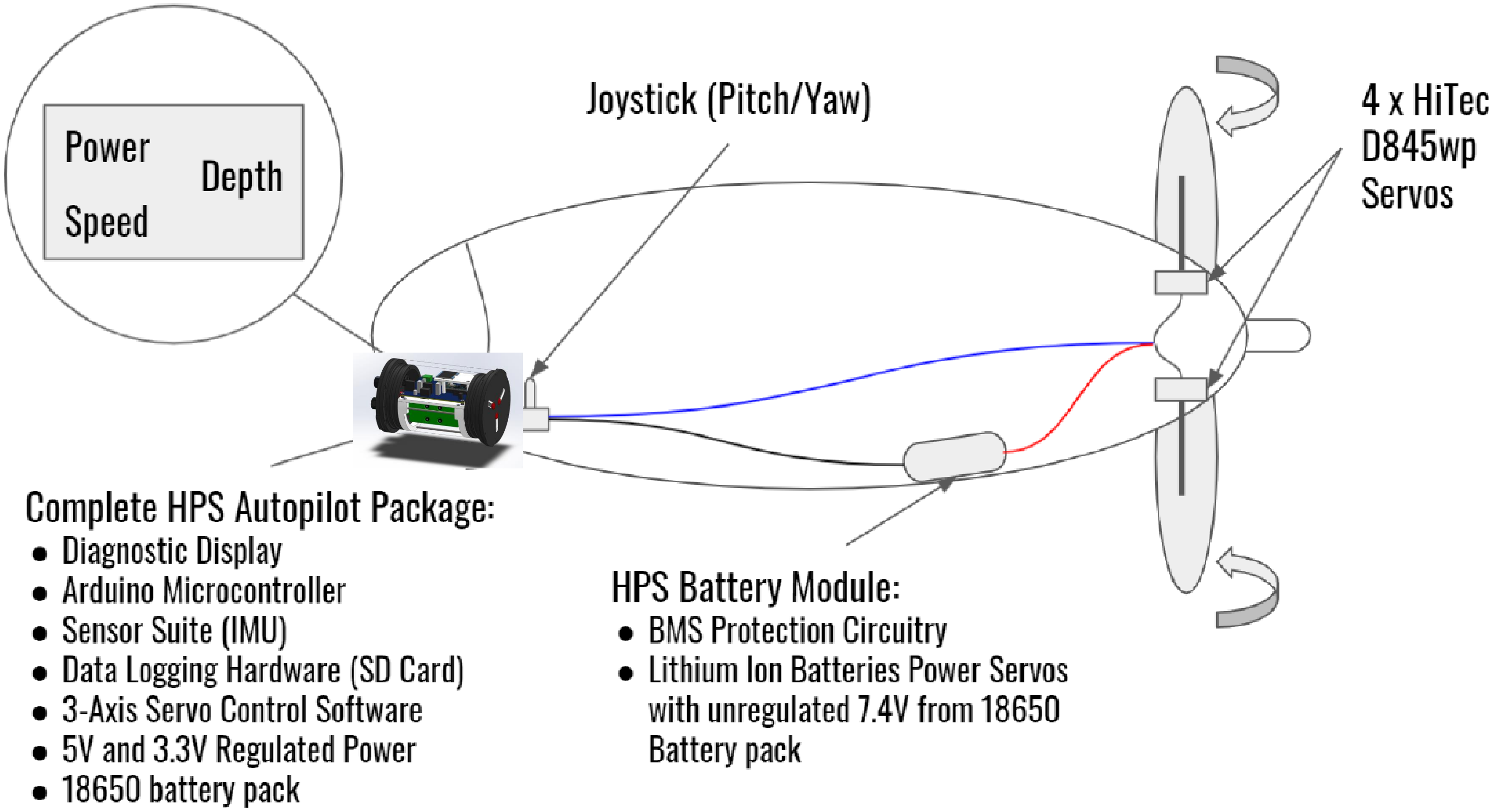
- **Desired Outcomes:**
  - Design Review
  - Test Bed Validation / Verification
  - M&S Environment Development
  - Test Plan Development
  - Test Execution
- **Skillsets to be applied:**
  - Electrical **prototype fabrication** experience including: soldering, mounting, wiring, Software engineering – embedded programing experience (power management and data collection)
  - **System integration** – Test bed and sensor suite for M&S environment
- **Aerospace and Marine Systems Engineering applicability**





GOAL FOR JUNE 2022

Fully Tested and Updated module for HPS integration



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Go Dawgs!
THE

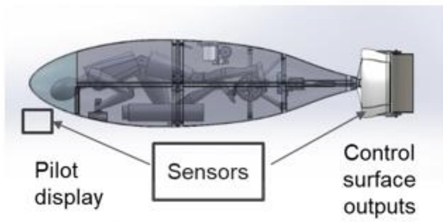
BACKUPS

PROGRESS TO DATE

Applied Physics Laboratory
UNIVERSITY of WASHINGTON

Phase 1 - 2020

Solution Concept Overview

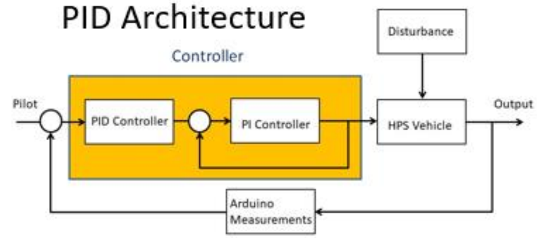


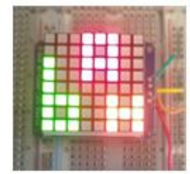

Surrogate Pressure Vessel


Arduino Nano 33 BLE

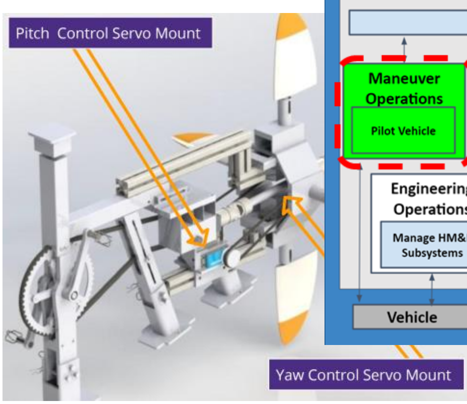
R&D Testbed

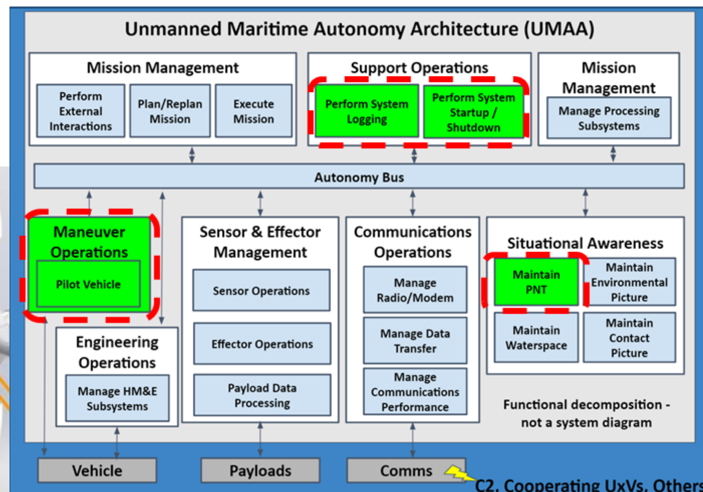
PID Architecture

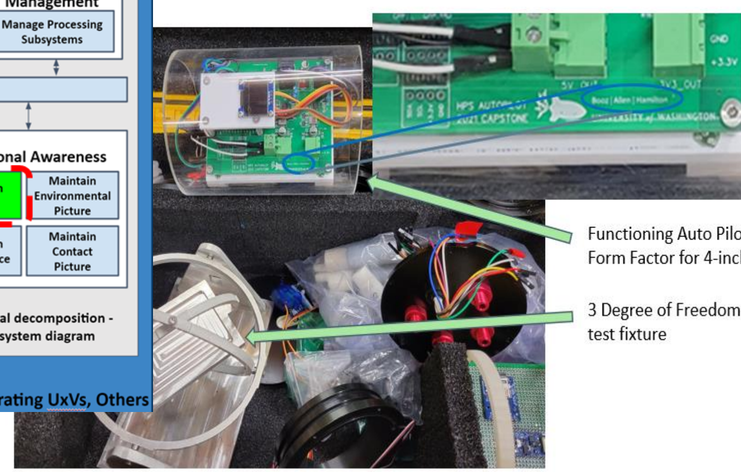



Hardware Demonstration

Phase 2 - 2021







Functioning Auto Pilot Module; Form Factor for 4-inch UUV

3 Degree of Freedom prototype test fixture

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

Rafael Guerrero
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Tupl Inc.

Who We Are

- Startup focused on automation of complex operations for multiple sectors such Telecom, Agriculture and Healthcare
- Offices in North America, Europe and Asia
- Software development using state-of-the-art Big Data technologies
- 6th year sponsor of UW Capstone project
- 6 students got internship offer after Capstone project

Project Description

- **ML Models Drift Detection**
  i.e., detection of a reduction in the prediction power of a ML model
- **Data Science and Engineering**
  - Collection and postprocessing of ML performance metrics
  - Analysis using Time Series techniques
  - Apply ML / Active Learning algorithms to retrain the models
  - Automatic Model Updates
- **Development and Integration**
  - Programming language: Python
  - ML frameworks: scikit-learn, TensorFlow
  - Web API: Flask
  - Visualization framework: React (Facebook)
  - Deployment: Docker / Kubernetes

Desired Outcomes and Deliverables

- Drift Detection and Retraining
  - Automatic Drift Detection Module
  - Retraining module / Active Learning Module
  - Automatic Model Update Module

- Process Visualization
  - Build a simple UI that monitors model performance
  - UI shows baseline performance and current deviation
  - UI shows performance measurement criteria, retraining policies, and new model candidates

Design Parameters, Scope, & Performance Criteria

- System
  - Should give meaningful results
  - Good time/memory performance

- Maintenance:
  - Clean code
  - Clear documentation/report
  - Easy to deploy

Required Disciplinary Skill Sets

- Software Development
  - Any programming experience with Python
  - Basic Git knowledge
- Machine Learning
  - Basic understanding of ML concepts
  - Basic Time Series analysis concepts is a plus
  - Experience with ML frameworks such scikit-learn, TensorFlow is a plus
- System Integration
  - Any experience with REST APIs programming, Microservices, Docker / Kubernetes is a plus

Data Acquisition for RF Amplifier Load Test

V2.2 Pitch, 7MB

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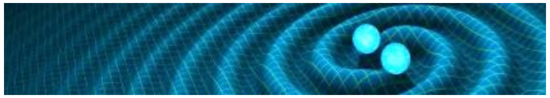
ELECTRICAL & COMPUTER ENGINEERING

ACCESS LASER

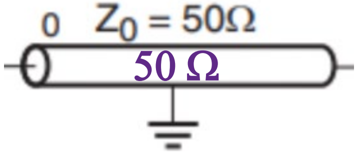
Access Laser Overview 1

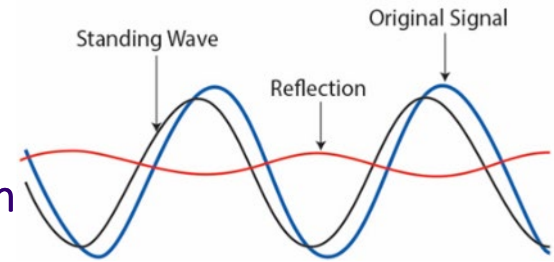
- Years ago, we began as a **small, entrepreneurial company in a garage.** And then Access Laser caught the wave! International companies came to our door. A few more years, and we became part of a **German-owned, global laser company.**

- Nowadays our applications include **medical,** such as CO2 lasers used at dermatology clinics! Includes “IPL” treatments, dentistry, etc.
- Also material ablation, for **PCB’s and semiconductor processing**.
- Our research customers include **the LIGO gravity wave detector.** They could not detect gravity waves, until **Access Lasers were delivered and installed.**

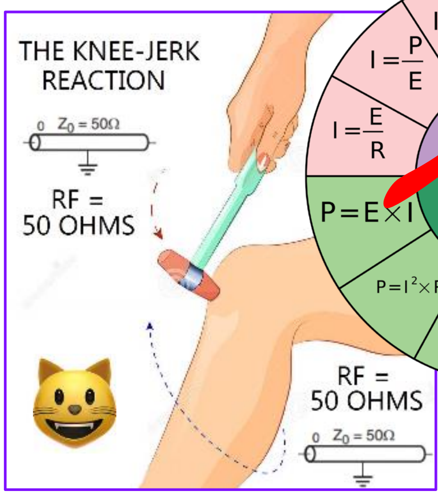


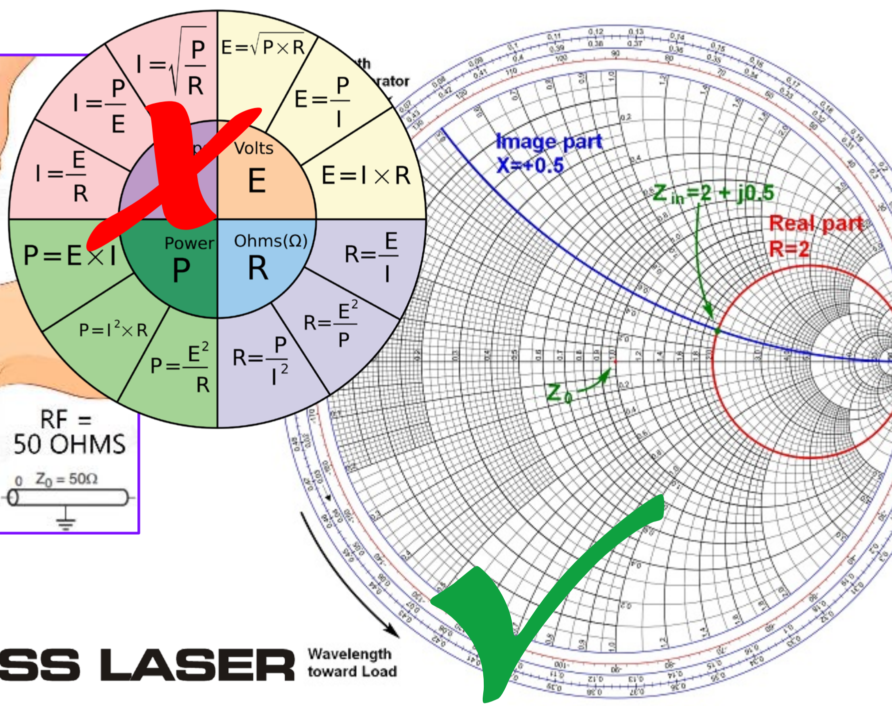
Capstone Project Overview 2





- In the domain of RF Radio Frequency, the **power-signal wavelength is comparable to the cabling and layouts** involved.
- With those effects, **Ohm's law needs a replacement! It's the Smith Chart.**
- As EE's, if we hear "RF", we have a "knee jerk reaction": We think **"RF is 50 ohms".** However, **other loads are probable.** This project helps strengthen your RF talents.
- Some of those other loads, may cause **the RF amplifier to perform poorly, or destroy itself.** If that happens, no more gravity wave detection!

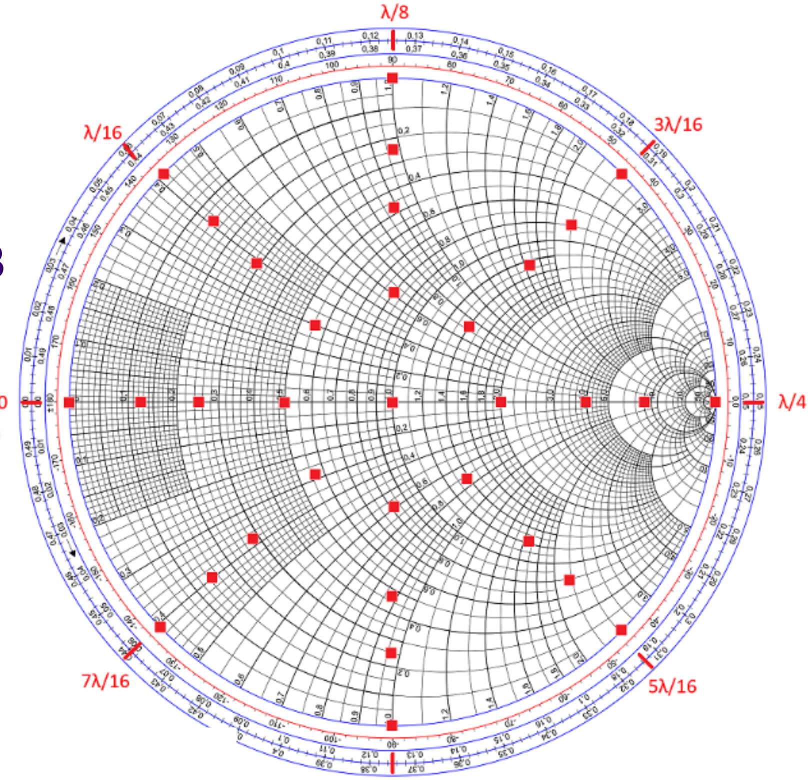




ACCESS LASER

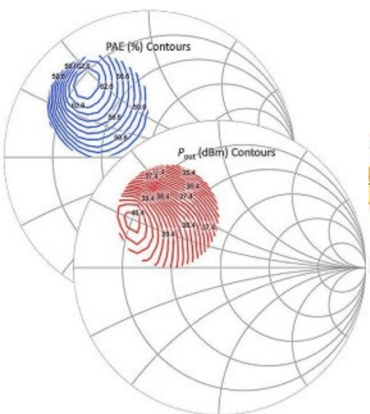
Capstone Project Overview 3

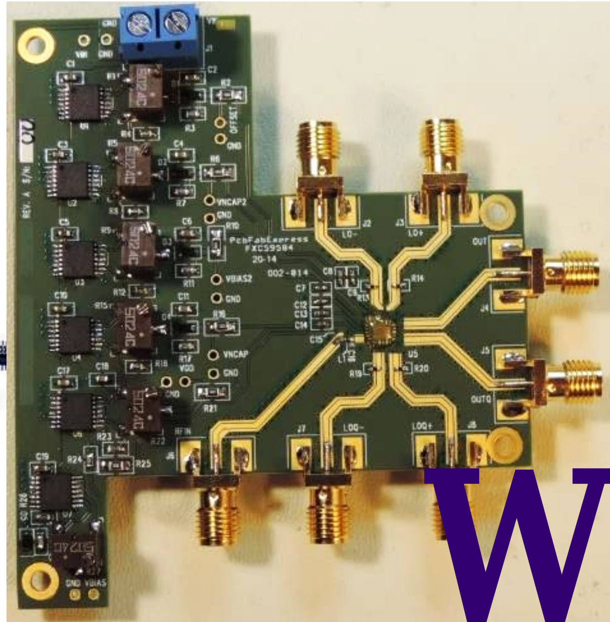
- To attain project goals, Access Laser will guide you through a circuit board design, that will **develop 33 different test points, on a Smith Chart**. These loads are set by **digital bits, driving RF relays:**



33 Impedance Test Points

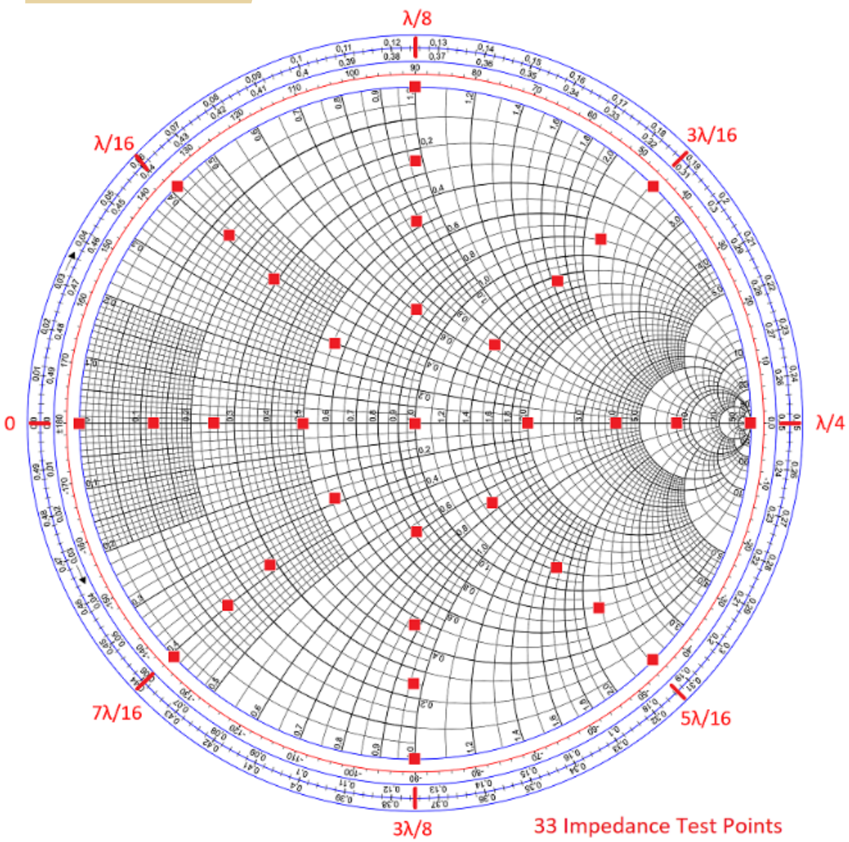
- In the RF world, this **Capstone project is known as a "Load Pull".** That's when RF loading is not 50Ω. Industry recognizes that a non-50Ω load, tends to "pull" the RF amplifier output, into **unpredictable or damaging results.**





- **Purchased Instrumentation can cost up to $250,000** However it's better for Access Laser to **build this, by working with U.W.** (To gain more industry insight, Google "Rohde & Schwarz, load pull test").

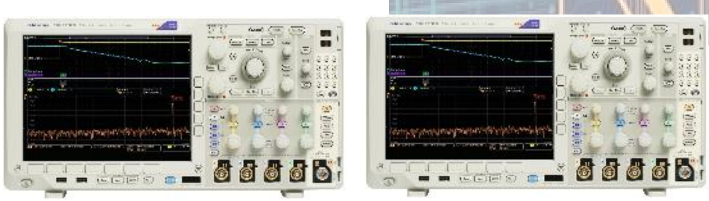
Capstone Project Overview 4



33 Impedance Test Points

- The majority of your project activity, is the Data Acquisition. After setting the RF load with digital bits, the RF amplifier is commanded to pulse. The two triggered 4104 Oscilloscopes, deliver up to 7 channels of data to record. These individual waveforms need to be easily accessed. Simple information such as peak or RMS power, can be displayed by your software, at red data points.

- Along with the fun part (writing the GUI software on desktop PC) the custom-RF-load circuit board must also be developed. When you have questions about the best ways forward, we're here to help.



SUMMARY:

- Will be **used by RF engineers**, to characterize **new RF amplifier prototypes**, in the lab. Typically after changing parts, circuit topology, or RF design to meet **all-new customer applications**.
- **Start out by planning circuit board**, with schematic, parts, layout.

Extensions and Stretch Goals

- **Enhance the GUI** for indicating all possible data files, on-screen (prior test runs).
- **Extra computations,** for best summary of RMS Voltage, Power, Current, at each datapoint.
- Evaluate the performance of the **RF-load circuit board (VSWR matching).** Use network analyzer to demonstrate how accurately the PCB impedance **hits each of the 33 test points**.

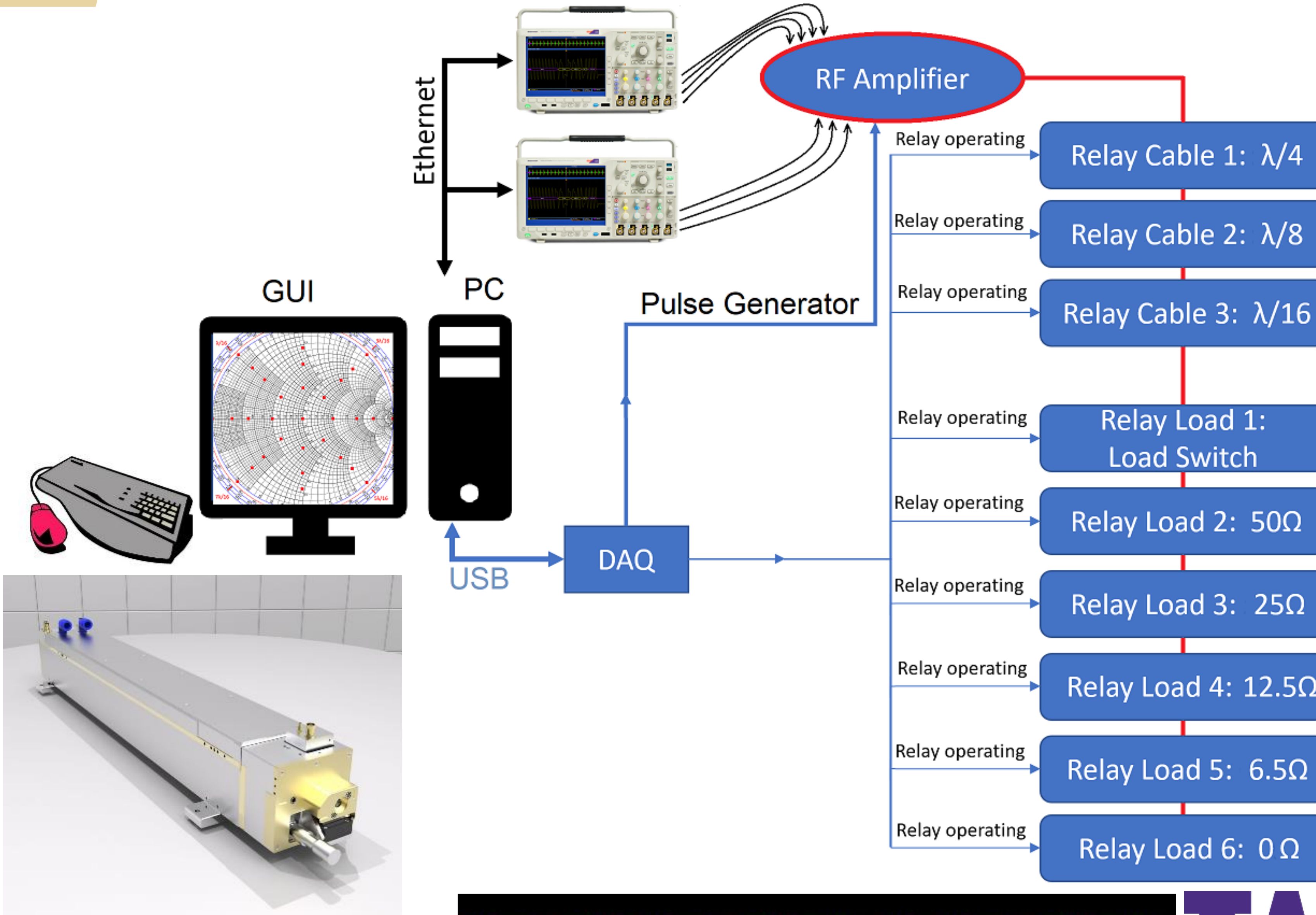
Required Skill Sets (pre-existing or rapidly acquired)

- **Circuit Design** Strengths, especially analog and digital circuit design.
- **CAD skills** for schematic capture, plus Electronic PCB layout (Altium).
- Plan a **GUI software** package, running on desktop PC, for data acquisition, data storage, and to display details about the data acquired. Data-mining techniques.
- **USB and ethernet** communication.
- General **familiarity with SW** setup (for Microsoft desktop PC in an EE environment).

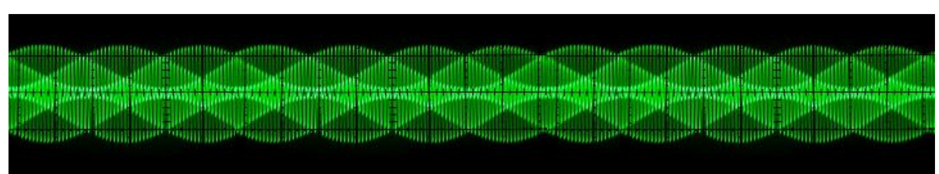
ACCESS LASER

Summary

Thanks to UW EE Department, faculty & students, for looking carefully at our project. For closure, this block diagram helps to visualize the details….



ACCESS LASER



Industrial Strength AI-Based Self-Driving Tech for Mission-Critical Institutional Applications

Vivek Burhanpurkar
CEO, Cyberworks Robotics
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ELECTRICAL & COMPUTER ENGINEERING

Company Video

https://www.youtube.com/watch?v=M4n6WedNzl0

Project Description

- Autonomous Wheelchairs increase freedom and ease of mobility for the most vulnerable peoples in society.
- Large Scale Campus Wide autonomous navigation of a power wheelchair faces numerous corner case confounds ranging from loss of localization due to feature-sparsity to human motion sickness.
- This project aims to identify and address corner cases that allow for robust persistent navigation over vast indoor and outdoor regions within the UW campus and fleet integration to the cloud for remote monitoring, user authentication and over-the-air updates.

Desired Outcomes and Deliverables

- Identification of navigational confounds in a complex large scale indoor/outdoor environment
- AWS Robomaker cloud connectivity, monitoring, authentication and software management
- Monocular Visual Odometry based on Clement, et al and Visual Inertial Odometry
- Human Interfaces GUI
- Graceful robust autonomous wheelchair navigation in large scale real world environments at an affordable price using the Cyberworks Autonomous Navigation Stack (U Michigan papers)

Design Parameters, Scope, and Performance Criteria

- Must be easy to use for lay people
- Should be hardened for mission-critical applications
- Should allow for user recovery in failure situations (user regains manual control of the chair)

Required Disciplinary Skill Sets

- ROS
- Gazebo Simulator
- VSLAM (Cartographer)
- Python QT
- C++
- Kalman Filter (UKF)

Specific Project Scope and Deliverables may be adjusted/customized based on ***each*** Student's level of competency (or lack of) in the above disciplines

Rise of Web-based Client-Computing Trend

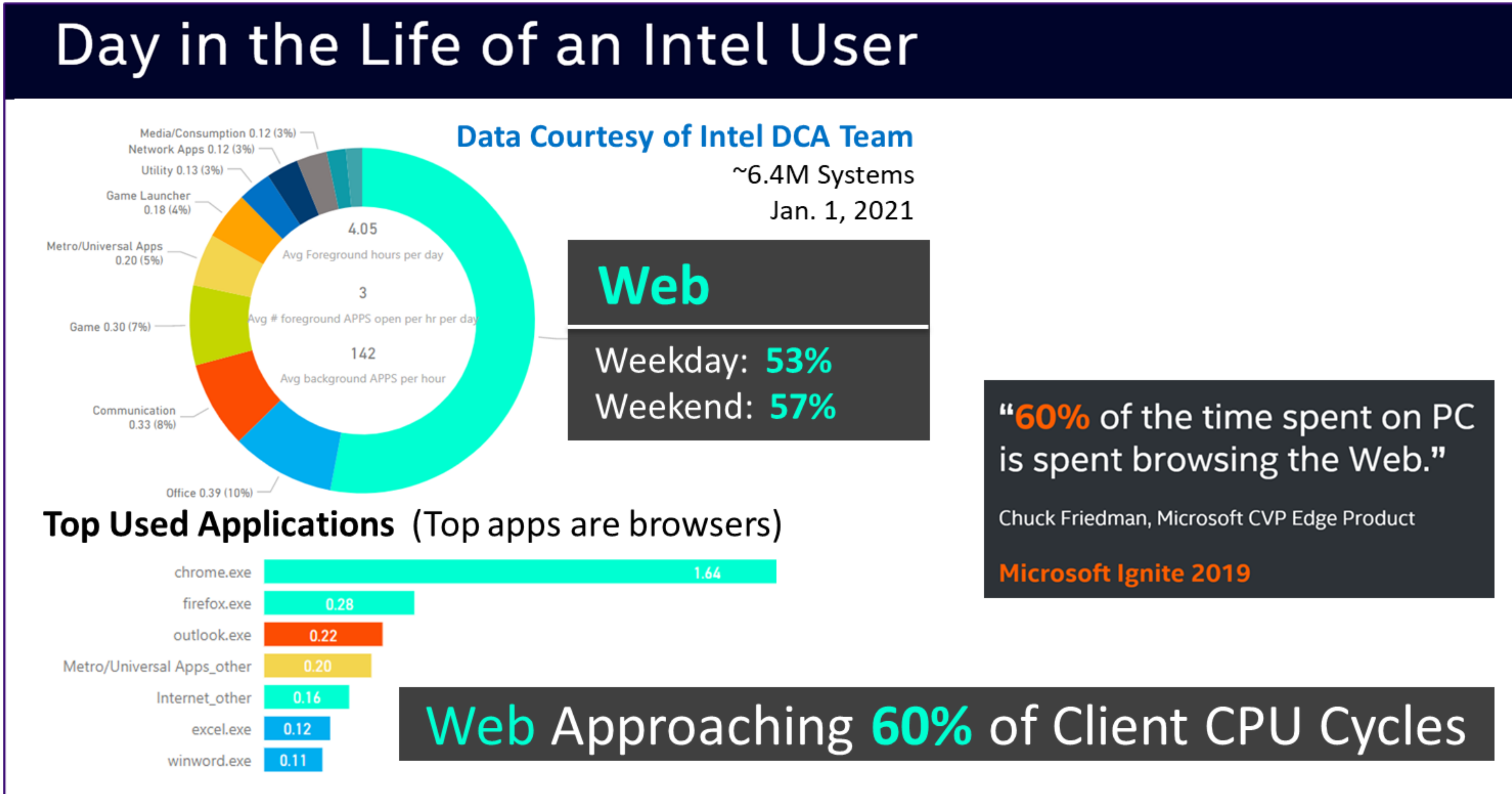
Bijan Arbab, Director Telemetry Technology
Kenneth Christiansen, Senior Staff Engineer
Moh Haghighat, Senior Principal Engineer
Sruti Sahani, Data Scientist

Intel Corporation
November 10, 2021

ELECTRICAL & COMPUTER ENGINEERING

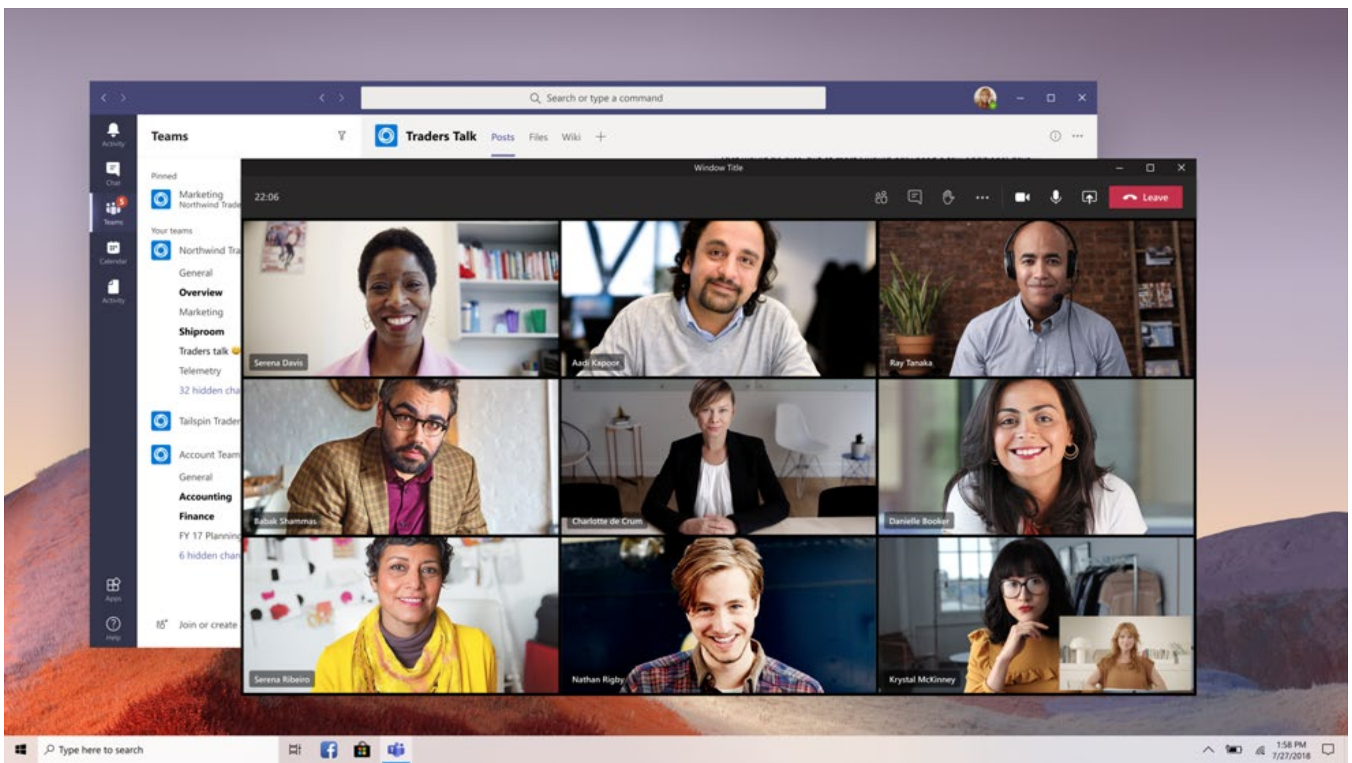
Project Description

Study the trend of the modern web and its platform implications



Hybrid & Progressive apps are here today

Many of the apps we use today are mostly–web based



Rise of Web-based Computing

TREND

Client Computing is increasingly based on Web technologies

THIS RESEARCH

Studies the trend toward web-based applications and its client platform implications

DELIVERABLES

Actionable insights

- HW architects
- Web platform Architects
- Web analysis capabilities

DCA Classification of Web-usage Categories§

§ DCA capability applied to 4M anonymous users, January 27, 2021

Desired Outcome and Deliverables

Analysis of Web-based Computing Trends (in browser, PWA, hybrid)

- Growth over time of web categories
- Resource utilization (CPU, GPU, accelerators) and change over time
- System execution characteristics over time (e.g., power, context switch rate)
- Computational demands over time
  - Are apps becoming more or less demanding of the client capabilities?
  - Which aspects of computations are changing the most?

Related Data

- **PWAs**: Microsoft: Office 365, Google: Stadia, Drive, Maps, Photos, …
  https://www.beezer.com/blog/important-pwa-statistics/
  https://www.pwastats.com/
  https://github.com/hemanth/awesome-pwa
- **Hybrid**: Teams, VSCode, Slack, Skype, …
  https://www.electronjs.org/apps

Required Disciplinary Skill Sets

- Software Programming
- Familiarity with Web technologies and Data Science
- Passion for mining large data and identifying trends

What you will learn

- Deep system execution characteristics of the Modern Web
- Systems telemetry
- Principles of data science
- Database processing

JetRacer Soccer League

10 Nov 2021

Daken Starkenburg– Optical Engineer Sr

Pete Sulcs – Data Scientist Senior Staff

James Waltner – Data Scientist Analyst Staff

Matt Nguyen – Electrical Engineer/UW alumnus

LOCKHEED MARTIN

PIRA: [MOR202110012]

Introduction

At Lockheed Martin we develop some of the most advanced technologies in the world…

F-35 Joint Strike Fighter

Orion Crew Capsule

Raider X

HELIOS LWS

Developing artificial intelligence and machine learning technology enables us to:

- **Unlock new system capabilities**
- **Process large amounts of data and translate it to information**
- **Reduce time to develop systems**
- **Improve system performance**
- **Decrease development costs**

Project Description

- Build up to four 1/10th scale self-driving vehicles (JetRacer design)
- Utilize machine learning to allow the vehicles to compete in 1v1 and 2v2 soccer setting
- Design a portable arena for the JetRacer Soccer League

Design Parameters and Performance

The students will design, develop, deploy, and iteratively improve upon an autonomous vehicle which must:

1) Strike a defined ball in a controlled trajectory
2) Score a ball into a goal
3) Perform image recognition
4) Work collaboratively with allies to score
5) Work against foes who try to score in the opposite goal
6) Have the ability to be manually overridden with a standard RC transmitter

This project focuses on developing **artificial intelligence** to enhance **collaboration** between **allies**

Deliverables

The deliverables on this project are:

1) Open source guide with information to replicate the artificially intelligent vehicles
2) Open source information containing build instructions for soccer arena
3) Up to four JetRacer vehicles with operation sensors and software
4) Reconfigurable and easily transportable soccer arena
5) Simulation and experimental data acquired through project
6) PowerPoint summary of the results of the work and objectives achieved
7) Requirements verification testing

STEM Engagement

At the end of the project, the **JetRacer Vehicles** and **Arena** will be used in **on-going demonstrations** to promote **STEM** engagement.

Desired Skillsets

Discipline	Required Skills	Desired Skills
Computer Science/ Computer Engineering	Software development	Experience with Jupyter Notebooks, Machine learning
Electrical Engineering	Engineering intution	Machine Learning
Mechanical Engineering	Engineering intution	
Physics	Core Physics Concepts	Problem Solving

LOCKHEED MARTIN

Intelligent Interfaces for Remote Collaboration in VR

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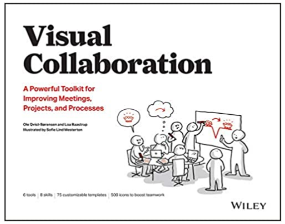
moonbeam

Project Description

Moonbeam provides professionals tools to immersive collaboration

In this project, we seek to test R&D hypotheses such as:

- **Toolkit**: Professionals are better able to co-create with VR-based toolkits for knowledge capture (see Visual Collaboration by Qvist-Sorensen and Baastrup);
- **Conversational Intelligence**: AIs can extract sentiment, linguistic ques, and other characteristics that can improve user experience in virtual reality.



Source: VROOM Telepresence – MS Research

Source: Emotiv

Project Description

This year, the project will be focused on implementing a conversational AI

Benefits of a conversational AI

- Increases productivity
  - Easily create reminders/new meetings
  - Interact with the space using conversational AI
    - Example: Upload PDF on screen
- Applies efficient human support
  - Prompt user to document motivation level/health status

Desired Outcomes and Deliverables

- **A Research Hypothesis**: Based on the team's skills and development goals, the team will work with the team to select a research hypothesis and articulate how they are planning to test this through a series of experiments.

- **Software/Hardware Prototype**: The team will produce an instantiation of the proposed feature integrated into the Moonbeam platform with documentation.

- **Feature Viability Report**: The team will conduct usability testing of the feature and assess effectiveness. This report should include recommendations on improvements and next steps.

Design Parameters, Scope, & Performance Criteria

- **Scope:** Feature selected should be scoped to a hardware and software solution that can be built, tested, and refined.
- **Testable Design:** We expect the team to design their own test scenarios and desired used profiles – Moonbeam staff will assemble a focus group to test the feature
- **Example:** For a conversational intelligence with VR, we are expecting the team define the stakeholders the tool is designed for, a catalog of the end state of features this tool would have, and an estimate of progress against that end state. The task should be broken into manageable subtasks, e.g. (1) evaluate conversational ai tools (2) test features of the conversational ai, (3) implement into Unity scene, (4) add unique features that improve user experience, (5) export product and test.

Benefits

- Create features within Virtual Reality
- Experience with Unity/software development
  - Game development API
    - Was used to create popular games today like Temple Run and Beat Saber
- Engage with the Oculus Quest 2
  - Will have the opportunity to understand how Virtual Reality games are developed
  - Test multiple VR applications

Is Oculus Quest 2 Real? Seems Everyone Hopes So – VRFocus

GDC 2018: 'Beat Saber' is Every Bit as Fun as It Looks (roadtovr.com)

Desired Disciplinary Skill Sets

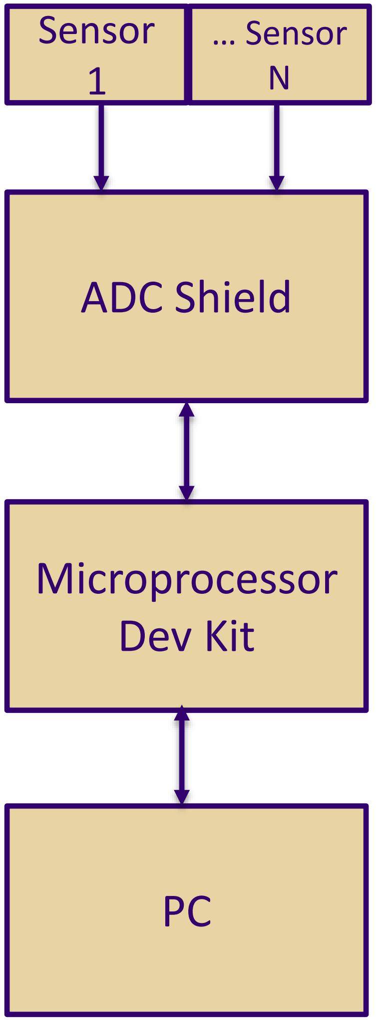
- Intense curiosity and an interest in design thinking and effective multi-user collaboration
- Required Skills:
  - Software Development
  - Virtual Reality\Augmented Reality
  - Unity development
  - UX/UI
- Useful Skills
  - AI
  - Backend development
  - Speech recognition & AI integration

Discrete ADC Board for Sensor Interaction

Marcella Bennett
ella.bennett@flukenetworks.com
Fluke Corporation, Fluke Women In Engineering (WIE)

Project Description

- Design a discrete ADC shield with a flexible and adjustable signal capturing platform
- Demonstrate data collection and analysis from off the shelf sensors
- Benefit: Separating the ADC into a shield, integrating the microprocessor separately and offloading processing to PC simplifies evaluation of different ADCs for alternate applications and performance requirements



Desired Outcomes and Deliverables

- ADC shield designed for TI ADS8686S
- Demonstrate concurrent acquisition from channels at necessary sampling rate
- Interface with PC:
  - Shield/hardware/sensors, ADI Dev Kit, Windows PC application or MATLAB, driver
- Demonstrate operation – configuration, acquisition, signal processing

Design Parameters, Scope, & Performance Criteria

- Interface with off the shelf sensors with analog output, including sensors with high rates of change
- Independently powered, whether a battery or external supply

Extensions and Stretch Goals

- Design a second shield with a different ADC and demonstrate similar operations

Required Disciplinary Skill Sets

- Digital signal processing
- Analog to digital converters
- Embedded systems design
- MATLAB or similar software
- ECAD tools (Cadence, Eagle, etc.)

Resources

Resources:

- TI ADS8686S ADC https://www.ti.com/lit/ds/symlink/ads8686s.pdf
- Analog Devices ADuCM410 https://www.analog.com/en/products/aducm410.html
- EVAL-ADUCM410 - Dev Board https://www.analog.com/en/design-center/evaluation-hardware-and-software/evaluation-boards-kits/eval-aducm410.html
- Design reference - 16-channel 24-bit ADC arduino shield with design files (could use as JOP for TI ADC based design) https://www.iascaled.com/store/ARD-LTC2499-3V3

CADRE Projects:
Autonomous Robotic Exploration

Andrew Gray
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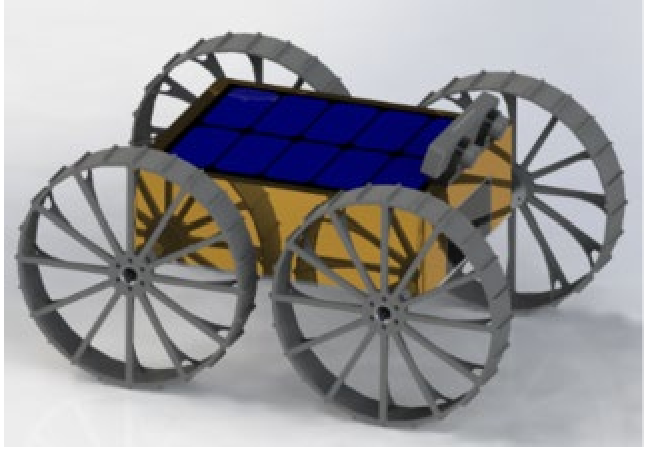
NASA Jet Propulsion Laboratory

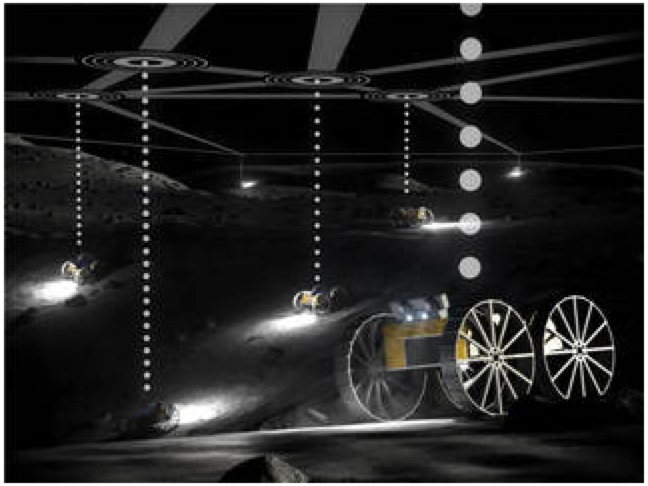
JPL's Cooperative Autonomous Distributed Robotic Exploration (CADRE)

Images from:
https://www.nasa.gov/directorates/spacetech/game_changing_development/projects/CADRE

Some early discussion available at:

- https://www.nasa.gov/feature/glenn/2021/cadre-of-mini-rovers-navigate-simulated-lunar-terrain
- https://www.jpl.nasa.gov/news/a-cadre-of-mini-rovers-navigate-the-lunar-terrain-of-slope
- https://www.hackster.io/news/nasa-s-a-puffer-cadre-projects-could-put-a-swarm-of-autonomous-nvidia-jetson-nanos-on-the-moon-8e1e3fc95454
- https://www.technologyreview.com/2021/11/02/1039091/nasa-new-mobile-rovers-autonomy-cooperative/





Project Description

- **Objective:** Develop and demonstrate software algorithms capable of supporting autonomous exploration of a new physical environment using heterogeneous hardware robots and sensors provided by the Jet Propulsion Laboratory
  - Example: Heterogeneous network of robots to develop collaborative product; COTS Helicopter and CADRE robot prototype team to develop 3-D map
- **Motivation**: advance the start of the art in autonomous exploration using heterogeneous robotic systems without humans in the loop.

JPL or subcontractor will provide robots or robot kits designed for prototype & testing of software algorithm, payloads, sensors, network testing. Will come with capable microprocessor based on Mars Helicopter heritage and other avionics and perception sensors that are "feed-forward" to space qualifiable systems.

Desired Outcomes and Deliverables

Desired products:

- 1. Exploration algorithm block diagram and architecture description for heterogeneous system
- 2. Heterogeneous exploration algorithm test plan
- 3. Demonstration of exploration algorithm on provided heterogeneous robot system

Required Disciplinary Skill Sets

- 1. Algorithm development
- 2. Software development and test
- 3. Optimization theory, mathematical methods for quantifying uncertainty, estimation theory, control theory
- 4. Machine learning
- 5. Roboticist or EE with practical embedded software/firmware/hardware experience

Design Parameters, Scope, & Performance Criteria

The key design parameters are:

- 1. Modeling and simulation, test, validation and verification procedures for heterogenous robots.
- 3. Software used to test, validate, and verify teaming (collaborative robot) functions.
- 4. Software used to demonstrate some minimum teaming (collaborative) function.

Extensions and Stretch Goals

- Demonstration of collaborative development of a 3-D map of a previously undefined physical area with heterogeneous robots. Heterogeneity could be manifested in the physical view of the sensors on the robots, and the mobility systems of the robot, while avionics could be homogeneous. Software could be de-centralized or centralized. There are many other possible alternatives regarding robot type, with the collaboratively developed product being a common or shared 3-D map.

CADRE Projects:
Maker Robots for Autonomous Network Robot Systems Development

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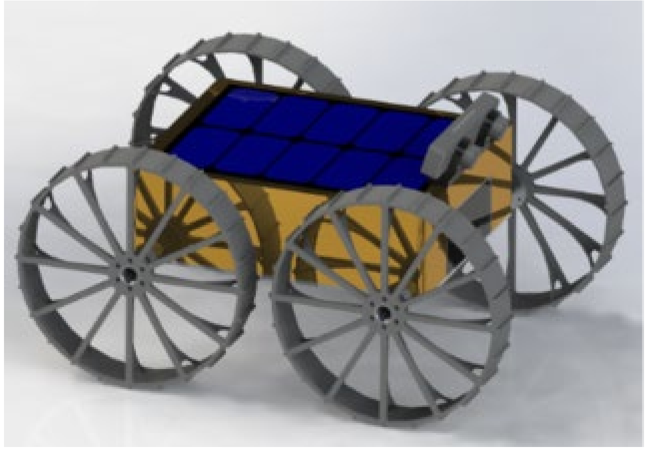
ELECTRICAL & COMPUTER ENGINEERING

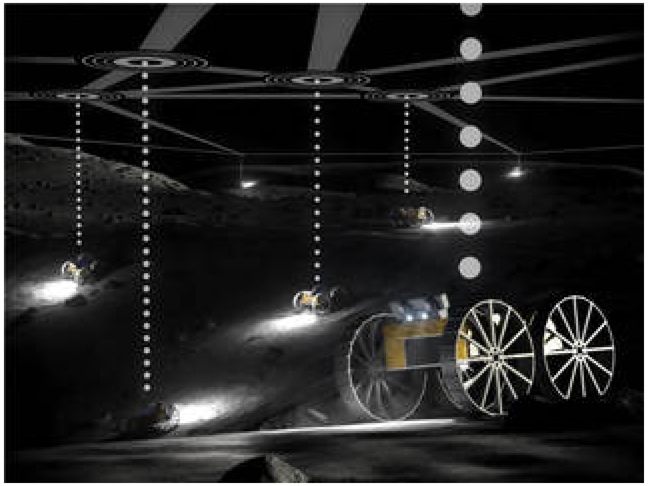
JPL's Cooperative Autonomous Distributed Robotic Exploration (CADRE)

Images from:
https://www.nasa.gov/directorates/spacetech/game_changing_development/projects/CADRE

Some early discussion available at:

- https://www.nasa.gov/feature/glenn/2021/cadre-of-mini-rovers-navigate-simulated-lunar-terrain
- https://www.jpl.nasa.gov/news/a-cadre-of-mini-rovers-navigate-the-lunar-terrain-of-slope
- https://www.hackster.io/news/nasa-s-a-puffer-cadre-projects-could-put-a-swarm-of-autonomous-nvidia-jetson-nanos-on-the-moon-8e1e3fc95454
- https://www.technologyreview.com/2021/11/02/1039091/nasa-new-mobile-rovers-autonomy-cooperative/





Project Description

- **Objective**: Demonstrate maker robots kits provided by JPL or its subcontractor(s) can be assembled, tested, and provide operational network robot capability.
- **Motivation**: advance the state of the art in autonomous exploration by making networks of robots with suitable perception and microprocessors available to larger community of technologist, researchers, and developers than would otherwise be possible.

JPL or subcontractor will provide MAKER robot kits designed for prototype & testing of software algorithm, payloads, sensors, network testing. Will come with capable microprocessor based on Mars Helicopter heritage and other avionics and perception sensors that are "feed-forward" to space qualifiable systems.

Desired Outcomes and Deliverables

Desired products:

1. Assembled and demonstrated maker robots

2. Demonstrated and documented assembly, test, validation and verification procedures.

3. Demonstration of minimum network robot capability on the system

Design Parameters, Scope, & Performance Criteria

The key design parameters are:

- 1. The maker robots (maker-bots), assembly, test, validation and verification procedures. Potentially suggested test fixtures and equipment.
- 3. Software used to test, validate, and verify basic robot functions.
- 4. Software used to demonstrate some minimum network robot capability.

Extensions and Stretch Goals

- Use network of robots to create a shared map

Required Disciplinary Skill Sets

- 1. Mechanical, electrical, and software assembly, test, verification and validation.
- 2. System integration and test processes and procedures
- 3. Software development and test.
- 4. Roboticist or EE or ME with practical embedded software/firmware/hardware experience

Intertidal sensor array for monitoring ocean change stressors in oyster farms

Paul McElhany (ECE Mentor)
NOAA Northwest Fisheries Science Center
Jacqueline Padilla-Gamiño (Lead PI)
UW School of Aquatic and Fishery Science
Joth Davis
Baywater Shellfish
Shallin Busch
NOAA Northwest Fisheries Science Center

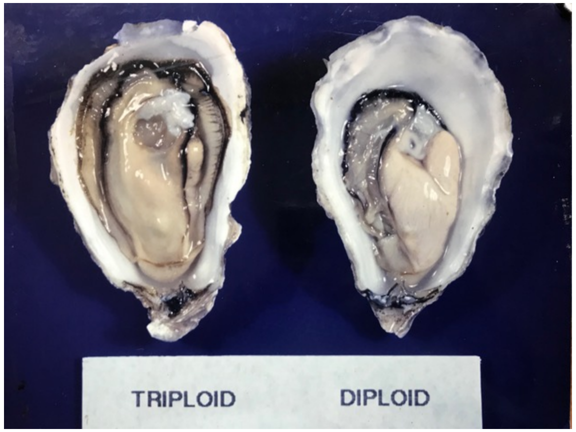
NOAA FISHERIES

SCHOOL OF AQUATIC and FISHERY SCIENCES

BAYWATER SHELLFISH COMPANY

University of Washington
ECE Project Pitch
November 10, 2021

The Project: Sensors to measure climate effects on diploid and triploid oysters



Deliverables

- Field deployable sensor array to measure:
  - Temperature, Salinity, pH and Chlorophyl
- Data logging and communication package
  - blue tooth or cellular
- Open source analysis and visualization software
- Calibration and deployment SOPs and software documentation

Method and Challenges

- Combine commercially available and custom hardware
  - Research suitability of commercial options
  - Design integration of commercial components
    - Power supply
    - Communication
    - Rugged housing
  - Create custom components for deliverables goal
- The pH sensors will be particularly challenging…

Security Attack and Defense Reasoning Framework

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Nutanix

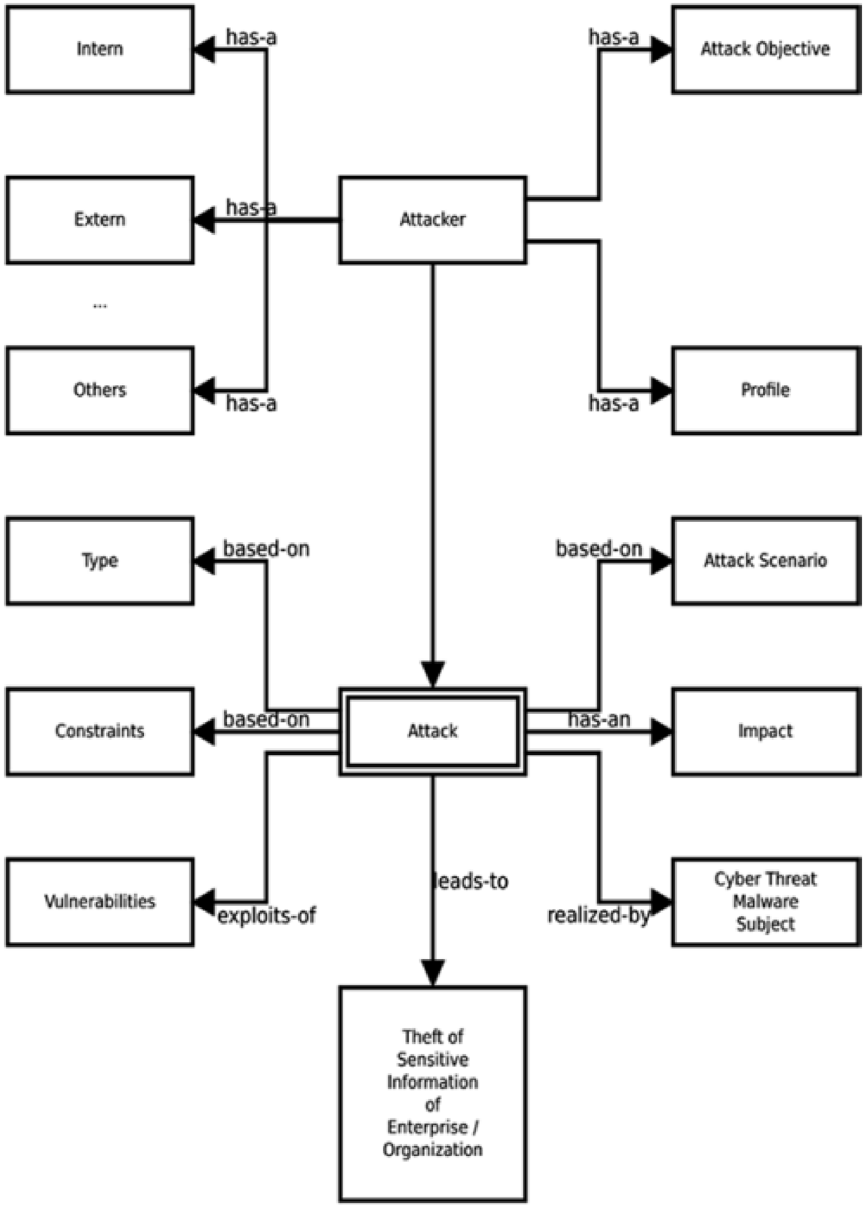
ELECTRICAL & COMPUTER ENGINEERING

Project Description

- Build a system that can use existing knowledge, acquire knowledge from inputs, and provide answers to questions using known facts and via deduction
- Knowledge and facts should be stored and expressed using an ontology for cybersecurity
- System should be capable of explaining answers that it provides

Desired Outcomes and Deliverables

- System that stores and gathers knowledge and provides insights into the data via deduction



Design Parameters, Scope, & Performance Criteria

- An ontology that models the cybersecurity threat domain that is portable and can be modified
- Defined knowledge base of facts using the built cybersecurity ontology
- Deduction system that utilizes knowledge base to provide answers and is capable of explaining how the answers are derived

Extensions and Stretch Goals

- Tooling to make modifications to the cybersecurity ontology and knowledge base a user-friendly experience
- Devise a way to interact with system from a standard python interpreter

Required Disciplinary Skill Sets

- Constraint logic programming
- Inductive logic programming
- Reasoning systems
- Knowledge of offensive and defensive cybersecurity concepts

Wire Harnesses BOM Auto-Tracer

Blake Pedrini
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PACCAR Technical Center

Project Description

- Develop a path finding system through multiple lists of point-to-point node descriptions
- There can be more than 2 connection at any given node, including loop backs
- Nodes may not be named the same on multiple BOM (Bill of Materials) lists, must be able to handle a decipher code
- Must be able to keep track of features and variation for each potential path

Desired Outcomes and Deliverables

- Deliver a list of all connections throughout multiple lists of point-to-point node lists
- Highlight special features at the request of the program operator
- Allow for flexibility for changes for non-conforming BOM lists

Design Parameters, Scope, & Performance Criteria

- Should be portable
- Should allow a user to not need to understand tracing algorithms
- Should be able to handle a sample configuration in < 5minutes
- Modifiable to meet with multiple different BOM form inputs

Extensions and Stretch Goals

- Read harness drawing to be able to pull out section lengths, for CAN physical layer verification
- Compare mating connectors
- Compare mating pin types
- Detect variation loops

Required Disciplinary Skill Sets

- Software programming
- Human Machine Interface

Compact Broadcast Band Radiating Antenna

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PACCAR Technical Center

Project Description

- Develop a compact radiating antenna that will efficiently cover the AM broadcast band and produce E fields at greater magnitudes than a currently used antenna.
- The antenna needs to be physically small or be able to be broken down into smaller pieces that can be quickly assembled for use in the test setup.

Desired Outcomes and Deliverables

- Student presented design concepts
- Functional concept (prototype design)
- Final delivered design product
- Portable, self supporting, compact AM broadcast band radiating antenna which is capable of generating signal levels needed for the full vehicle radio noise test practice.

Design Parameters, Scope, & Performance Criteria

- Size: The compact broadcast antenna in a disassembled state needs to fit through a common building personnel door. Once assembled it should be no more than 3m tall by 2m wide. It needs to be self supporting.
- Electrical performance: The antenna needs to be capable of generating a signal level of >30dBuV (including line and connection losses) as measured by a spectrum analyzer using the vehicle antenna feed with additional cable connected to the spectrum analyzer. A maximum of 120dBuV is available from the signal generator to drive the antenna. A 500 kHz tunable bandwidth centered on 1000 kHz is desired. The source impedance of the antenna needs to be 50 ohms.

Extensions and Stretch Goals

Required Disciplinary Skill Sets

- Electromagnetics
- Radio frequency (RF)
- Antenna design
- Mechanical design (support and packaging)

Robotic Arm for Automation of Tester Connection

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PACCAR Inc.

ELECTRICAL & COMPUTER ENGINEERING

Project Description

- Develop a robotic arm capable of automating the connection of tester cabling to a semi-truck dash assembly
- Reduce errors and damage caused by incorrectly installed cables
- Enable operator to more effectively utilize their time

Desired Outcomes and Deliverables

- Working robotic arm capable of being installed in a manufacturing plant
- All relevant information required to build more:
  - Source Code
  - Cad Models
  - Electrical Diagrams
  - Et Cetera

Design Parameters, Scope, & Performance Criteria

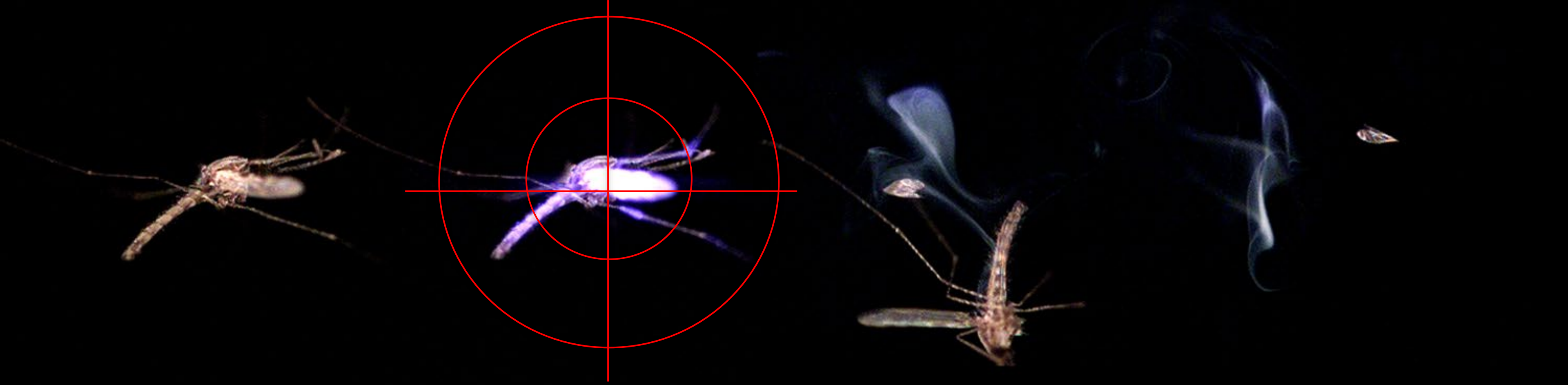
- Robust enough to survive in the plant environment
- Enough range to reach cable connection from where the arm is mounted
- Able to lift and handle heavy payloads at range
- Maintainable by PACCAR after the project is completed

Extensions and Stretch Goals

- Add ability to switch payloads based on which type of dash is being tested
- Determine and implement method for connecting to loose connections

Required Disciplinary Skill Sets

- Robotics
- Electronics
- Manufacturing
- Control Systems
- Embedded Systems
- Software Development



PHOTONIC SENTRY

BENCHMARKING PERFORMANCE OF A STEREO VISION SYSTEM FOR INSECT TRACKING

UW CAPSTONE PROJECT PROPOSAL

November 2021

What kills more people than the COVID-19 Pandemic?

More than 1 million people worldwide already die each year from Malaria, Dengue, Chikungunya, Yellow Fever, Eastern Equine Encephalitis, West Nile Virus, Zika and others.

Coming Soon to a Neighborhood Near You

Climate Change Will Expose Half of the World's Population to Disease-Spreading Mosquitoes By 2050

***Yale Environment E360, March 5, 2019**

Human Disease Is Just the Beginning

Insects feast on plants, spreading disease, destroying crops and costing billions of dollars

Livestock and domestic animals are also sickened and killed

PHOTONIC SENTRY

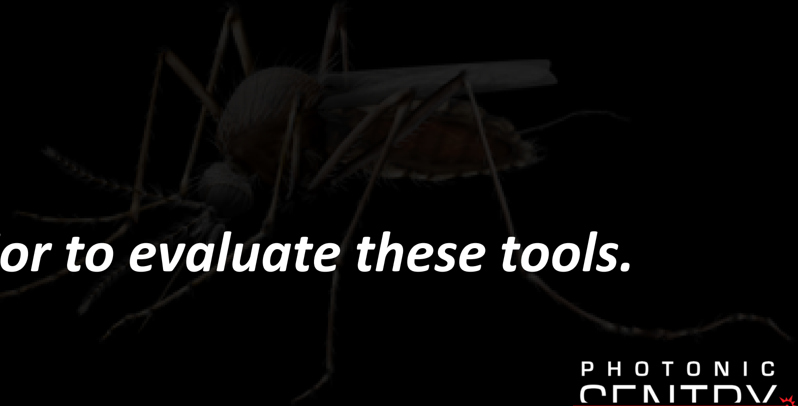
Today's Approaches Don't Adequately Address the Problem

Insecticides are being banned

May not work on invading species

Sterile insect and GMO techniques have biosafety concerns

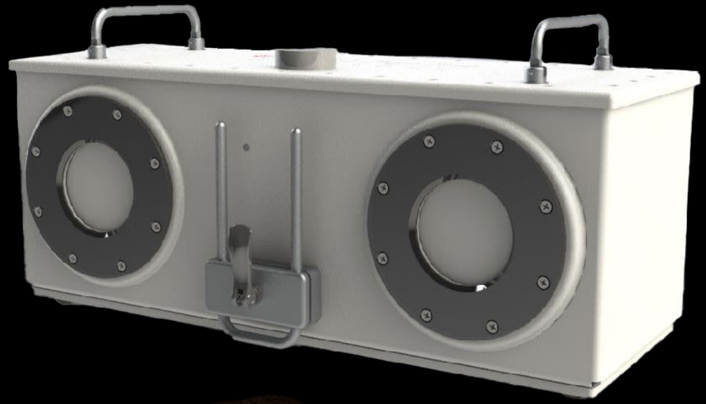
Insecticides are expensive to develop, and are used only after infestation is confirmed



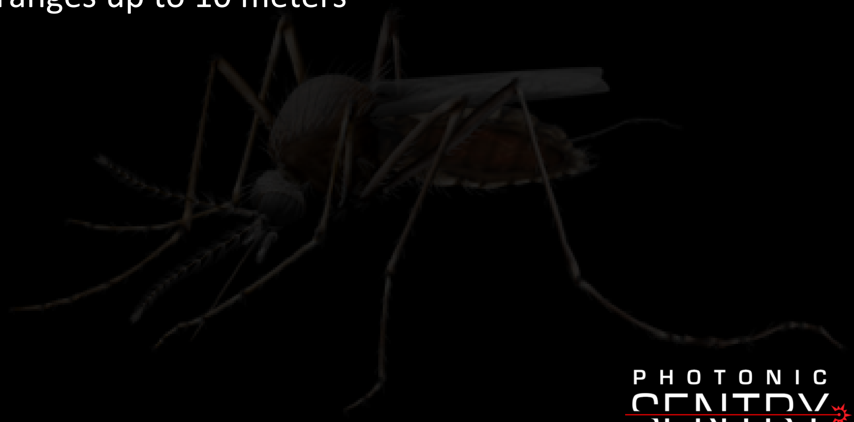
We need better data on insect behavior to evaluate these tools.

PHOTONIC SENTRY

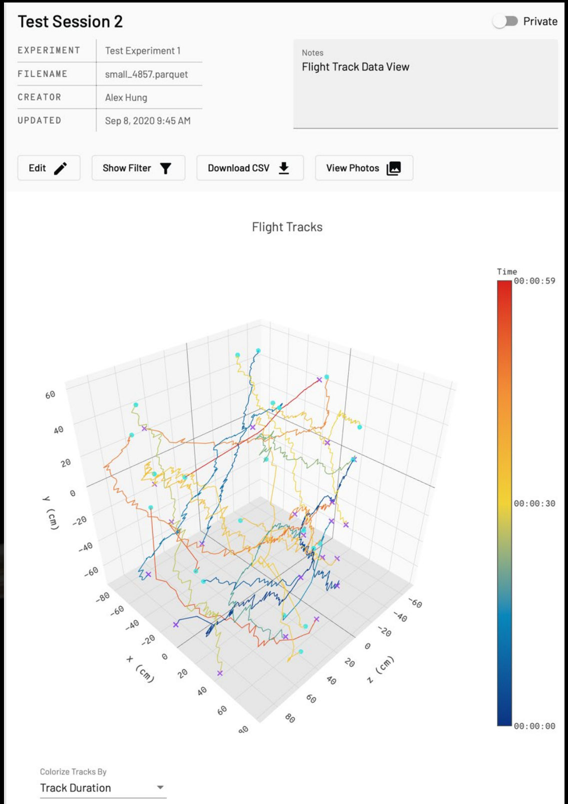
The Photonic Fence Monitoring Device

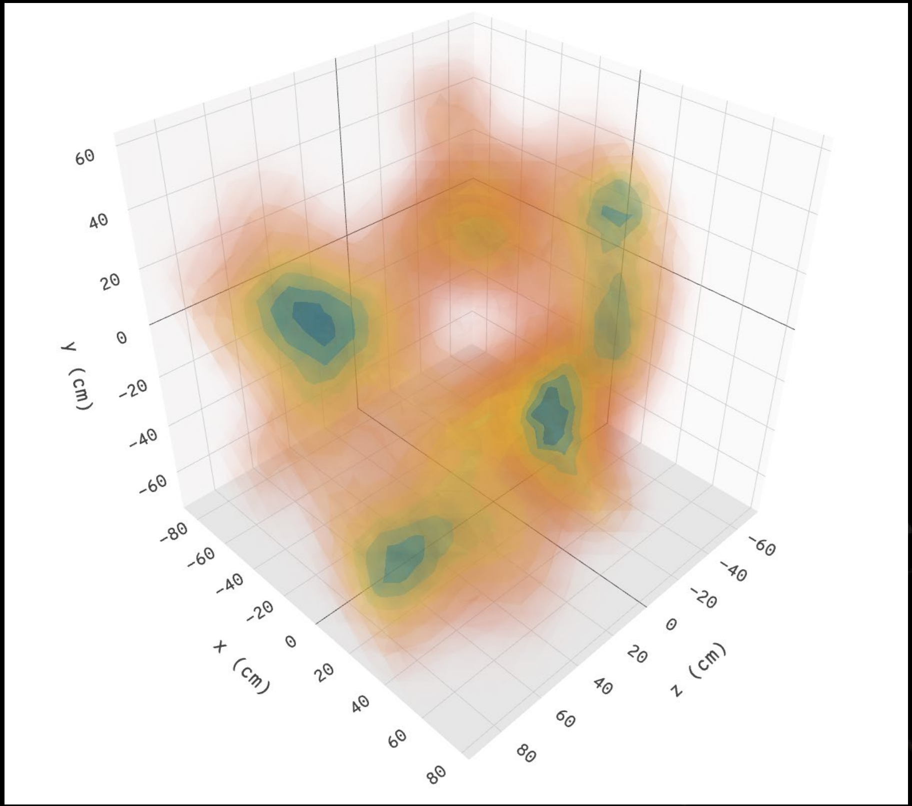


- Tracks up to 1000 flying insects simultaneously at 100 frames/sec
- Cloud-based data analysis and visualization
- Distributed machine learning: edge+cloud pipeline
- Automatic hardware calibration, no video cameras to set up
- File sizes that fit on a thumb drive
- Monitoring ranges up to 10 meters

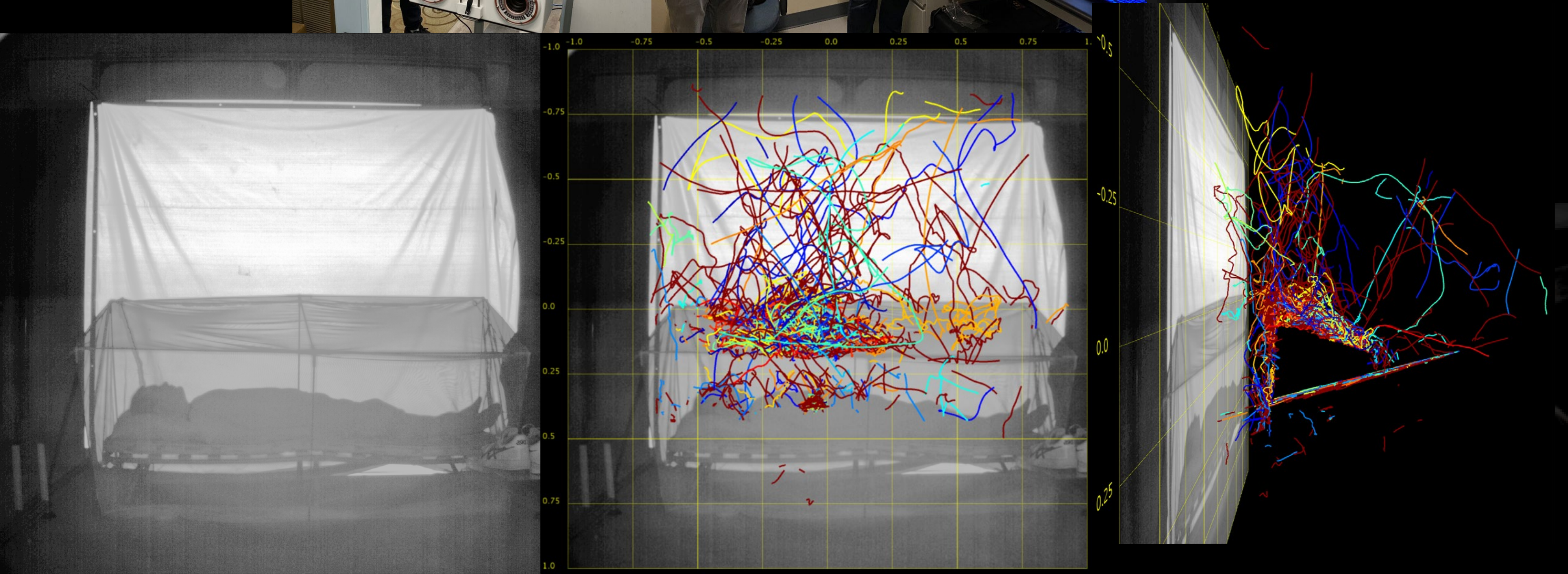


PFMD Researcher Interface – Web App for Data Analysis & Visualization





First Deployments in 2021 Generating Data In Labs and (soon) Field Experiments



Project Goals

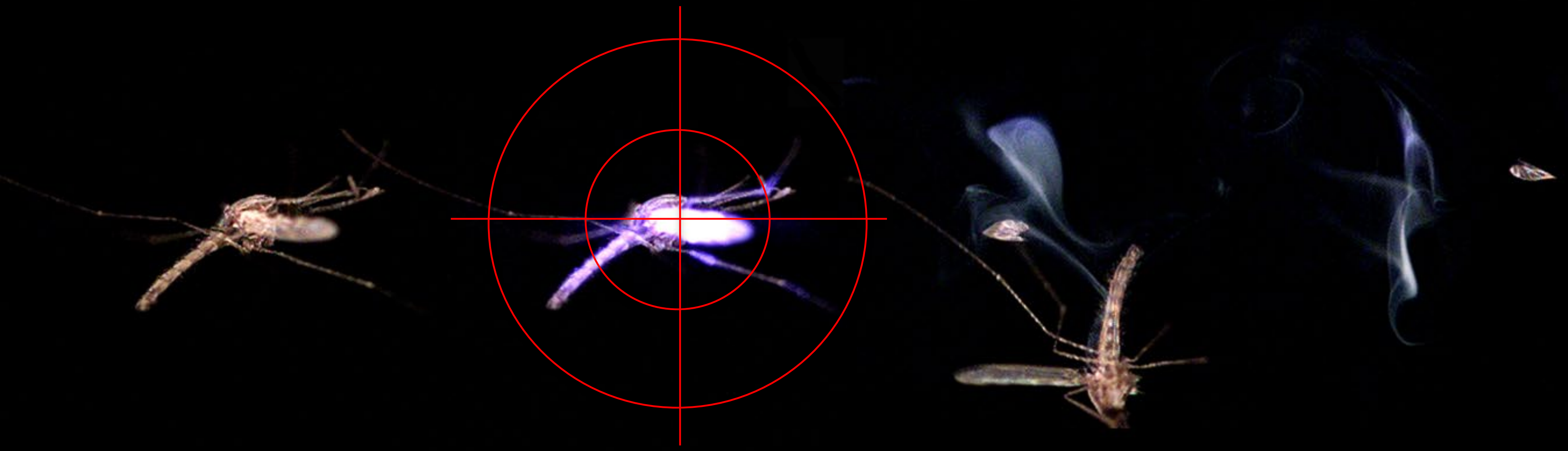
- Characterize performance of monitoring system: how accurately do we measure positions, speeds, sizes?
  - Access to user-collected data & internal experiments
- Categorize failure modes in lighting conditions, hardware, analysis pipeline to prioritize improvements
- Inform next-generation of development on lethal laser system based on benchmarks of insect tracking system

PHOTONIC SENTRY

Relevant Skills

- Data analysis for performance benchmarking
- Statistics
- Dynamics
- Software development
- User experience design
- Current team has engineers with backgrounds in systems design, mechanical, electrical, physics, and data science

PHOTONIC SENTRY



PHOTONIC SENTRY

matt@photonicsentry.com

Multiport USB Charger

Josh Henry / Bernie Thompson

josh@plugable.com / bernie@plugable.com

Plugable Technologies

ELECTRICAL & COMPUTER ENGINEERING

Project Description

- Develop an innovative USB charger and see it come to market
- Learn how USB Type C power works
- Team will do a PCB layout using standard low-voltage components and a 5V 4A power supply to charge up to 5 USB-C devices overnight.
- Design relies on USB’s standardized Type-C power capabilities, plus Plugable's patented "priority charging" algorithm
- The resulting device delivers more USB charging ports and decreases wasted power supply capacity, at lower cost

Desired Outcomes and Deliverables

- Plugable’s algorithm supports charging the highest priority port charging at up to 15W, with power dynamically shifting to the lower priority ports as each device completes charging in succession
- This shifting is done via current sense ICs, voltage summation of their outputs, potentiometers for the USB-C 900mA/1.5A/3A USB-C power capability signaling of each port, and power switches to de-power unused ports entirely.
- This is an exciting opportunity to design a product that will actually go to manufacturing and be brought to market by Plugable, based on the students' successful work.

Design Parameters, Scope, & Performance Criteria

- The hope is this can be achieved with a fully analog circuit. A microcontroller + firmware is the backup plan.
- The project will first be designed and simulated via https://www.circuitlab.com/
- Then rendered into prototype parts using EagleCAD
- Then manufactured with http://oshpark.com/ and off-the-shelf components soldered by the students
- A successful design will allow charging 5 devices like the iPhone 11 “by morning” or 1 device at the highest 15W rate

Required Disciplinary Skill Sets

- **CircuitLab simulation skills**
- EagleCAD PCB layout skills
- Understanding of low-voltage DC-DC power circuits
- Microcontroller programming in C

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

Suzanne Schreck
Sound Transit
Suzanne.Schreck@soundtransit.org

Project Description

- Design, build and test an upgradeable wireless mesh network for low bitrate sensing data transfer, to relay telemetry and sensor data between coaches that make up the consist for Sounder commuter trains
- Provide a technical recommendation to Sound Transit for implementation of the network, which would replace multiple wired and wireless systems currently utilized for connectivity between coaches

Desired Outcomes and Deliverables

- Design, simulate, develop hardware/software and validate a wireless mesh network for Sound Transit Sounder commuter rail trains
- Develop a uniform system to replace multiple wireless systems for low bit rate sensing data transfer
- Allow for future upgrades to relay HD video footage from each coach to a central storage location on the train

Design Parameters, Scope, & Performance Criteria

- Point-to-point system between cars that are linked (train consist)
- Inter-vehicle communications: Establish a secure link between any two vehicles that are physically connected
- A given wireless device should not be capable of connecting to a consist occupying a parallel track
- The consist must contain its connection when going around bends
- Minimum 300Mbps data transfer throughout the train

Extensions and Stretch Goals

- Relay HD video footage from each coach to a central control location on the train
- 1 Gbps data transfer throughout the train

Required Disciplinary Skill Sets

- Wireless communication fundamentals
- Signal processing fundamentals
- Python or other language programming

Wireless Airway Management Sensors

Clinton Siedenburg

clinton.siedenburg@stryker.com

stryker

ELECTRICAL & COMPUTER ENGINEERING

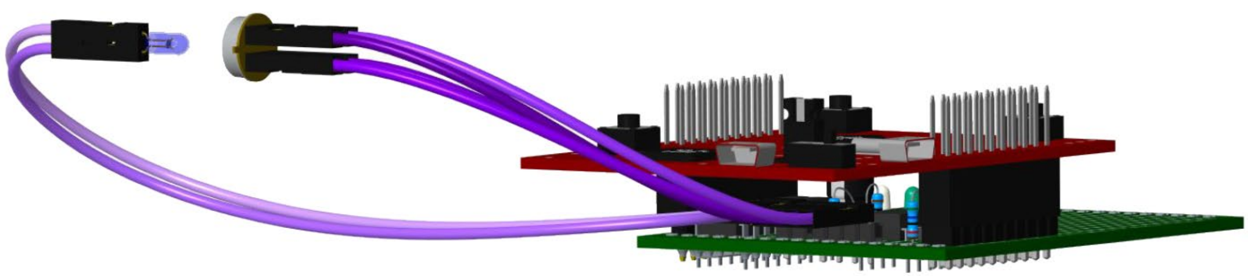
Project description

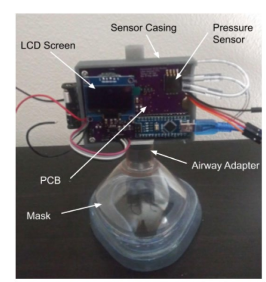
stryker

Continue development of next generation Advanced Life Saving (ALS) airway management sensors such as those used by Seattle Medic One

Previous years…

- ❑ Identified theory to measure etCO2 using light, pressure/flow with other sensors
- ❑ Developed basic sensor hardware + micro controller eval board + BLE eval board
- ❑ Wirelessly conveyed and displayed waveforms on a laptop via Bluetooth eval board
- ❑ Developed basic algorithm for determining airway CO2 concentration, pressure, and flow





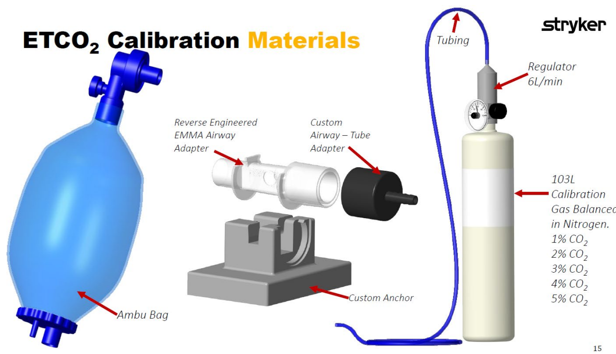
Assembly Prototype v2: Completed Physical Prototype

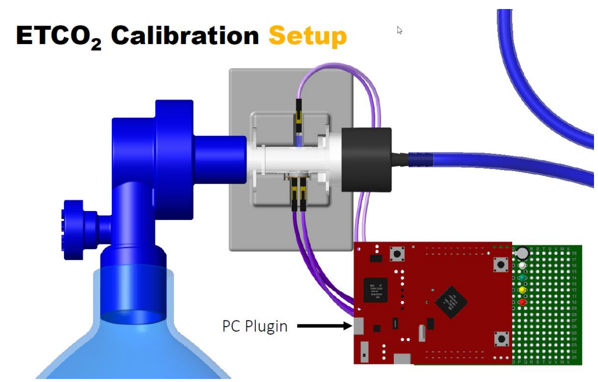
W ELECTRICAL & COMPUTER ENGINEERING

Project **description**

This year…

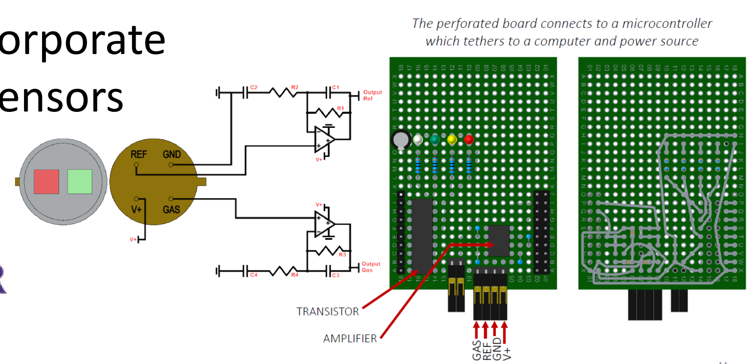
- ❑ **Objective 1: EtCO2 accuracy**
  - ○ **Evaluate etCO2 accuracy comparing to ALS equipment**
  - ○ **Improve sensor performance**
- ❑ **Objective 2: Pressure and flow prototype**
  - ○ **Incorporate pressure and flow sensors to last year's etCO2 sensor**
  - ○ **Evaluate pressure / flow accuracy**





Objective 1: Measure etC02 accuracy

Objective 2: Incorporate pressure/flow sensors



ELECTRICAL & COMPUTER ENGINEERING

Project deliverables

stryker

- ❑ Evaluation **report**
  - ○ EtCO2 measurement accuracy and comparison to real-world ALS equipment
  - ○ Airway pressure and flow measurement accuracy
- ❑ Working **prototype** of etCO2, airway pressure, airway flow sensors
  - ○ Electrical prototype documentation
    - – Schematics, PCB layout, costed BOM
  - ○ Software prototype documentation
    - – Software description
    - – Software source code and coding environment

ELECTRICAL & COMPUTER
ENGINEERING

Required skills

- Electrical design, build, test (schematic, layout, assembly, test equipment)
- Software programming (GUI, Bluetooth, signal processing, test support)

Wireless Blood Oxygenation Sensors

Clinton Siedenburg

clinton.siedenburg@stryker.com

ELECTRICAL & COMPUTER ENGINEERING

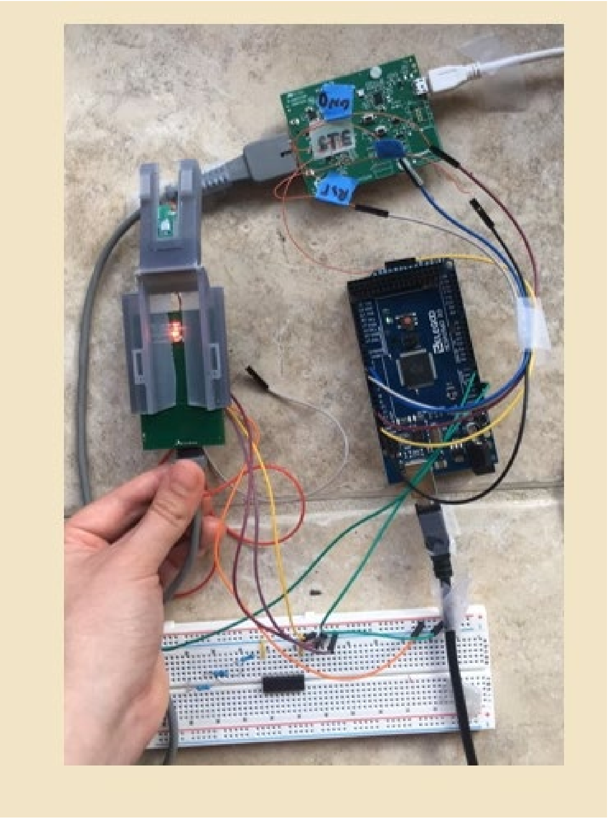
Project **description**

stryker

Continue development of next generation Advanced Life Saving (ALS) oxygenation sensors such as those used by Seattle Medic One

Previous years…

- ❑ **Identified theory, developed algorithm, to measure SpO2, SpMet, and SpCO using light**
- ❑ **Developed basic sensor hardware + micro controller eval board + BLE eval board**
- ❑ **Wirelessly conveyed and displayed waveforms on a laptop via Bluetooth eval board**
- ❑ **Designed finger clip to hold LED and photodiode PCBAs**



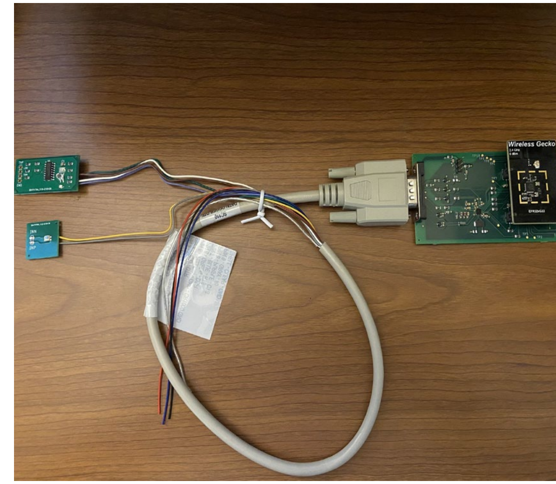
ELECTRICAL & COMPUTER ENGINEERING

stryker

Project description

This year…

- **Objective 1:**
  - **Fix PCB layout issues of last year's electrical design and integrate the BRD4182A radio board with the AFE4403 chip**
  - **Integrate the LED and photodiode PCBAs into figure clip for testing**
- **Objective 2:**
  - **Evaluate SpO2/ SpMet / SpCO accuracy with test equipment**



Objective 1: Fix last year's issues and finish sensor

Objective 2: Measure accuracy

ELECTRICAL & COMPUTER ENGINEERING

Project **deliverables**

- Working **prototype** of wireless SpO2 / SpMet / SpCO sensor
  - Electrical prototype documentation
    - Schematics, PCB layout, costed BOM
  - Software prototype documentation
    - Software description
    - Software source code and coding environment
- Evaluation **report** (*most important*)
  - Accuracy measurements
  - Comparison to test equipment

Required skills

- Electrical design, build, test (schematic, layout, assembly, test equipment)
- Software programming (GUI, Bluetooth, signal processing, test support)

Wireless Broadband Service Quality Prediction App

Alan McDonald, Timur Kochiev, Nick Lambert

Ahmad Armand

Project Description

- Develop a system comprised of:
  - An Android app
  - Associated logic & predictive model
  - A centralized cloud-based server
- The Android app would read low and FDD mid-band frequencies signal quality being detected in the home and using an ML-based model, predicts service quality for the higher TDD mid-bands.

.

Performance Criteria

- The phone App should predict quality of indoor-coverage for "wireless broadband" frequencies (higher mid-bands: 2.5 to 5 GHz) that may not yet be deployed in the customer's neighborhood.
- The customer would start the app at the location in their home that they plan to install their CPE (Customer Premise Equipment).
- After completing the test, the app should provide a customer-friendly response of service level, for example "Great!" "Good" or "Try another location"

Deliverables

- Completion of paper and hands-on investigation of outdoor-to-indoor radio propagation for low, mid and high frequency bands.
  - Capture logs of radio signals indoor will be captured using state-of-the-art logging tools
  - Data will be scrubbed and formatted to be used for ML model training
- Development of a ML model based on investigation results and produces a predictive model of indoor broadband service level with confidence intervals.
- Development of a simple, customer “do-it-yourself” tool embodied as an Android App
  - The app would include the above described ML-based model
- Development of a cloud-based centralized server to be accessed by the App

Required Disciplinary Skill Sets

- Recommended Team Background
  - Classwork and Experience in Machine Learning model development and training
  - Experience in Android handset App development

- Skills Developed During Project
  - Understanding of wireless network architecture
  - Radio link test tools, and testing procedures
  - Appropriate UX development of a simple customer “do-it-yourself” app
  - Application of ML/AI to a real-world user case.

T-Mobile®

THE UN-CARRIER®

Point of Interest Deduplication

TELENAV

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ELECTRICAL & COMPUTER ENGINEERING

TELENAV

Telenav enables OEMs to build lasting relationships with customers through delightful connected car experiences

Navigation

Commerce

Infotainment

Project Description

- To provide navigation service, Telenav uses POI data set provided by data provider, such as infogroup, HERE.
- POI duplications is one of common problems in POI data set and it is challenging to solve.
  - For example, in POI dataset, there is one POI named 'Costco' and another POI named 'Costco Wholesale' at same location. These two POIs are duplications. However, POI 'Costco' and POI 'Costco Gas' are not duplications.
  - With consideration of additional attributes such as POI category, phone number, open hour, this problem is even more complex.

Project Description

- The goal of this project is to create one solution to find and remove the duplications in POI dataset.
- This solution should be used as one key step of POI data offline processing pipeline.
- This solution should also be used for online deduplication when results are aggregated from multiple POI services.

Desired Outcomes and Deliverables

- Outcomes
  - The desired outcome will be one library meeting the performance and quality metric and design parameters.
- Deliverables
  - The artifacts should be one library.
  - Create command line application interacted with library.

Design Parameters, Scope, & Performance Criteria

- Scope of the project
  - Create one solution to find and remove the duplications in POI dataset.
  - This solution should be used as one key step of POI data offline processing pipeline.
  - This solution should also be used for online deduplication when results are aggregated from multiple POI services.
- Design Parameters
  - The artifacts generated should be one library.
  - The library should be deployable on edge device as well as cloud.
  - The binary size should be as minimal as possible.
  - Programming language is Java. Other language (preferably Python) could be used.
  - The library should work & have testability in standalone mode (command line) with minimal dependency.
- Performance criteria
  - Performance of the library should be under 200ms on edge device and under 50ms on cloud.
  - Evaluate algorithm/solution with golden data set and the accuracy of the detection should be higher than 95%.

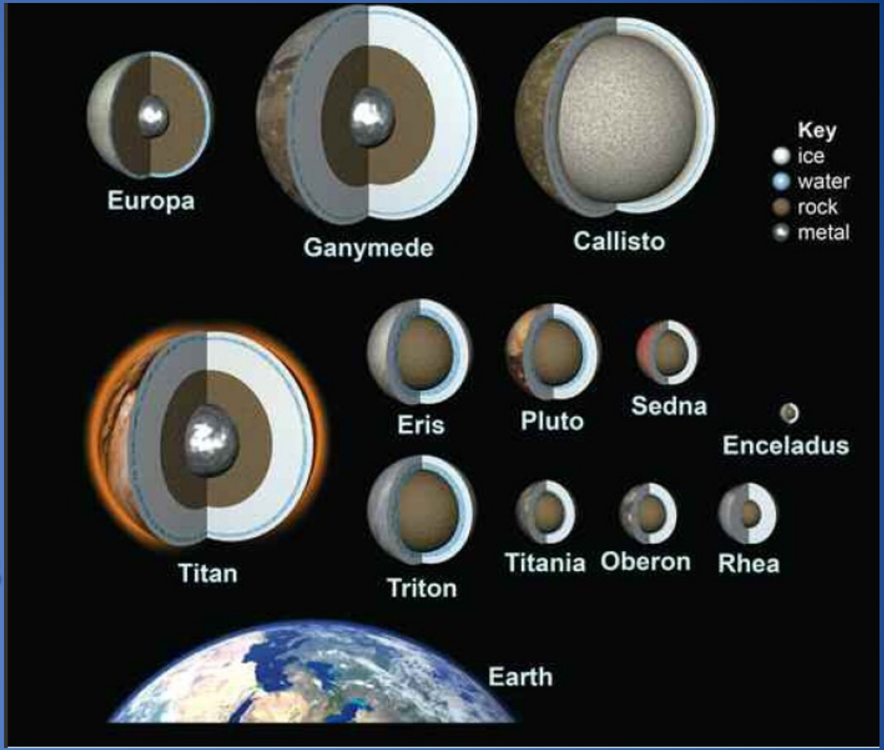
Required Disciplinary Skill Sets

- Software programming: Java/Python
- Supervised/unsupervised Machine learning.
- Model creation & evaluation skills.

Solar System Ocean Worlds

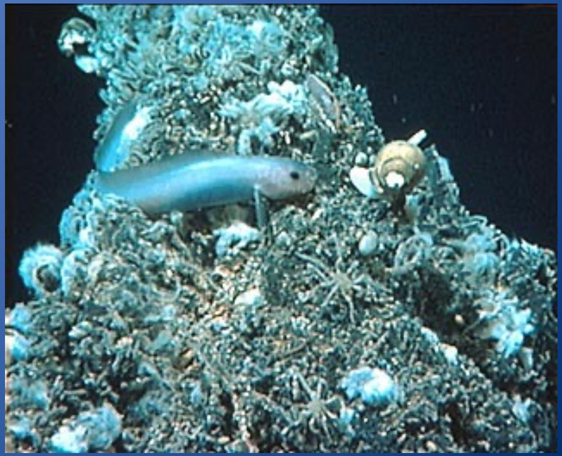
Judging from our solar system –

- Ice-covered seas may be common in the cosmos.
- Some in prolonged contact with rock with energy fluxes (e.g. Europa and Enceladus).
- Some (e.g., Europa) may have fluxes of oxidants into sea. Some (e.g., Enceladus) maybe not.

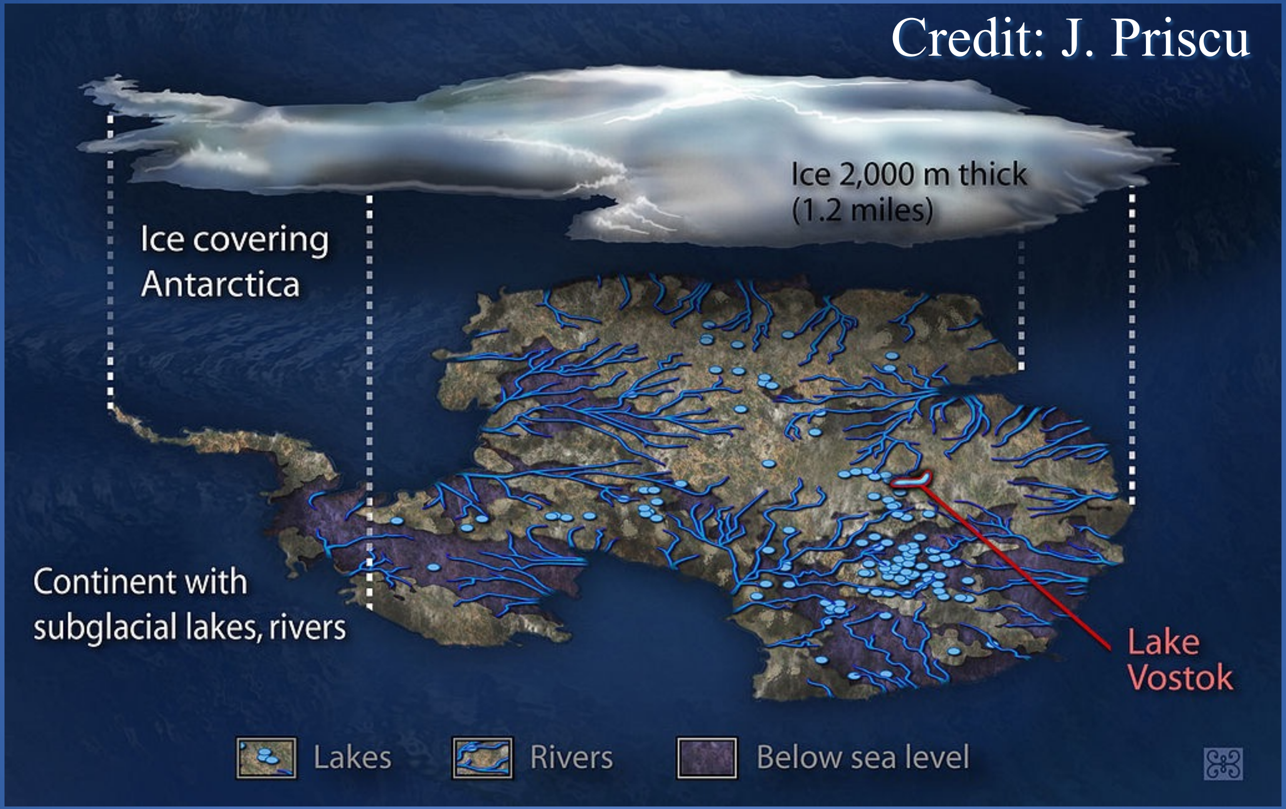


Questions – Is life beneath kilometers of ice ubiquitous or rare? What are ways for it to ‘make a living’?

Can complex life occur only on planetary surfaces, or also in (perhaps common) ice-covered seas?



Diverse, Unexplored Earth Analogs



- Ca. 400 subglacial lakes beneath kilometers of ice in Antarctica
- Diverse in size (up to Lake Ontario-sized)
- Diverse in glaciation history (~35 My to ~100 Ky)
- Diverse in geochemical settings. e.g., oxidant flux due to melting at lids, possible methane reservoirs [Wadham et al. 2012]

Applied Physics Laboratory Ice Diver in 2013

Barrel diameter 6.5 cm (flange 1.3x), length 1.7 m

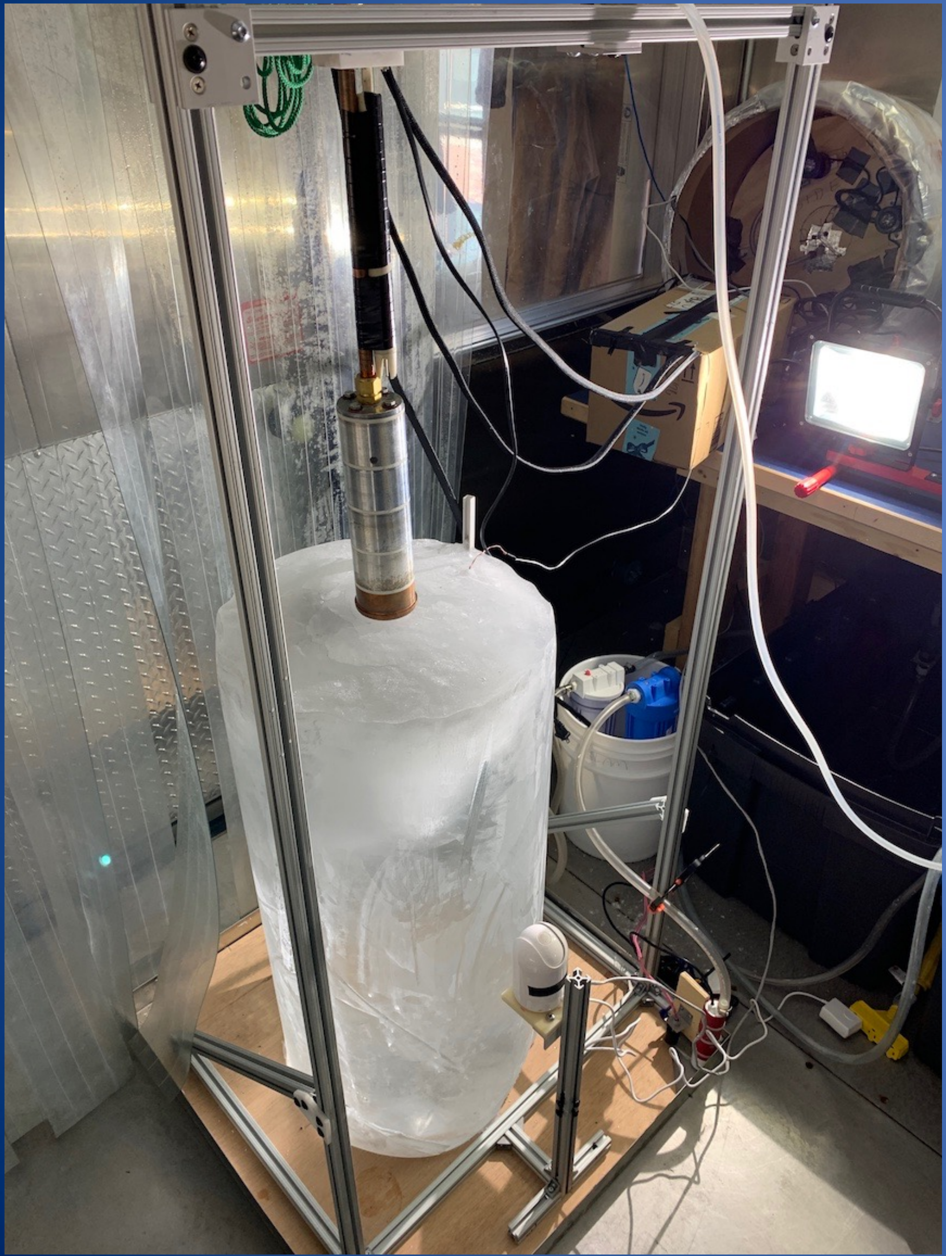
Initial operation at 1100 V, 700 m of 20-gauge, FEP-insulated wire

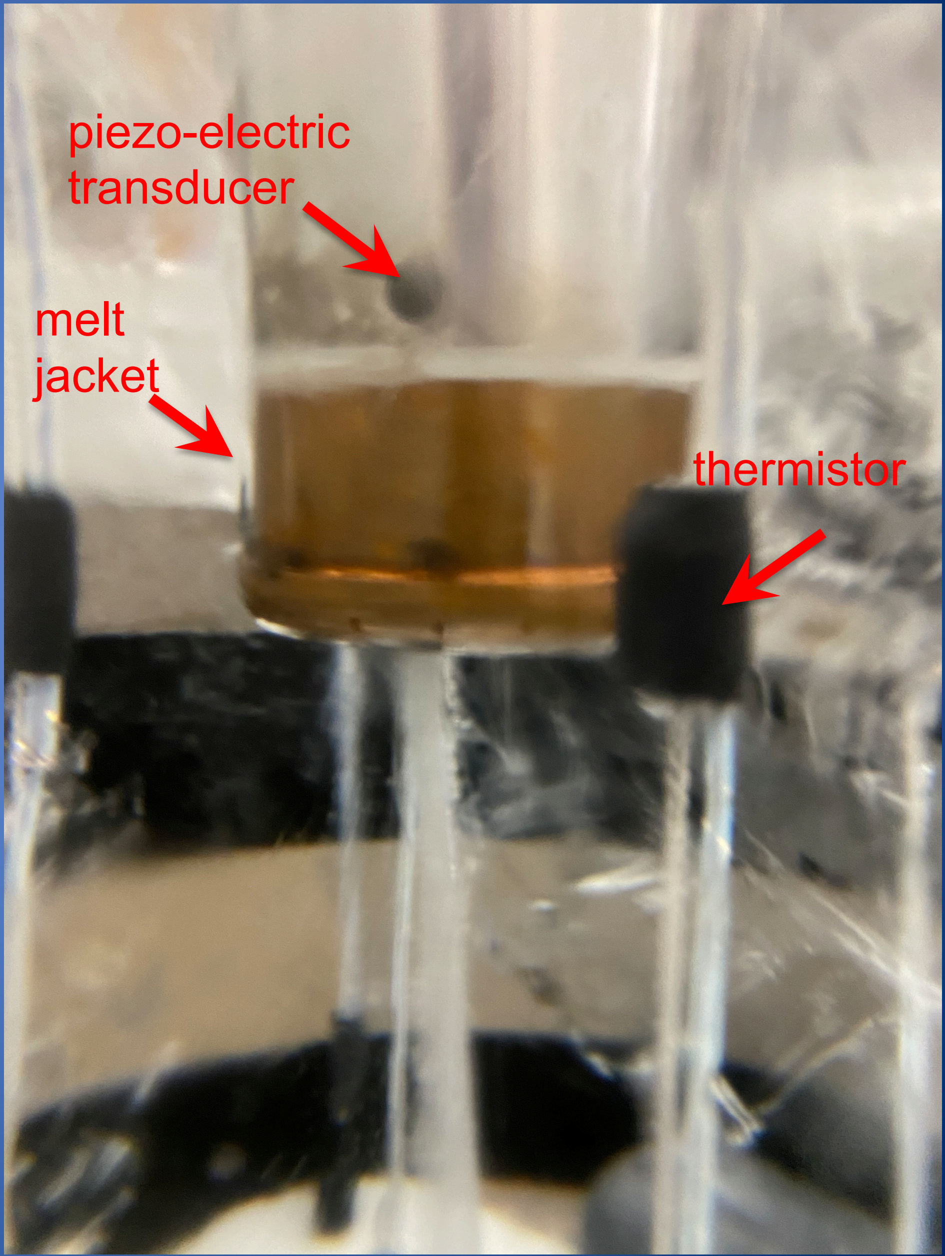
27 cartridge heaters in 3 parallel banks

thermostatic control, 2-way comms/control using inductively coupled modem

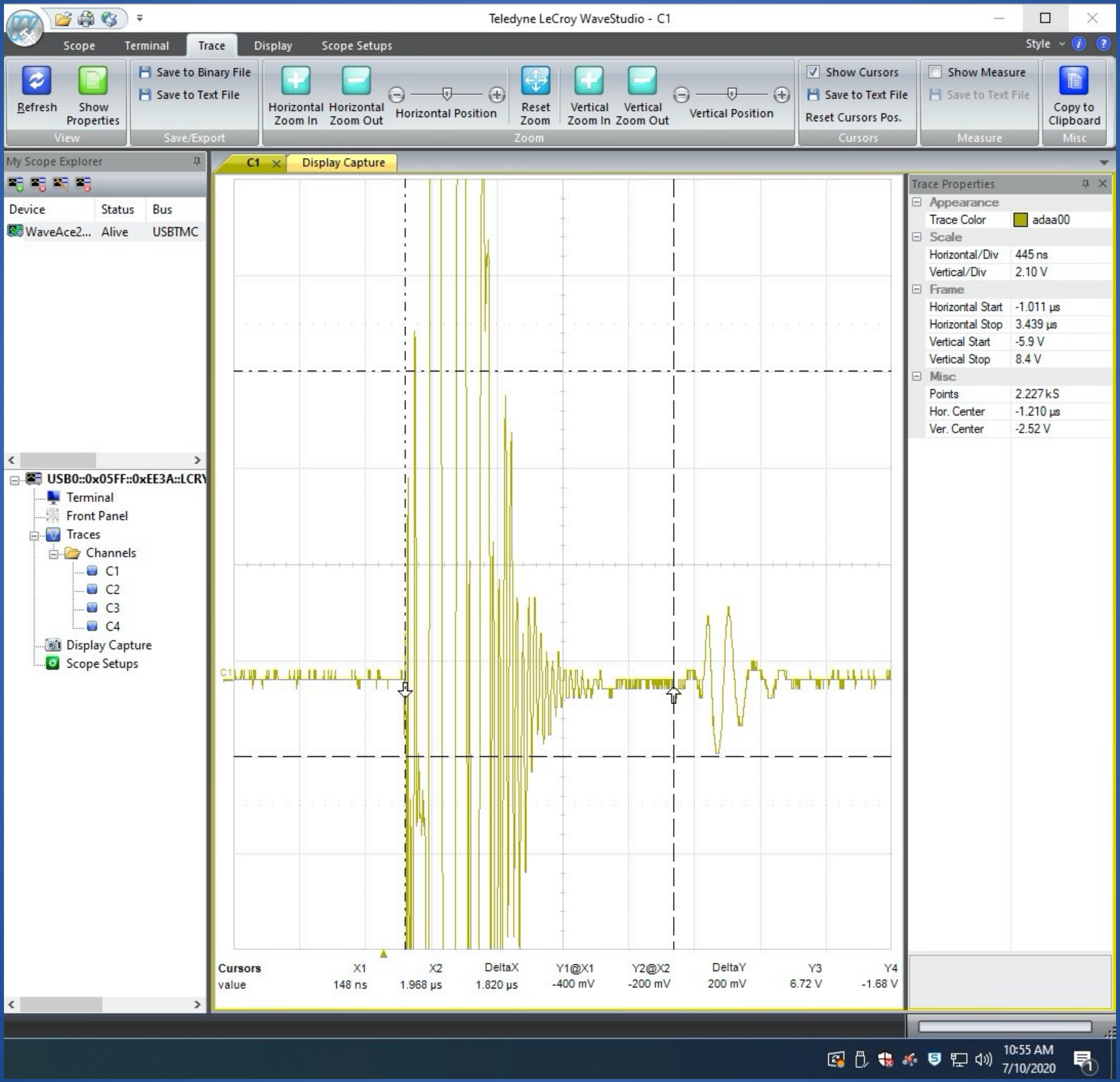
THE PROBLEM: We fly blind (we don't have any information about the hole around the probe).

NASA Jet Propulsion Lab Sub-Scale Melt Probe





July 2020 Melt Jacket Measurement Example



ECE Capstone 2021-2022 Project

Description: Develop analog electronics
(a) to drive a specified piezo-electric transducer with a voltage spike;
(b) to receive an echo arriving within 0.5 - 5 milliseconds

Deliverables:
(a) characterization of a piezo-electric transducer in terms of an equivalent circuit
(b) design and breadboard an analog circuit to impose a short (< 1 millisecond) voltage spike across the transducer input
(c) characterization of circuit/transducer response using a fast oscilloscope
(d) design, breadboard and demonstrate a receiver circuit

Required Skills:
(a) analog circuit design, construction and characterization
(b) writing skills to compose a clear, comprehensive report

Degree Progress: Web app for Student Degree Planning

Payman Arabshahi, Stephanie Swanson
UW Electrical & Computer Engineering
paymana@uw.edu, stepswan@uw.edu

Project Description

- Degree Progress will simplify and personalize the degree planning process for undergraduate students.
- The application will provide a comprehensive list of degree requirements and will make it simple for students to select and plan courses for future terms.

Desired Outcomes and Deliverables

- Students can use Degree Progress to:
  - Create and manage a term-by-term personalized pathway that aligns with courses in their degree plan.
  - Track progress towards achieving their degree pathway goals.
  - See degree percentage completion in major and minor(s)
  - Understand how degree and career path decisions have an impact on their overall degree progress.
  - "Simulate" different quarter course options and see their effect on degree completion
  - Import planned courses directly into registration

Design Parameters, Scope, & Performance Criteria

- User-friendliness
- Comprehensive coverage of the ECE curriculum
- Portable to other engineering majors in the future via changes in the backend/course databases
- A fully working web based tool using open-source technologies, for degree planning, mobile friendly as a web app, usable across Android or iOS without OS-specific programming.

Extensions and Stretch Goals

- Integration with UW NetID, myUW, and UW online course registration

Required Disciplinary Skill Sets

- Software programming
- Web technologies
- Databases

UW MCF

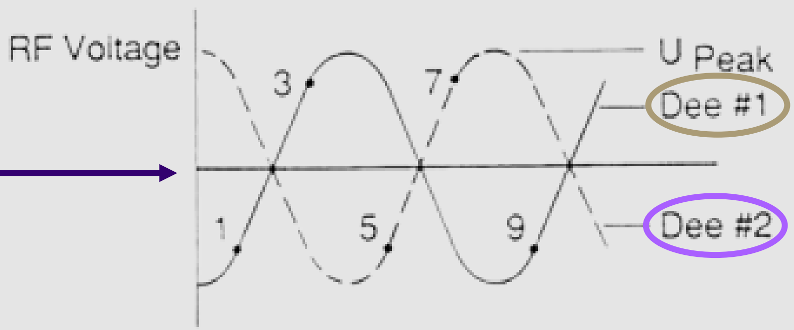
UW Medicine
DEPARTMENT OF RADIATION ONCOLOGY

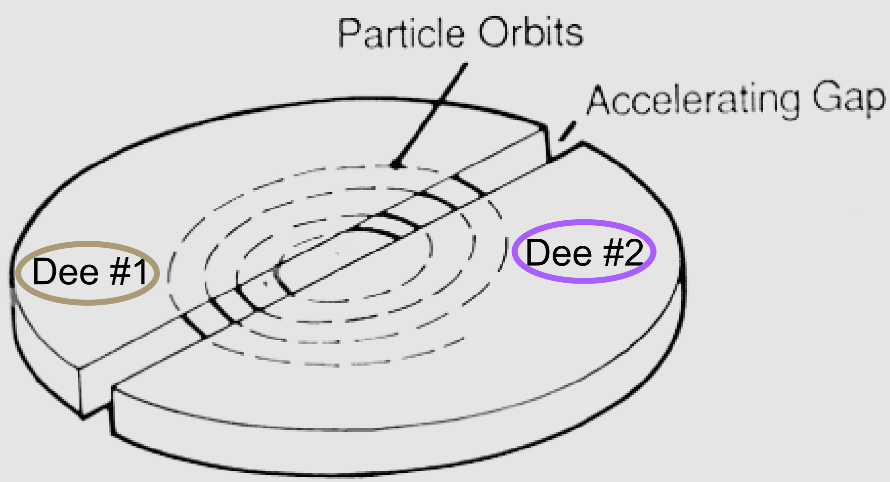
High Frequency RF Phase Meter for Medical Cyclotron

Marissa Kranz
kranzm@uwmcf.uw.edu

Brief Background

- The cyclotron accelerates particles using two high frequency RF signals (~20MHz) that oscillate an electric field
- The phase difference between these two signals is a critical parameter
  - Affects acceleration path inside machine and extraction efficiency
- We need to measure this phase difference for use in closed loop control





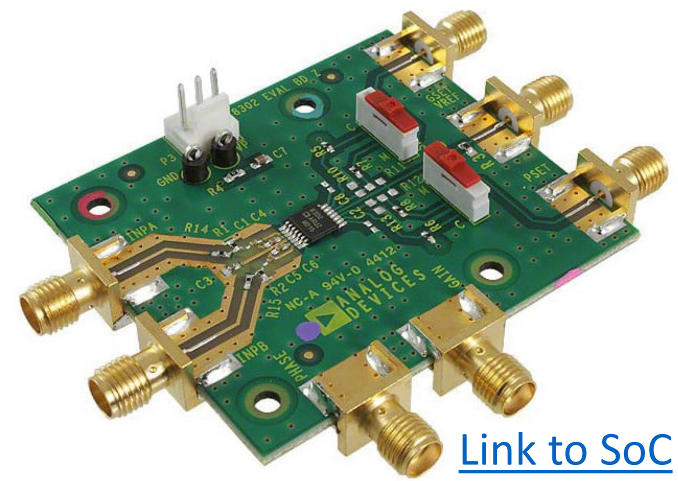
Ideal Case: phase difference of 180°

Reality: phase difference closer to 176°

Project Description

- Design and build a system to measure the phase difference between the RF signals and output a -5V to 5V signal (where 0V is 180° out of phase)

- We have identified an SoC that we think will work for this and you get to investigate if it will:
  1. function as needed
  2. integrate with the larger RF system (mainly has to do with characteristics of output signal)



Link to SoC

- Pending successful feasibility test, build supporting circuitry for chip and integrate into the larger system with guidance from staff engineers

Outcomes & Deliverables

- Documented feasibility study including evaluation parameters, outcomes, and a final recommendation
- Either a design for a new phase meter using the SoC or an investigation into suitable alternatives
- The full design would include power supplies/distribution, circuit protection, A/D converter, and connectors all mounted in a 19” rack
- Full set of documentation (write-ups, schematic, etc)

Parameters & Scope

- Input: two ~20MHz RF signals with 50Ω input impedance
- Output: one voltage signal on the -5V to 5V range to integrate easily into the existing closed loop control
- SoC mounted on eval board will be provided from the start

Required Skill Set

- Circuits Design and Analysis
- Technical Writing
- Electronics Testing and Evaluation

Helpful Knowledge

- Interpreting standard circuit diagrams
- Cabling and Mechanical Assembly
- RF Signals and Systems

UW MCF

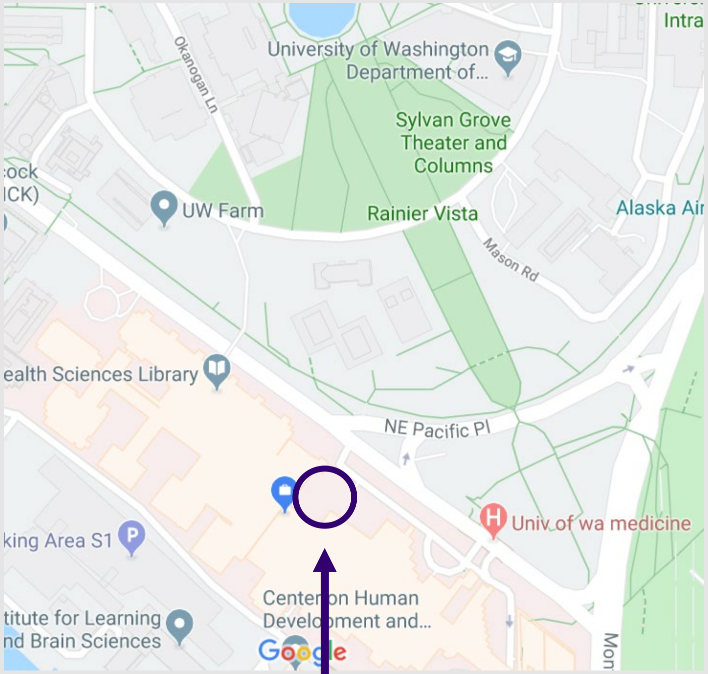
UW Medicine
DEPARTMENT OF RADIATION ONCOLOGY

Logistics

Location: UW Medical Center

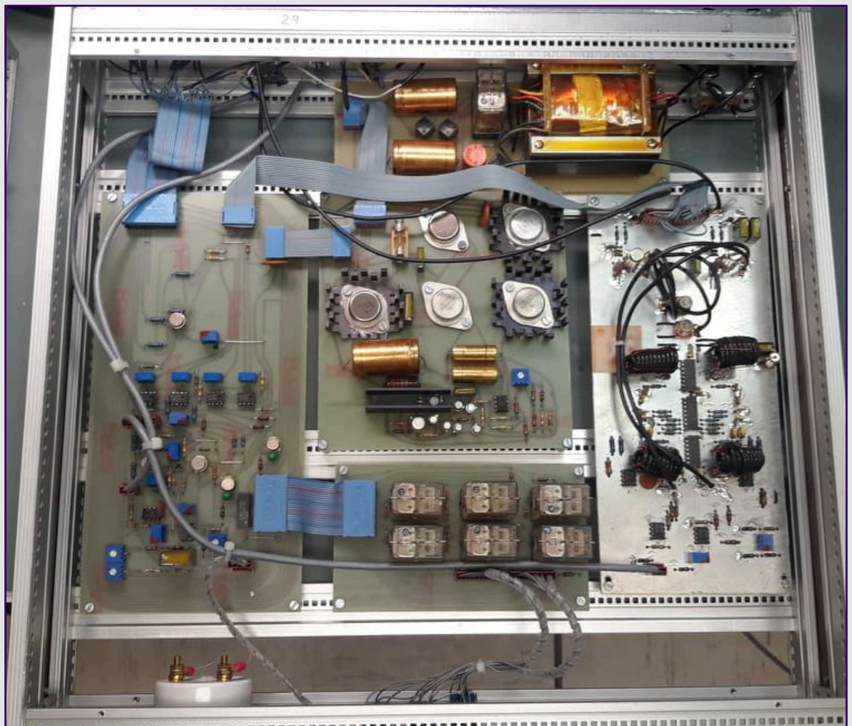
Time Restrictions:

- In-Person Development: M-F roughly 8-5
- System Testing: Daily on testbench; Mondays, afternoons, weekends for integrated testing

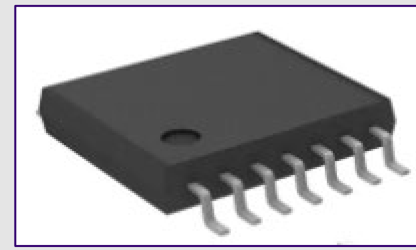


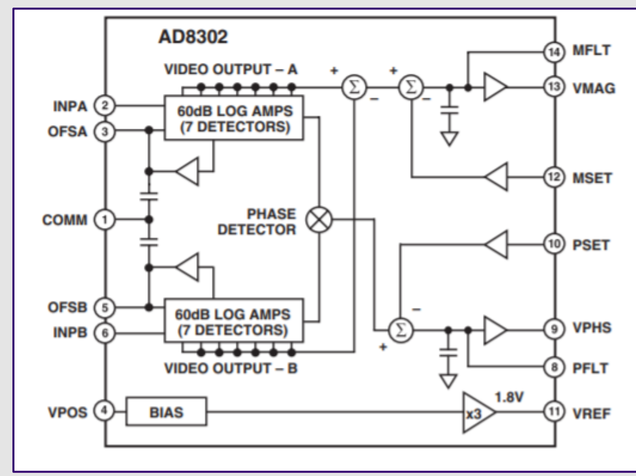
You would work here

40 Years of Advancements



Replace entire box with single new chip



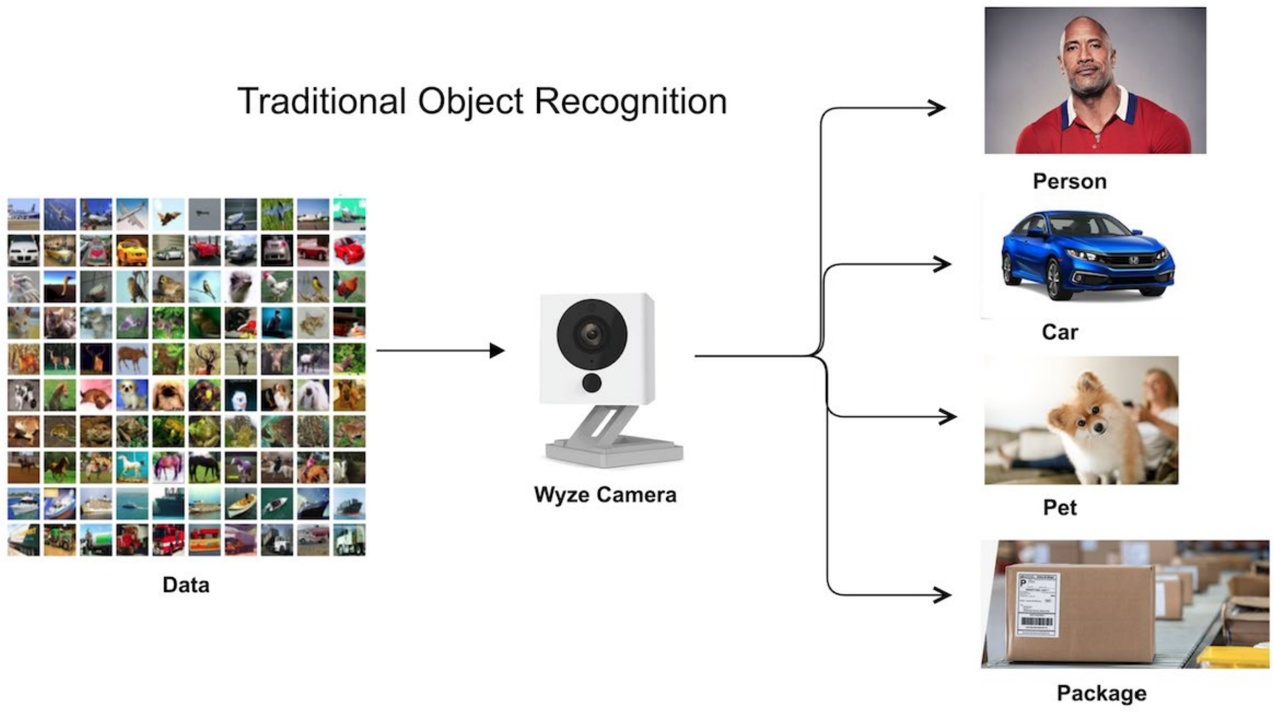


Fine-Grained Object Recognition using Wyze Cam

Pradeep Singh, Zhongwei Cheng
Wyze Labs, Inc.

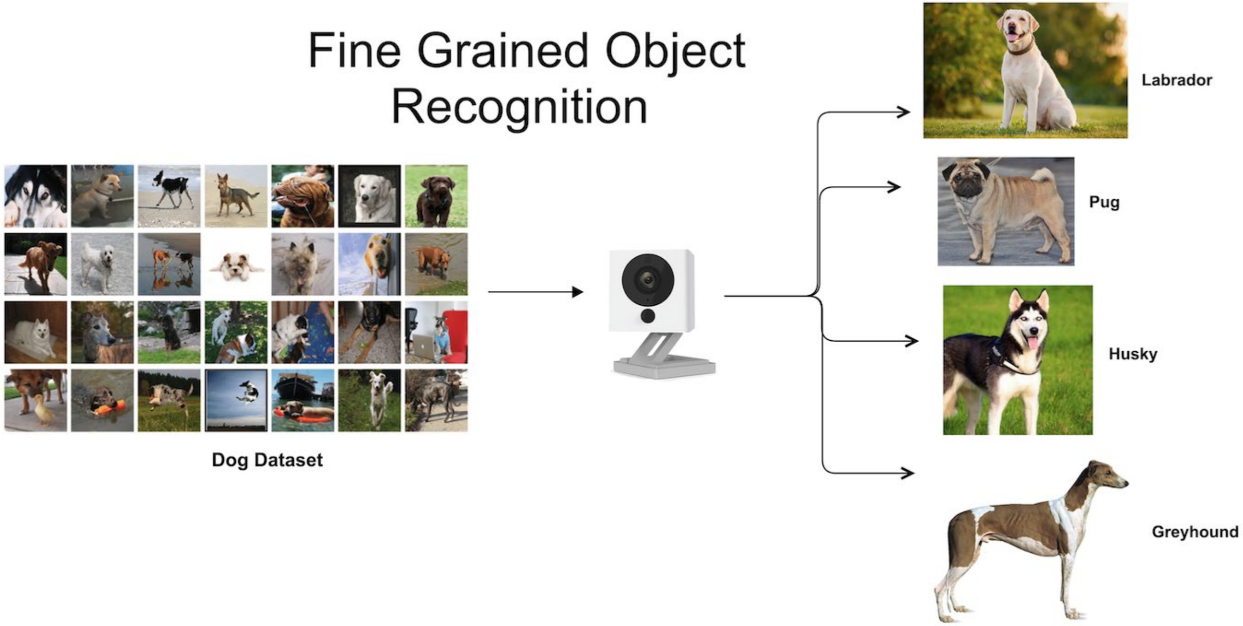
Object Recognition

Object recognition is a computer vision problem for identifying objects in images or videos.



- Well defined problem in ML
- Coarse-grained meta-categories
- Objects are very different
- Dataset abundance

Fine-Grained Object Recognition



- Fine-grained meta-categories
- Objects are very similar
- Small inter-class variations
- Large intra-class variations
- Data scarcity

WYZE

Project Scope

1. Research: Investigate state of the art algorithms in Fine-grained Image Classification and related topics.

2. Problem Definition: Define the target class taxonomy for home monitoring scenario.

3. Data: Sourcing open-source data sets, collecting dedicated data with Wyze devices and building data assets for model training and evaluation.

4. Software: Developing machine learning model and corresponding model building and hosting software system.

Project Deliverables

1. Model: A model that can classify a given image into its subclasses.

2. Software: A codebase of training and evaluating this model.

3. Dataset: A dataset with labeled target class taxonomy on Wyze device captured data.

4. Documentation: All the reports/ presentations describing the project.

Required Skill Sets

1. Computer Vision and Machine Learning knowledge background, graduate students in related areas are preferred.

2. Coding language: Python, C/C++

3. Deep learning frameworks: PyTorch/ TensorFlow

4. Scientific libraries: NumPy, SciPy, Matplotlib, scikit-learn etc.

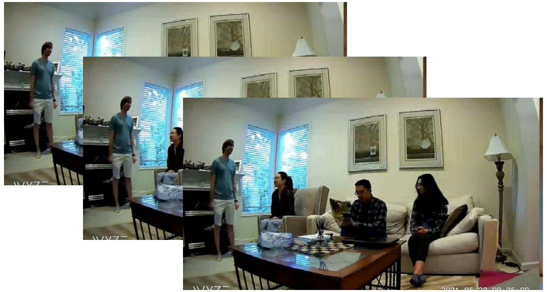
WYZE

Smart Home Memorial Event Video Captioning

Hung-Min Hsu, Zhongwei Cheng

Video Captioning

Video Captioning is a computer vision problem for generating descriptions for videos.



Four people are in the living room.

WYZE

Wang, Bairui, et al. "Reconstruction network for video captioning." *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2018.

Project Scope

1. Research: Investigate state of the art algorithms in video captionig and related topics.
2. Problem Definition: Automatically generate captions for home monitoring scenario.
3. Data: Sourcing open-source data sets, collecting dedicated data with Wyze devices and building data assets for model training and evaluation.
4. Software: Developing machine learning model and corresponding model building and hosting software system.

WYZE

Project Deliverables

1. Model: A model that can generate caption for a given video.
2. Software: A codebase of training and evaluating this model.
3. Dataset: A dataset with labeled captions on Wyze device captured data.
    - The project is to use the pre-trained model of state-of-the-art video captioning methods to generate the video caption for the collected data. Then, you need to refine the generated captions manually.
4. Documentation: All the reports/ presentations describing the project.

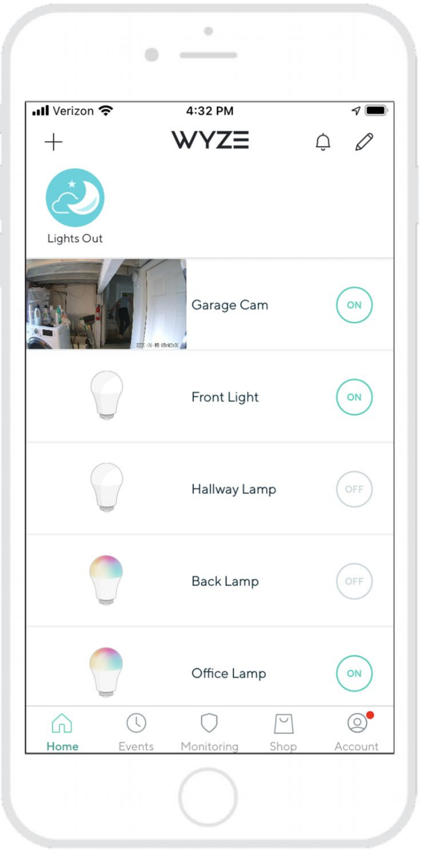
Required Skill Sets

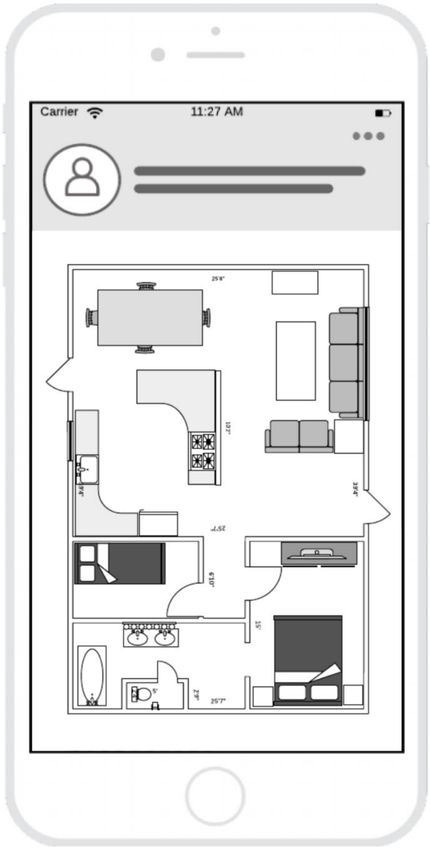
1. Computer Vision and Machine Learning, graduate students in related areas are preferred.
2. Coding language: Python, C/C++
3. Deep learning frameworks: PyTorch/ TensorFlow
4. Scientific libraries: NumPy, SciPy, Matplitlib, sk-learn etc.

WYZE

Wyze Places

Randy Tang, Sreekanth Ruthala, David Hwang
Wyze Labs, Inc.





Project Overview: Wyze Places

Design and create a new mobile app (Android and/or iOS).

Visually depict a user's physical space.

Display "bird's eye" visualization of the state of a Wyze smart home.

Project Scope

1. Problem Definition

   Typical smart home apps present a hierarchical list of devices, which lacks context.

1. Design Solution

   UI with visual metaphors to provide richer contextual information about relationship between smart devices, physical spaces, and people who occupy that space.

1. Implementation

   The app will allow users to organize and arrange icons on a “map”, so they can interact with devices by tapping on placed icons.

Functional Requirements

1. add, edit, delete map
2. add, edit, delete devices on the map
3. access and control devices from the map
4. integrate with existing Wyze backend services

   [stretch goals]

1. integration with home automation for real-time monitoring
2. unit tests

WYZE

Project Deliverables

1. Code

   Complete source code

1. App

   Functional, executable Android and/or iOS app

1. Design Documentation

   Wireframes, user flows, HiFi design mocks, etc.

1. Technical Documentation

   GitHub readme, including build and install instructions & other technical information.

WYZE

Required Skill Sets

1. Computer science

   Data structures, algorithms, object-oriented programming

1. Design

   Graphical user interface skills

1. Front-end mobile development

   Familiarity with (or strong interest in) native mobile programming (Java, Kotlin, Obj-C, or Swift)

1. Collaboration tools

   Git (GitHub)

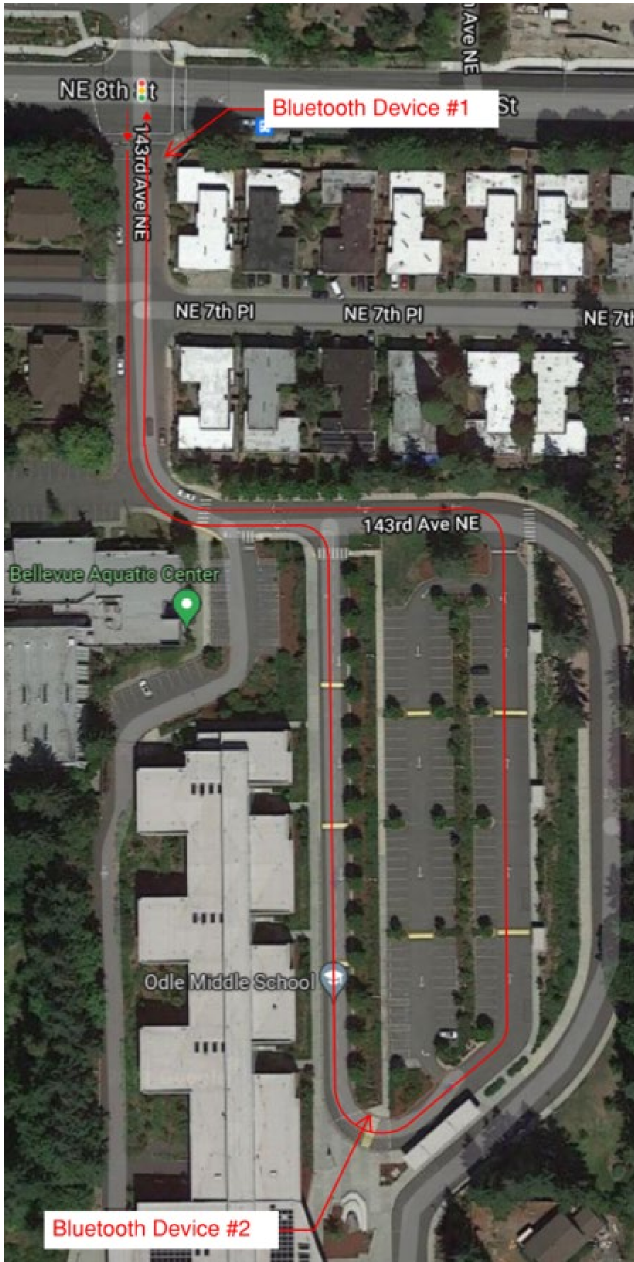
Thanks

School Zone Traffic Queue and Wait Time Monitoring System

Daniel Lai
dlai@bellevuewa.gov
City of Bellevue

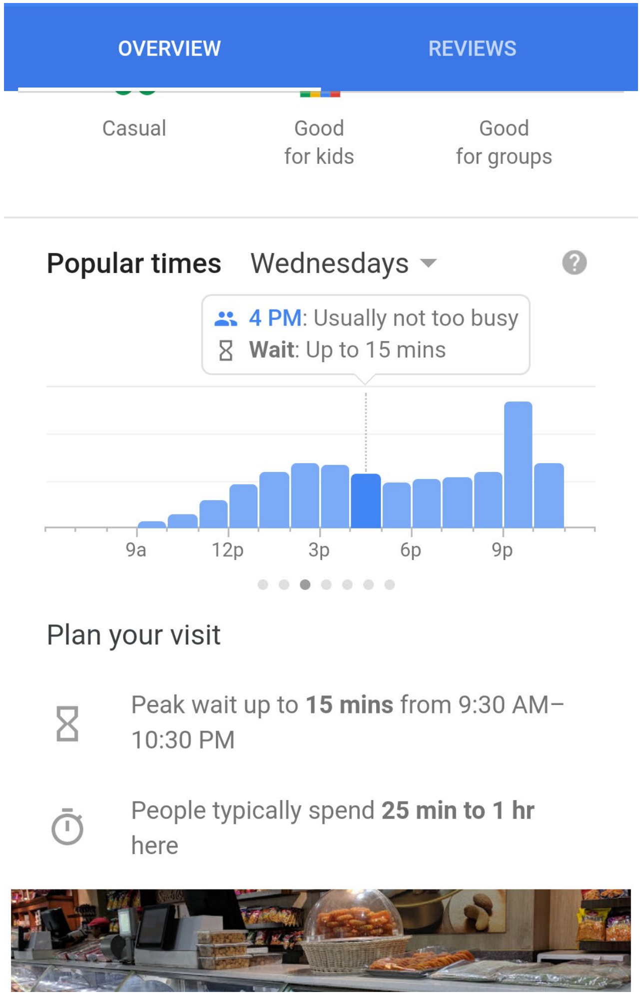
Project Description

- Utilize City of Bellevue’s travel-time system to analyze wait times and estimated queue lengths at 2 Bellevue Schools during peak pick-up and drop-off periods.
- Develop a wait time prediction algorithm/model that considers prevailing conditions (i.e. weather, queue capacity, school schedule, etc.)
- Apply other data sources (i.e. crowdsourced data), as available
- Validate the accuracy of the algorithm using traditional ground-truthing methodology.



Desired Outcomes and Deliverables

- **Outcome:** Ability to predict traffic queue and wait times at Bellevue schools and demonstrate scalability to other locations with known recurring congestion.
- Think Google's "historical busyness information"
- Deliverable includes:
  - A comprehensive study of queue formation and wait times
  - A predictive model for queue length and wait times.



Design Parameters, Scope, & Performance Criteria

- Algorithm shall be developed using no less than 4 months of data.
- Traffic queue lengths to be reported in units of feet and wait times to be reported in minutes. Average, median and normalized values for each of the metrics to be furnished.
- Consider the use of traditional predictive analytics models and artificial intelligence capabilities
- Algorithm format should be transferable/forward compatible with a City of Bellevue accepted platform for applications development.

Extensions and Stretch Goals

- A public-facing version of the application developed on Android/iOS/web platform, which meets City of Bellevue applications development standards.
- Standards to be determined with City of Bellevue IT department.

Required Disciplinary Skill Sets

- Embedded design, programming
- Controls
- Communications
- Software programming

Broadcast Remote ID Transceiver with Traffic Display Interface

Matthew Hamilton
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Sagetech Avionics

ELECTRICAL & COMPUTER ENGINEERING

Project Description

- Sagetech Avionics designs micro transponders and collision avoidance systems for use in primarily UAS but are also relevant to crewed aircraft.
- UAS are now required to equip with a remote ID solution, essentially a Bluetooth 4/5 or Wi-Fi transceiver that broadcasts data that can be displayed on a smart phone. The device needs to reach a range of 2km.
- There is a specified data format that is detailed to transmit the UAS ID, type, timestamp, operational status, Position, altitude, velocity, heading, etc.

Desired Outcomes and Deliverables

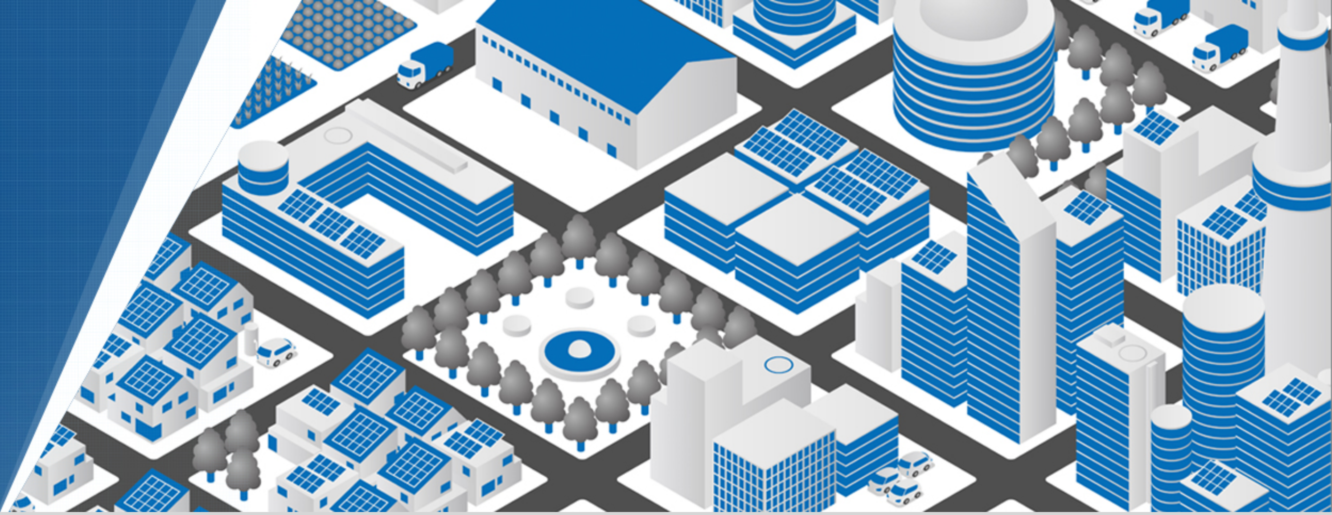
- FPS - Functional Product Spec
- SRS - System Requirement Spec
- Requirements Trace matrix that allocates high level (SRS) requirements to specific low level functions (HW, SW, Mechanical)
- Low level requirements docs
- Test plans to cover all requirements documents
- **Prototype hardware that can be used on multiple UAS to be tracked on a common display application on a smart phone/tablet.**

Design Parameters, Scope, & Performance Criteria

- PDR - (Preliminary Design review): FPS complete, draft SRS, schematic and CAD models complete, vetted SW development on dev board, have beta display application.
- CDR - (Critical Design review): SRS complete, Requirements matrix has requirements allocated, lower level req docs created, Test plans created.
- Final submittal - Drawing Package complete, Hardware, software prototype developed, application software test plans executed, and results documented. Applicable Environmental tests performed.

Required Disciplinary Skill Sets

- There would be Electrical and mechanical work to do the circuit board design, mechanical enclosure design and verify the design over performance and environmental testing.
- A lot of it would be Embedded software engineering to program the Transceiver to output the appropriate protocol that aligns with the ASTM specifications.
- There would also be some application software engineering to create the apple or android application to display the traffic on a smart device.



Augmented Reality Mobile App for Building Automation Technicians

Augie Livres
augiel@atsinc.org
ATS Automation Inc.

AUTOMATION

Project Description

- Develop a mobile app or WebApp.
- Utilize the devices rear-facing camera to augment visual aids when targeting a known BAS controller.

Desired Outcomes and Deliverables

- Mobile App (Android) or WebApp
- Augmented Reality Overlay:
  - Controller Identification
  - Input/Output Identification
- Self hosted instances (per project installation).

AUTOMATION

Design Parameters, Scope, & Performance Criteria

- Use modern UI design principles.
- Final app shall be deployed to Google Play Store. Sideloading during development is acceptable.
- Preferred WebApp framework (Angular 11+) OR
- A native or hybrid mobile application.
- QR code stickers, or similar methods, may be used by the app for controller identification.

AUTOMATION

Extensions and Stretch Goals

- Backend and database that compiles information for controllers and their inputs/outputs automatically.
- Support for all controllers offered by Alerton and Delta.
- Read live BACnet data over the network.

Required Disciplinary Skill Sets

- Software programming
  - Mobile or Web
  - Backend hosting
- Augmented Reality
- [optional] Building Automation (BACnet protocol)

E-commerce multi-modal product classification

Qian (Jane) You
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coupang.com

coupang

ELECTRICAL & COMPUTER ENGINEERING

Coupang and product classification at billion scale

- We're a $50B innovative[1] e-commerce company (NYSE: CPNG) serving South Korean market and rapidly expanding in Asia
- **Speed**: Orders placed by 11:59pm arrive by 7am
- **Size**: We deliver more than 3M orders per day
- **Growth**: We're growing 70% YoY

Good product classification is a must for: -

Search Experience

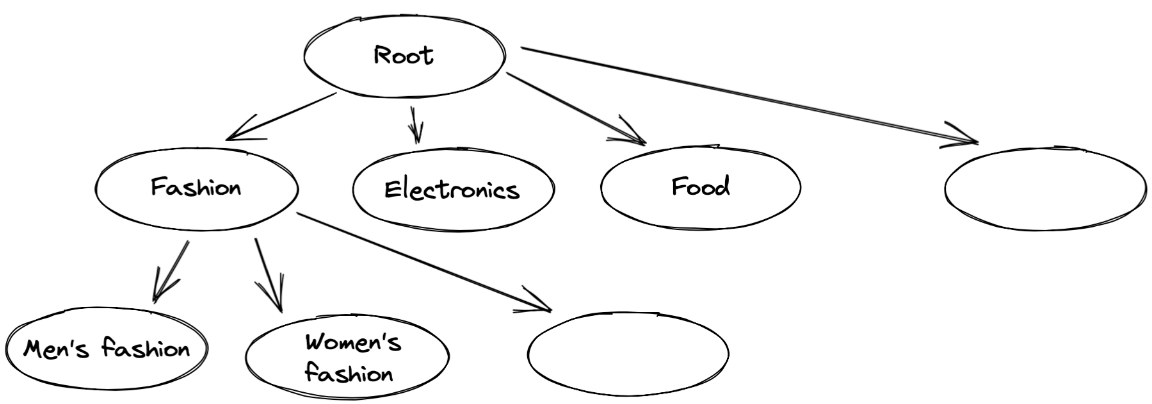
Price competitiveness

Listings and catalog

[1] https://www.fastcompany.com/90457940/asia-pacific-most-innovative-companies-2020

Project Description

- Develop deep learning model(s) to classify e-commerce products using multiple modalities like title and representative images by leveraging state-of-the-art developments
- The label space consists of 20,000+ categories arranged in hierarchical fashion
- Scale to perform inference on 500M+ Coupang products



Desired Outcomes and Deliverables

- Survey relevant research and white papers
- Jupyter notebooks documenting experiments
- Clear documentation to record literature surveys, experiment learnings, model architecture designs & decisions
- Code that is well written, code reviewed, and tested
- ML model(s) deployed into production with the help of MLEs

Design Parameters, Scope, & Performance Criteria

- We want to run the system in a real world setting: -
  - Classify 25M products every day in a few hours with ability to classify 500M+ products in reasonable time
- Design challenges: -
  - You'll be working with Korean and English language text
  - Highly imbalanced dataset
  - Product titles provided by third-party sellers contain garbage words
  - Output categories can be ambiguous
  - CPU based inference is preferred. GPUs can be used for training.
  - Model's output should handle the "I don't know" scenario

Extensions and Stretch Goals

- Innovative ideas are encouraged to be published
- Develop robust data pipelines for model re-training
- Bring down model latency for interactive use cases using: -
  - Quantization aware training
  - Pruning
  - Knowledge distillation
- Continuous learning with feedback mechanism

Required Disciplinary Skill Sets

- Python, Pandas, Pytorch, SQL, Git, Shell scripting
- Good communication and writing skills
- (Preferred) AWS, Docker, Pyspark, Apache Airflow
- (Preferred) Prior experience writing production code
- (Preferred) Prior experience with large scale data sets

Aircraft QR/Barcode

Nellie Suess
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Horizon Air

Project Description

- Develop a QR or barcode for each aircraft and major component in the Horizon Air fleet.
- Aircraft technicians would scan the code to obtain mod status for that aircraft or component.
- Currently, the mod status is available on an internal website, but it is not encompassing.

Desired Outcomes and Deliverables

- The maintenance technicians being able to know the mod status of an aircraft and major component by the barcode sticker.
  - This would improve efficiency, by knowing the mod status instantly, without having to walk back to a desktop and looking up the information.

Design Parameters, Scope, & Performance Criteria

- Unique bar code for each aircraft and major component.
- The ability for the information to be pulled from our internal database without the maintenance technician having to search on a computer.

Extensions and Stretch Goals

- Being able to access the mod status for each aircraft and component.
- Once selected, easy view of the mod status on a mobile device, i.e. iPhone or iPad.
- The application to work with either a tableau database, and or TRAX (Horizon’s Maintenance Database).

Required Disciplinary Skill Sets

- Embedded design, programming
- Controls
- Communications
- Software programming

3D-AI-camera-aided ⇔ VTOL-Multirotor Vehicle Control and Landing

Dr Dave Laning david.laning@insitu.com

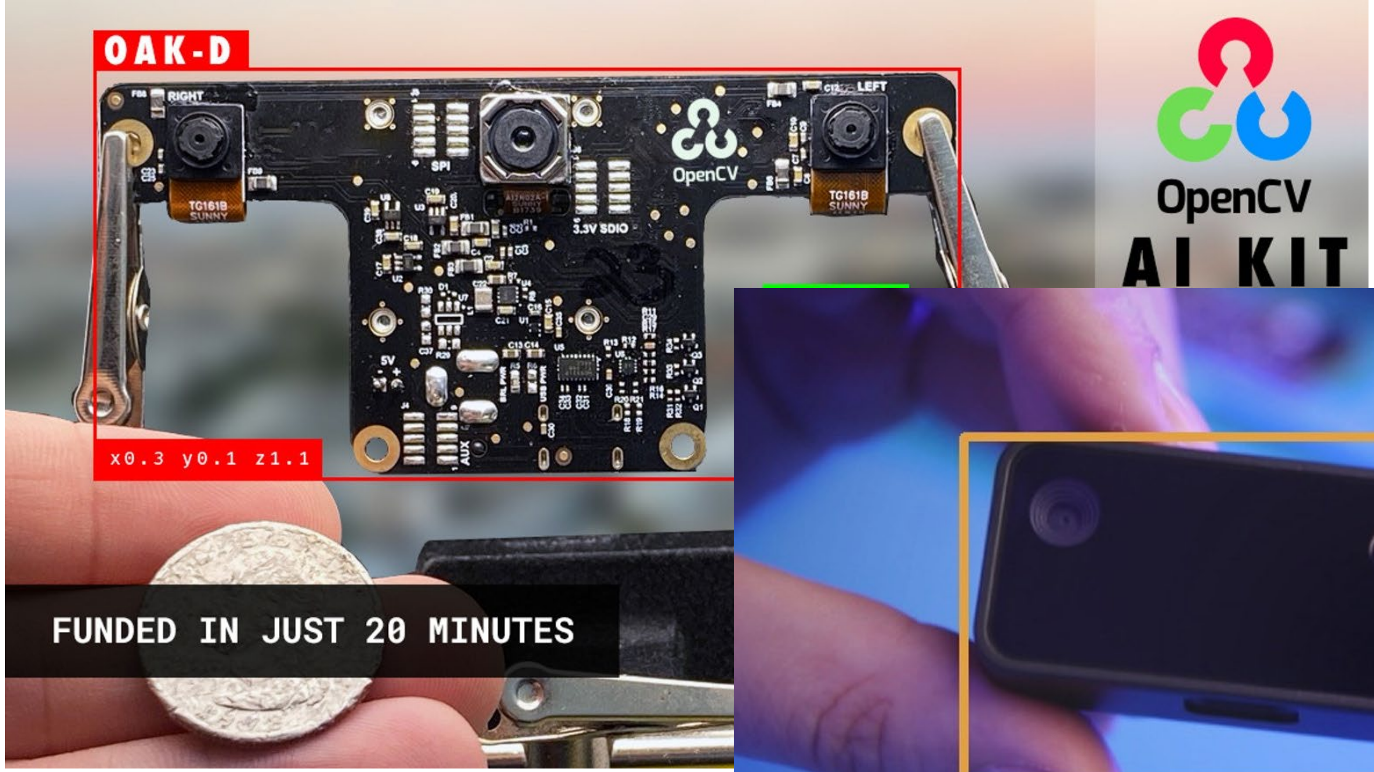
Jeff Decker jeff.decker@insitu.com

Project Objective and Description

INSITU
A Boeing Company

- Build an AI-camera enabled controller that makes it easy to land a multirotor vehicle in a confined space while that confined space is being moved/tipped/rotated
- Use an AI camera with depth perception
- Insert camera into the control loop of an open source ground controller used by an open source quadcopter (CoDrone Pro)
- See:
  – https://www.kickstarter.com/projects/opencv/opencv-ai-kit/description (available)
  – https://www.kickstarter.com/projects/opencv/opencv-ai-kit-oak-depth-camera-4k-cv-edge-object-detection (alternative if shipped in time)
  – https://shop.robolink.com/products/codrone (quadcopter with open source controller)

Project Objective and Description: 3D camera(s)



- OAK-D : Available
- OAK-D-LITE : On Order

Project Objective and Description: Programmable Drones (2)

INSITU
A Boeing Company

Visit the Robolink Store

Robolink CoDrone Pro - Programmable and Educational Drone Kit

54 ratings

Price: $214.99 & FREE Returns

Pay $35.83/month for 6 months, interest-free upon approval for the Amazon Rewards Visa Card

Brand	Robolink
Model Name	Codrone Programmable and Educational Drone Kit
Control Type	Voice Control
Are Batteries Included	Yes
Wireless Communication Technology	Bluetooth

See more

About this item

- Fun and educational drone
- Perfect for beginners learning programming
- Arduino Compatible controller
- Use your Apple or Android smart phone to fly, battle, voice control CoDrone
- Easily removable/replaceable motors

Compare with similar items

Desired Outcomes and Deliverables (General)

- Outcomes:
  - Multirotor vehicle will be able to land in the center of a (1m,1m,1m) cubicle container onto a landing fiducial even if the cube is being moved/ tipped / rotated during the landing process.
- Deliverables:
  - Recorded videos of key flight demonstrations and tests
  - Documented lessons learned
  - Pseudocode algorithms & Source code
  - Documented high level architecture and systems diagrams
  - System Performance Limitations and Observations Report
  - Design and System Trade-off Analyses
  - Any Stretch Goal (Desire [D]) Accomplishments
  - Future Work Statement

Design Parameters, Scope, & Performance Criteria (General)

- Multirotor vehicle will be able to land in the center of a cubical container onto a landing fiducial even if the box is being moved/ tipped / rotated during the landing process. (see above)
- High level diagram and system architecture:
  - (Confined Landing Space)🡐(Multirotor Vehicle)⬄ (Radio-control-link and AI-camera-observing-the-vehicle⬄(PC-based Control Logic)
- Insitu will negotiate a final demonstration plan with the UW faculty.
- Take Measurements of the limitations of control given roll/pitch/yaw/translate actions inside the landing cube will be determined. Accuracy and Precision of measurements are set by engineering needs for design improvements

Design Parameters, Scope, & Performance Criteria (Specifics) [Required] [Desired]

Requirements (Goals)

- Drone shall not touch sides of the box when landing [R]
- Design/Approach must be developed to identify and track via the camera vehicle orientation for forward/backward/left/right control [R]
  - Fiducials / Flight maneuvers / Other
- Camera must be fixed to the box frame of reference in the best location as determined by a trade analysis [R]
  - Bottom / Side / Corner / Above
- Land with +/- 10 degree roll or pitch fixed tip of box[R]
- Land while box translating at 10cm/sec in any direction[R]
- No Proximity sensors [R]
- No GPS [R}
- Powered flight all the way to within 5cm of the “ground” [R]
- 1st test : Stationary box auto landing by NLT April 1 [R]
- Measurements of performance must be recorded and analyzed [R]

- **Desirements (Stretch Goals)**
- Design and use fiducials on box and markers on vehicle – must not violate swap[R]
- Land smoothly even with box in z motion[D]
- Land in a breeze[D]
- Drone should land in less than 60 seconds once seen by camera [D]
- Error handling when out of FOV (lost) [D]
- Automatic switch to auto land when vehicle has entered FOV [D]
- Land while +/- 10 degree roll or pitch and while 10 sec tip period of box (1/10 Hz) [D]
- Land while +/- 18 degree/sec yaw rate of box [D]
- Land while box lifting/lowering at 2cm/second [D]
- Handle variable lighting conditions[D]

Required Disciplinary Skill Sets in Descending Order:

- A&A : Vehicle Flight Control / Auto-landing command logic / down wash handling design / control loop integration;
- CSE: Algorithm development / free flight to auto-landing handoff ;
- ECE: AI camera and control loop integrations ;
- ISE: Systems Engineering integration and trade studies;

--

- ME: Landing pad design and landing lock-down methods ;
- HCDE: Computer ground station user interface and controller design

References and Materials:

- Books and Papers
- On the web
  - https://www.kickstarter.com/projects/opencv/opencv-ai-kit/description (available)
  - https://www.kickstarter.com/projects/opencv/opencv-ai-kit-oak-depth-camera-4k-cv-edge-object-detection (alternative if shipped in time)
  - https://shop.robolink.com/products/codrone (quadcopter with open source controller)
  - https://www.youtube.com/watch?v=gCZ8YYQp9pw Apollo 13 docking
    - Note the alignment fiducials on the vehicle
  - https://www.youtube.com/watch?v=9sGP2XS5r6k Spacecraft Docks to ISS
    - Note the alignment fiducials on the camera and the vehicle (Start at 5:29)

Thank You!

- **Insitu Inc a Boeing Company**
- Dr Dave Laning,
  - david.laning@insitu.com
  - 530-318-0900
- Jeff.decker@insitu.com

vFit Value Engineering

Dwayne Bobbitt
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Joylux, Inc.

Project Description

- vFit Gold is the first smart wellness device that harnesses the power of red light, gentle heat, and sonic technology to improve strength, sensation, and natural lubrication all from the comfort and privacy of your home.

vFit Gold

World's first and only home-use, energy-based device to improve intimate wellness.

Desired Outcomes and Deliverables

- Develop a system of sensors to provide biofeedback to help with determining best treatment for each patient moving forward.
- To reduce the size of the current device by 10-15%
- To reduce the cost of goods by value engineering and looking at alternative components and technologies by 10-20%

Design Parameters, Scope, & Performance Criteria

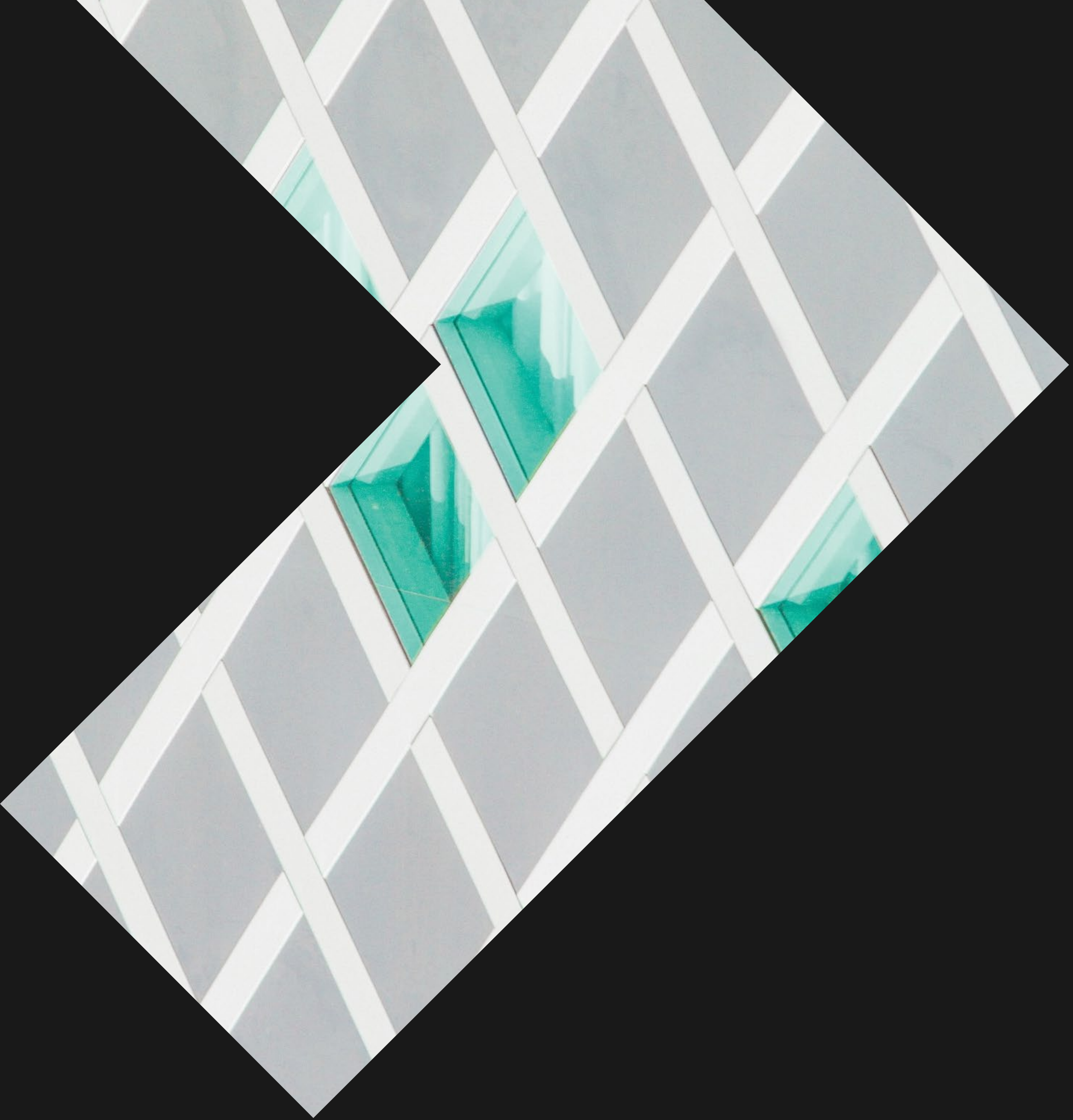
- Design must have the same mechanism of action and performance as current model.
- Vibration, heat and low level light therapy.
- Cutting edge technologies to drive down cost

Extensions and Stretch Goals

- Improved user interface that is more intuitive for demographic
- Technological upgrades with components or metals

Required Disciplinary Skill Sets

- Design for manufacturing
- Mechanical and
- Electrical Engineering
- Experience with plastics and
- Low Level Light Therapy
- LED's.



Intelligent schema advisor

(Working title)

Nick Benjamin

Nicholas.Benjamin@nintex.com

Project Description

At Nintex, we are building the next generation low and no-code platforms. One of the exciting product extensions we are developing allows customers who use the Nintex workflow product to store and manage data natively in the Nintex platform.

Design and build a 'wizard' to extend this platform to enable customers to quickly generate schema from a range of sources.

Example use cases include (but not limited to)

- Suggesting table schema from data (e.g. data in csv)
- Schema import from other well-defined sources (e.g. Nintex Form definitions, SQL Server, AirTable, Google Sheets, etc)
- Suggesting table schema from User Interfaces (e.g. A web page, PDFs, other form products)

nintex

Desired Outcomes and Project Deliverables

- A well-defined intermediate model / DSL
- Working software that can generate the intermediate model / DSL from a range of sources (e.g. data, source schema, etc)
- Working software that can create schema (against a Nintex-provided API) from the intermediate model / DSL

Design limitations and restrictions

- Adheres to Nintex's security guidelines
- Deployed as part of Nintex's (Azure-based) cloud platform and accessible via a web browser
- Meets agreed SLOs (which will define performance and other non-functional quality criteria)
- Leverages only supported libraries, services and platforms.

Extensions and Stretch Objectives

- The user interface is accessible on mobile devices
- The user interface be composed within Nintex's existing portals (by leveraging Nintex architecture and technology standards)
- A mechanism to automatically validate the intermediate model / DSL

Expected Skills

- Infrastructure engineering (cloud)
- Software programming (full stack)
- Machine learning
- Visual artificial intelligence

UW Capstone Project Proposals

Nov 2021

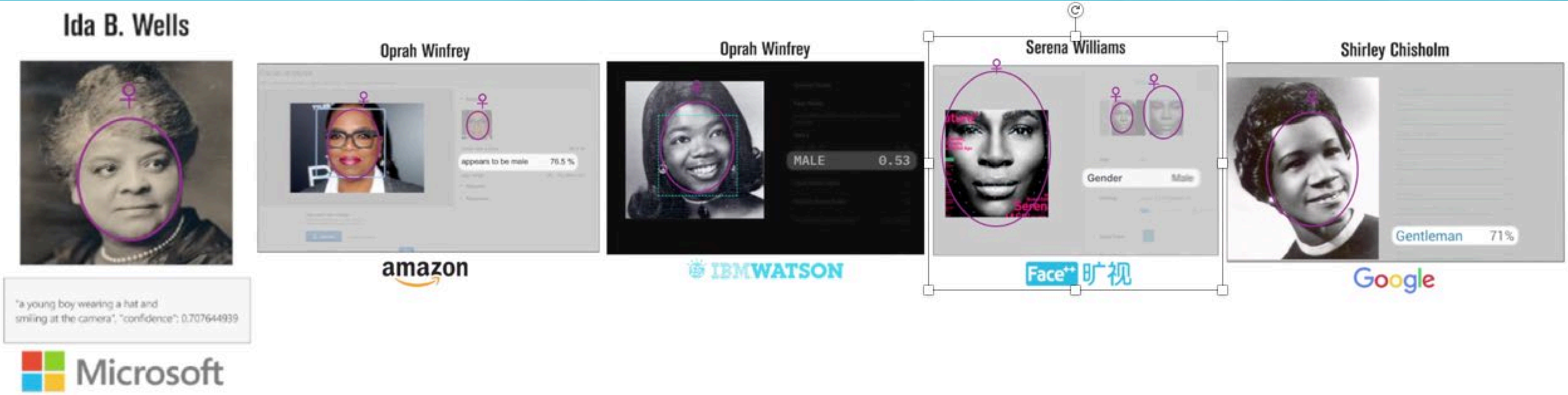
Reza Rassool, CTO

realnetworks

Proposals

- Bias in AI
  - To develop a tool set to measure and reduce bias in AI training sets, test sets, and resulting models.
- Video Facial Recognition
  - To Validate Speed matters hypothesis that FR accuracy for the same subject in the field of view compounds over successive frames of video content.
- SDR to HDR up-conversion using AI
  - To train a model to analyze an SDR image and generate the control parameters for its up-conversion to HDR.

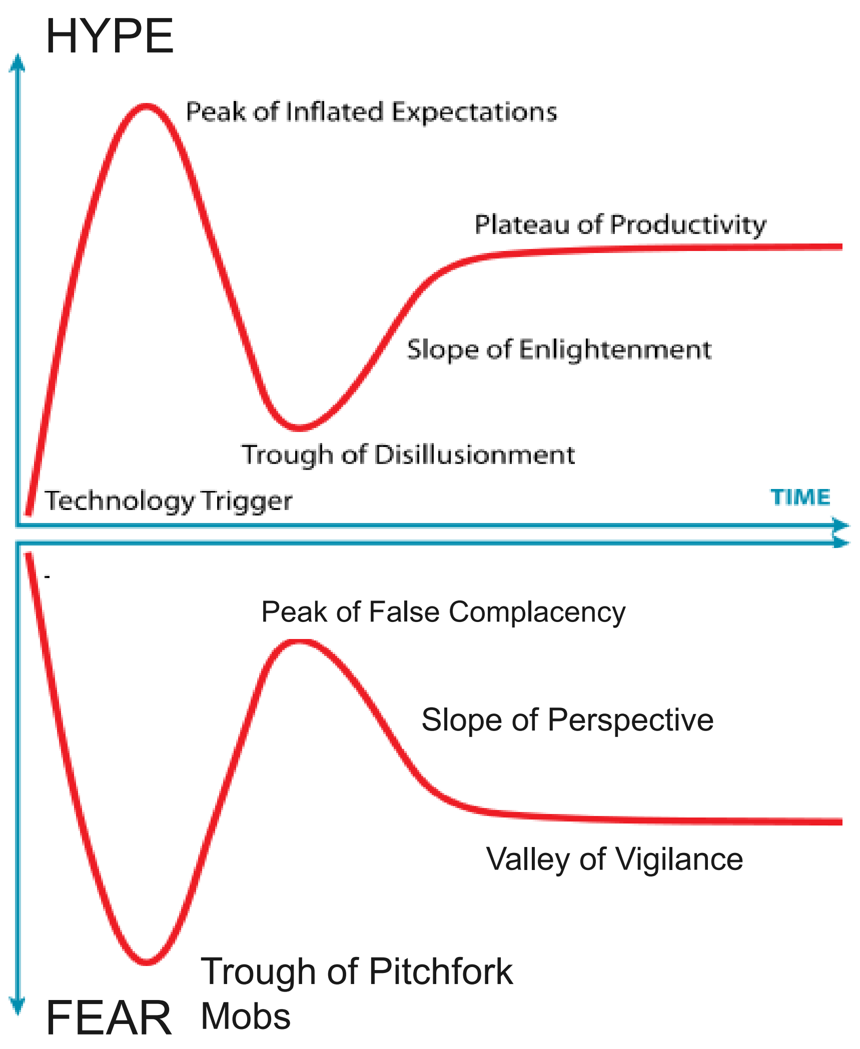
Bias in AI



Ida B. Wells
"a young boy wearing a hat and smiling at the camera", "confidence": 0.707644939
Microsoft
Oprah Winfrey
appears to be male 76.5 %
amazon
Oprah Winfrey
MALE 0.53
IBM WATSON
Serena Williams
Gender Male
Face++ 旷视
Shirley Chisholm
Gentleman 71%
Google

What is the Problem?

- The Gartner Hype Cycle shows how expectations often outrun the productive deployment of new technologies.
- Similarly, some new technologies incite fears that often outweigh rational arguments until we reach a point of acceptance and cautious vigilance.
- Fear sells
- Our Problem is to move the conversation along beyond fear mongering, to gain a perspective and recommend policy.



Project Description

- The project will focus on facial recognition (FR) as a subset of the broader field of AI.
- It will explore the paths through which bias 'infects' a model from data curation, training, and application.
- How can we quantify and measure bias?
- Can we detect bias early enough in the machine learning workflow?
- What is the minimum bias a model should meet in order for a model to at least 'do no harm?'
- Can these findings be generalized beyond FR to other AI?

Desired Outcomes and Deliverables

- A quantitative definition of bias in AI
- A quantitative definition of bias in facial recognition models
- A tool to measure bias in training and test data sets
- A tool to measure bias in an AI model
- A technique to deliver feedback during training to help reduce bias
- Policy recommendation on minimum bias for AI model by a range of dimensions and by application.

Design Parameters, Scope, & Performance Criteria

- Technical Paper including:
  - Quantifiable definition of bias in AI models and associated data sets.
  - A simple mathematical formula with sufficient statistical rigor and applicability across the AI problem domain.
- GitHub repository including:
  - Tool for measuring bias in data sets
  - Tool for measuring bias in models
  - Technique to deliver feedback during model training to reduce bias.
- Policy Whitepaper on Bias in AI including:
  - Recommendation for minimum bias in AI models across a range of dimensions and applications

Extensions and Stretch Goals

- Create a on-line bias league table of self-tested models similar to the Labeled Faces in the Wild (LFW) by U. Mass.
- Submit recommendation to NIST for on-going tests of FR algorithms.
- Establish an on-going program to iterate annually on reducing Bias in AI.

Required Disciplinary Skill Sets

- Engineering
  - Data Science
  - ML
  - Web development
- Tech Policy
  - AI and FR legal and regulatory landscape
  - Ethics, Guiding Principles
  - Policy frameworks
  - White paper authorship

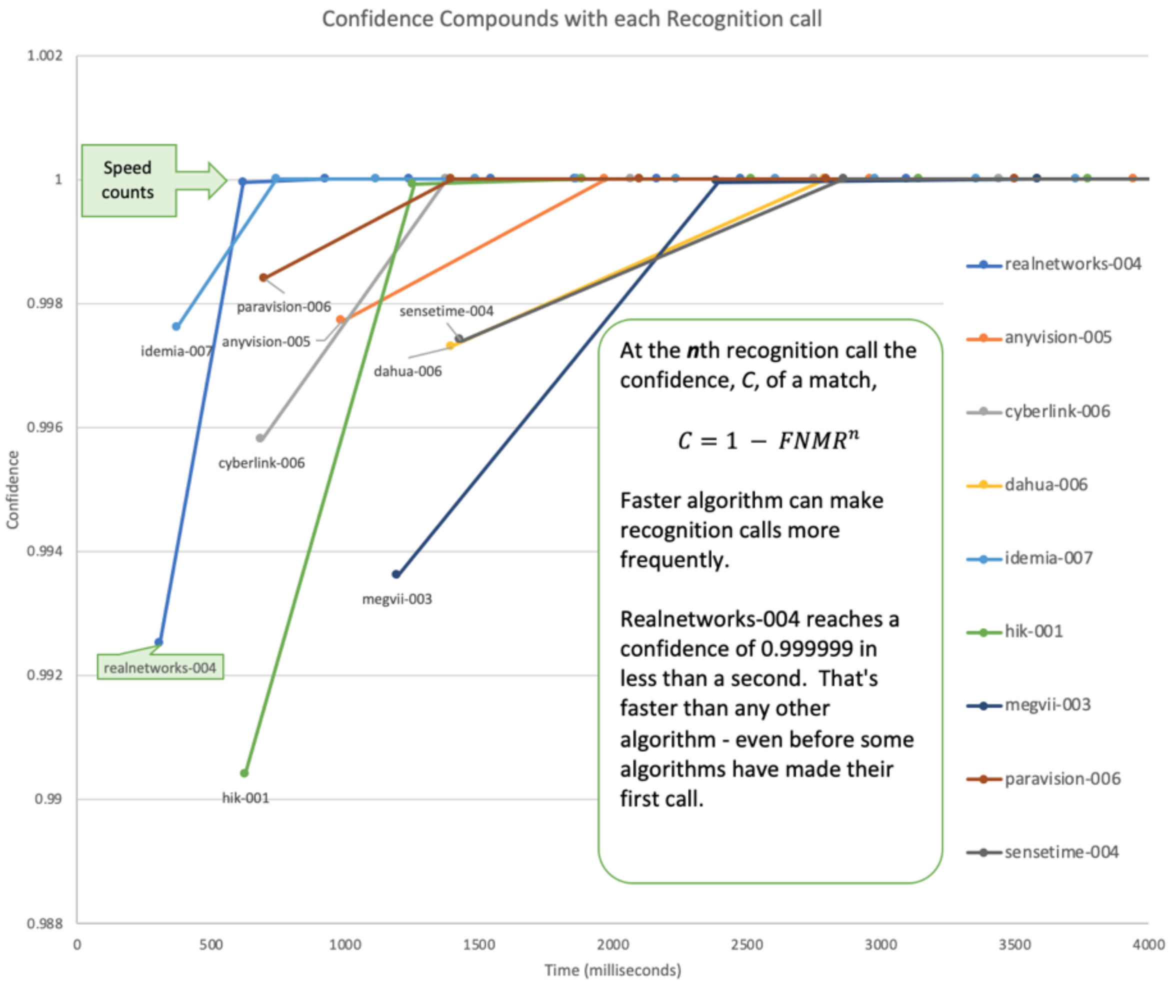
Video Facial Recognition

What is the Problem?

- Face Recognition has progressed from high-powered servers performing off-line search to ubiquitous IoT devices automating access control for consumers.
- Current FR evaluations performed by NIST use still photos. The accuracy of an FR algorithm is a measure of its ability to match a single probe (captured) image of an individual against a database of reference images.
- Now, for real-world, real-time operation the probe images would come from a live video feed such as an IP camera at 30 frames per second.
- Successive frames of a live stream provided a coherence and 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 prove the hypothesis that accuracy compounds with successive frames of a live video feed.**

Project Description

- To Validate *Speed matters* hypothesis that FR accuracy for the same subject in the field of view compounds over successive frames of video content.
- To develop strategies to improve the performance of real-world FR.



Desired Outcomes and Deliverables

- Develop a test protocol to measure the effective matching accuracy for a video facial recognition system. How does it vary with recognition rate?
- Compile a test data set of video content tagged with individuals present in the system.
- Conduct FR tests against the SAFR algorithm and other OTS FR algorithms.
- Validate or disprove the 'Speed Matters' hypothesis.
  - At the ***n***th recognition call, the confidence of match, ***C***, is given by:

$$C = 1 - FNMR^n$$

- Or develop an alternate formula.

Design Parameters, Scope, & Performance Criteria

- Compile a gallery of 10K identities
- Build a cloud application with web UI using the SAFR SDK to test the effective accuracy of FR for live video.
  - Measure FNMR @FMR of 1 in 10K.
  - How does accuracy vary with:
    - Face detection rate?
    - Face recognition rate?
    - Image resolution?
    - Video frame rate?
- Derive a formula for effective accuracy of video face recognition.

Extensions and Stretch Goals

- Increase the gallery size to 100K or 1 million identities
- Open the application to 3rd parties to test their own algorithms

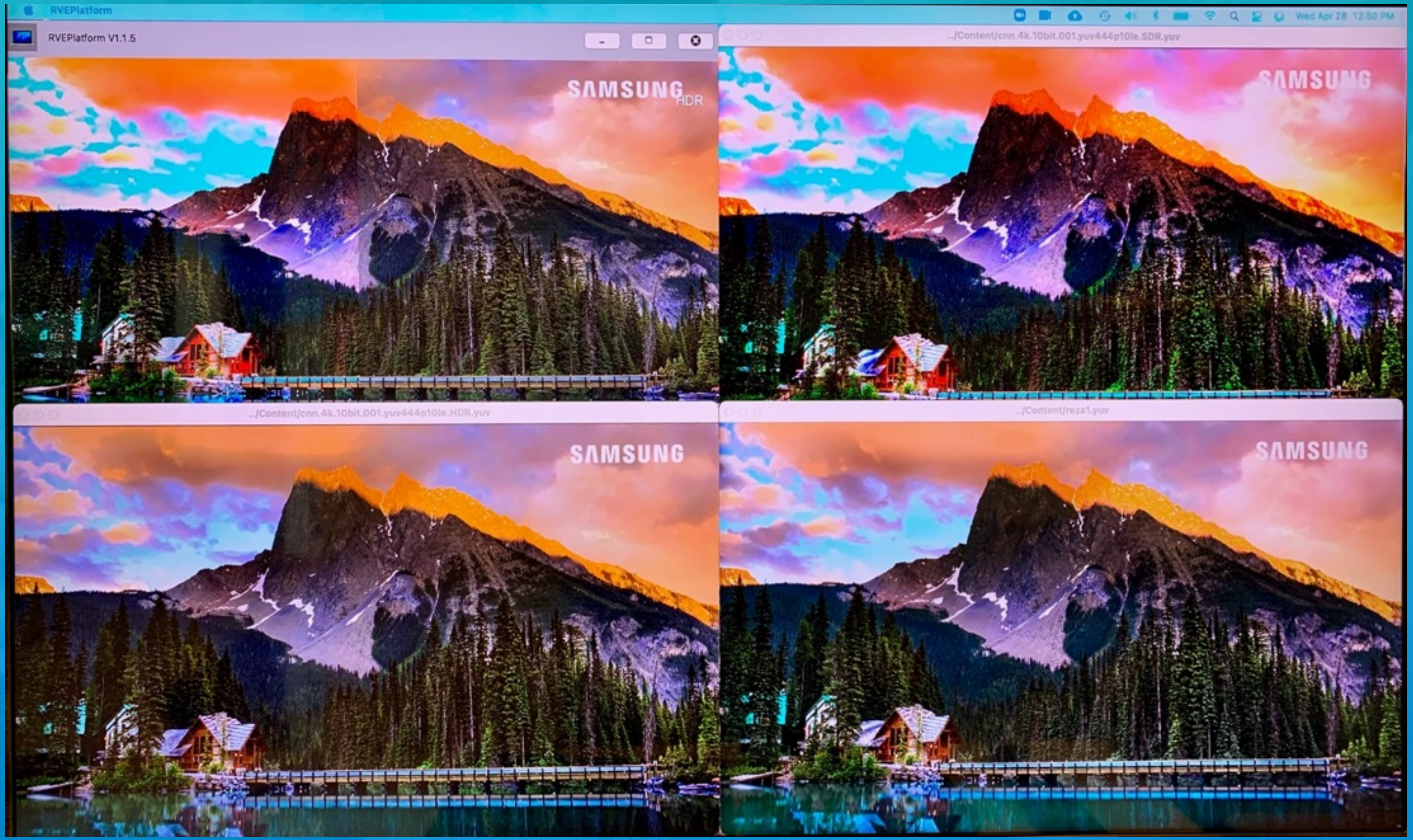
- Develop a strategy for interlacing face detection and recognition that delivers the lowest FNMR.

- Develop a gallery DB sorting, indexing, sharding strategy speed up identity matching.

Required Disciplinary Skill Sets

- Computer Science
- Data Science

SDR to HDR up-conversion using AI



What is the Problem?

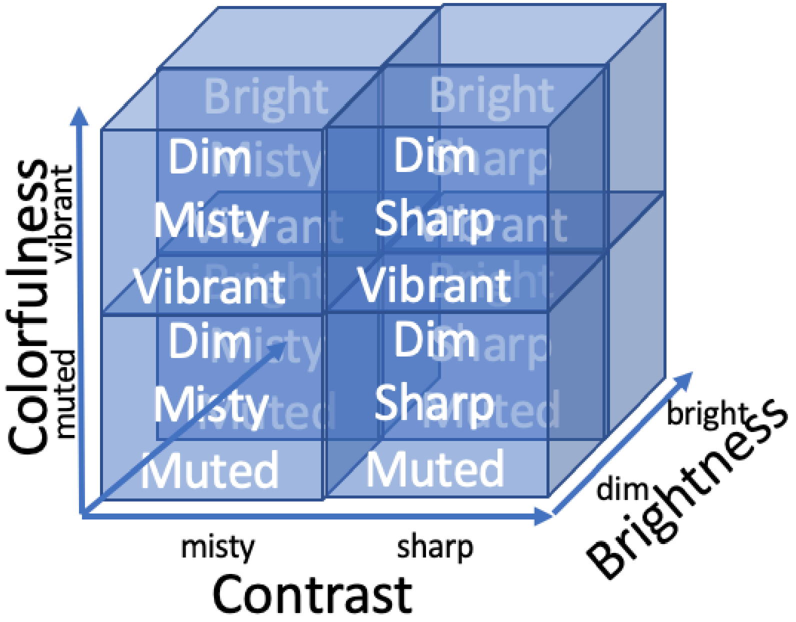
- Display technology has advanced over the past decade, providing consumers with smart TVs of higher resolution, frame rate, brightness and significantly more vibrant colors (HDR).
- However, content formats lag behind monitor specifications. Movies are still captured, encoded and rendered in a manner that doesn't take full advantage of the modern screen.
- This is the motivation of the current research into live video enhancement plugins.

Project Description

- If your new TV detects an HDR input it uses the embedded metadata to apply the correct tone map to properly display the pixels.
- If there's the no embedded metadata then the video is treated as LDR. So, new HDR-capable TVs spend most of their time in LDR mode when playing non-HDR content. Many TV broadcasts, OTT services, and packaged media remain in standard dynamic range.
- What if your TV could transform this legacy content to high dynamic range to take full use of the new display's capabilities? This capstone project is part of an ongoing development to render legacy low dynamic range (LDR) content on modern displays.

Desired Outcomes and Deliverables

- Build a test set of SDR and HDR video pairs.
- Measure performance of various inverse toning mapping (ITM) curves.
- Validate parameterized polar color space ITM.
- Build a training set of SDR and HDR video.
- Classify images by photographic styles
- Train model to optimize ITM parameters for each photographic style.

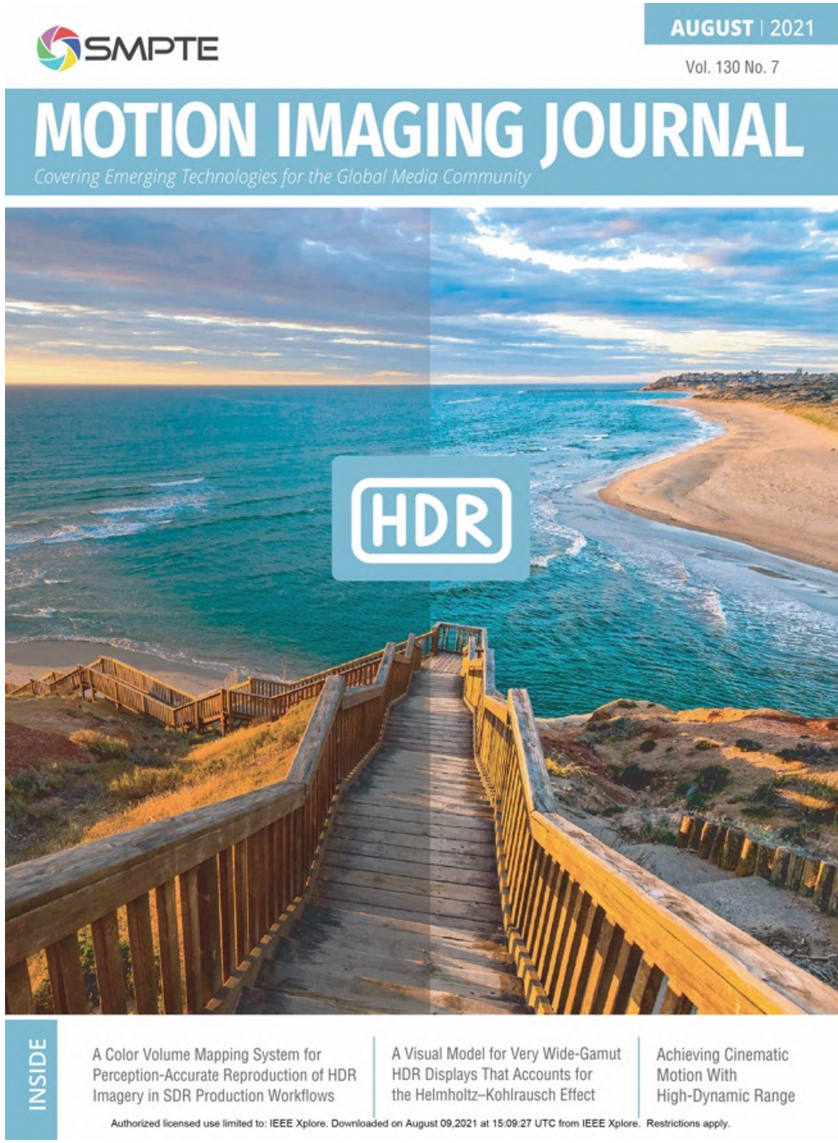


Design Parameters, Scope, & Performance Criteria

- AI techniques already exist to up-convert content including super-resolution, artificial colorization, and frame rate conversion.
- 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.
- The result will be a solution that can be embedded in a TV processor. This is typically an ARM quad-core processor.

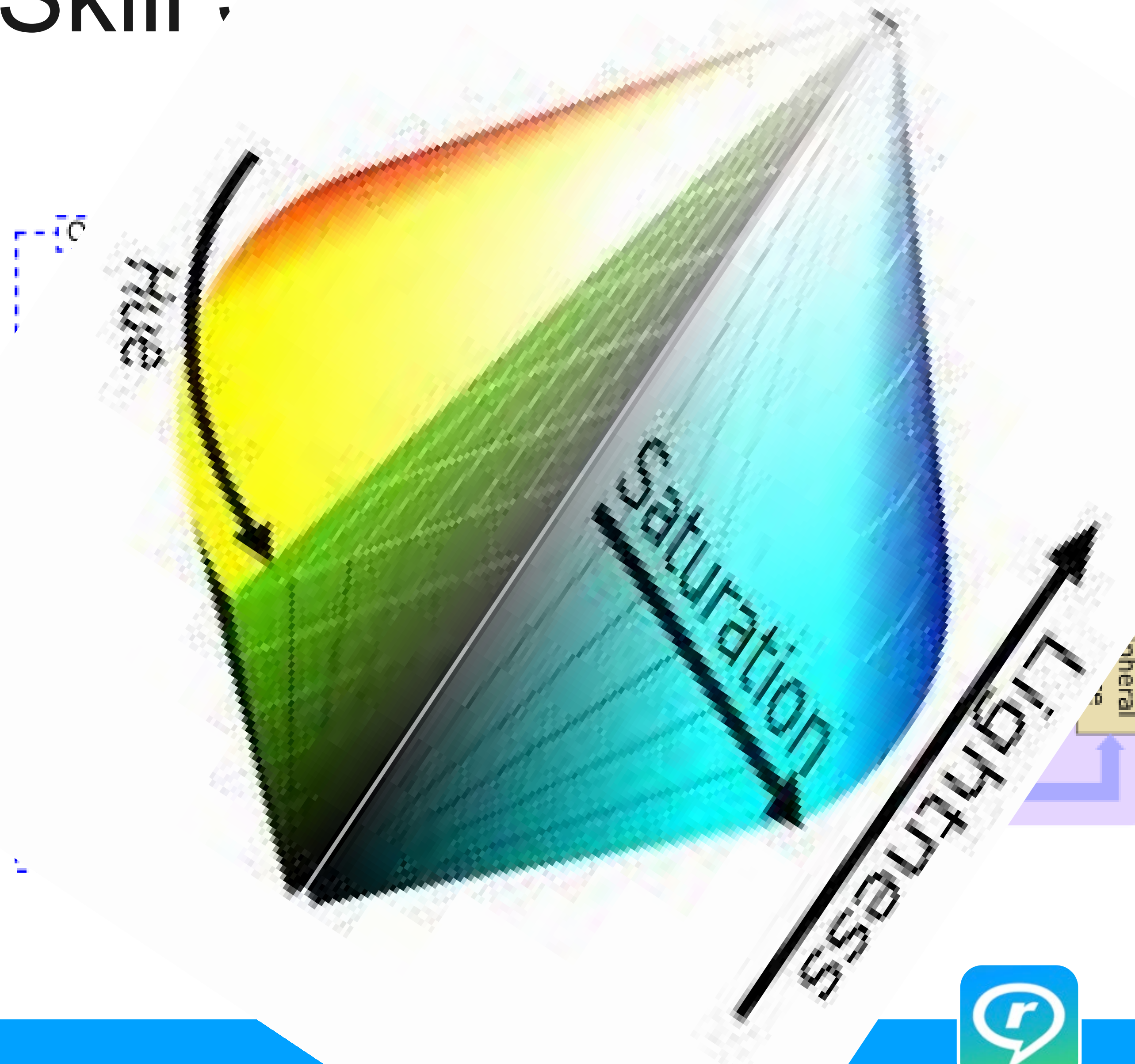
Extensions and Stretch Goals

- Implement ITM to run in real-time on TV processor.
- Expand our understanding of color theory.
- Submit a technical paper to the Society of Motion Picture Engineers (SMPTE), IEEE, SIGGRAPH or similar journal.



Required Disciplinary Skill S

- Computer Science
- Embedded Systems Development
- ARM Neon and Helium Instruction Set
- Machine Learning
- Color Theory (film, video, graphic arts) but this could be picked up as part of the project.



Drone Automated Payload and Battery Swap/Charging

November 10th, 2021

VOLANSI

Project Description

- Develop an innovative solution to load and unload a payload/package/batteries from an unmanned aircraft autonomously
- Method of charging the batteries autonomously

Design Parameters, Scope and Performance Criteria

- Simplicity is key
- Be able to operate outdoors in wind, rain, snow and dusty conditions
- Be able to last for long periods between maintenance – reliability, repeatability and maintainability is important

Desired Outcomes and Deliverables

- To provide/inform requirements to Volansi for future use on their systems
- Working proof of concept
- Show that the prodct can be reliable, repeatable and maintainable once in service

Required Skills

- Robotics/Automation
- Controls/Autonomy
- SW programming

Multi-Objective Parameterized Model for Aircraft Electrical Propulsion System

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Project Description

- A basic electric propulsion system for electric aircraft consists of an electric motor, motor controller, power distribution, and a method for energy storage (battery or fuel cell).
- Designing any one of these subsystems without considering the overall system may result in an power train system that is not optimized for safety, weight, efficiency and reliability.
- This project will develop a software package to parameterize critical aspects of the electric power train, generate expected aircraft performance, power train performance, and allow for optimization of specific performance indicators.

Desired Outcomes and Deliverables

- The software will consist of a user friendly GUI accepting system and subsystem parameters from the user, generate system performance data, and provide the ability to post process data in Excel and MATLAB.

Design Parameters, Scope, & Performance Criteria

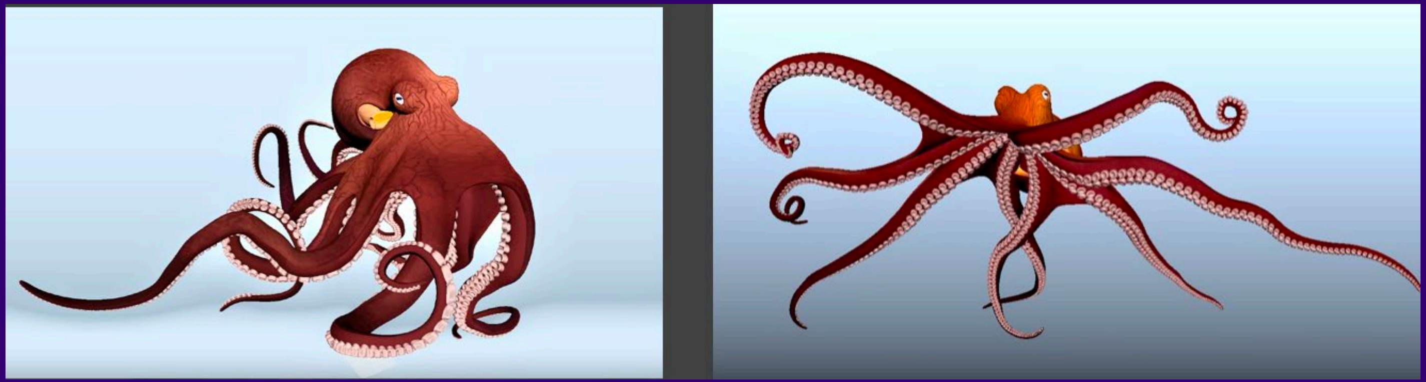
- Software interface shall be a user friendly GUI with the user being able to input parameter values to the tool.
- Software shall be able to calculate system performance parameters.
- Software shall be able to calculate inverter performance parameters.
- Software shall generate charts for each parameter (grouped when relevant).
- Software shall be able to generate details leading to an optimized system for weight, efficiency, flight distance, and/or fuel consumption (Hydrogen).

Extensions and Stretch Goals

- Optimization of GUI with UI/UX studies:
  - The GUI will be the primary link between the engineer and the calculations being performed.
  - One challenge is the presentation of the inputs required by the user and the data output.
  - Because a power train is a complex system, there will be many inputs and many outputs; likely more than can be displayed on a single screen at the same time.
  - Critical to the user experience will be presenting this information on screen in such a way that the user can logically follow/understand the results.

Required Disciplinary Skill Sets

- **Electrical:** Power electronics, Power Semiconductors, control systems
- **Computer Science:** Computational mathematics, optimization, data visualization, UI design
- **Aerospace:** Interest in aircraft propulsion, analysis of flight performance, propellor performance
- **Mechanical:** Thermodynamics, Fluid dynamics

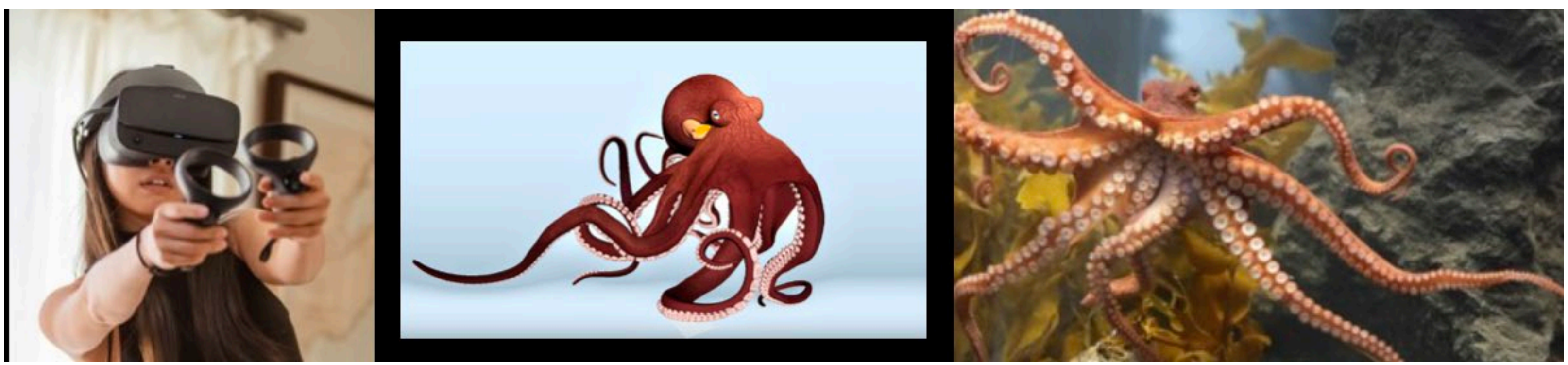


Using VR to Develop a Control Interface for an Octopus Inspired Soft Robotic Arm

Josh Smith and Barbara Mones
UW Computer Science and Engineering

Project Description

- Develop an interface that translates human motion into the movement of a simulated octopus arm and that translates simulated sensory feedback to a human sensory feedback system



Desired Outcomes and Deliverables

The creation an interface that:

- Translates human movements into known octopus arm behaviors.
- Will be performed by a simulated octopus arm.
- Translates simulated sensory information into a form that can be interpreted by human senses.

Design Parameters, Scope, & Performance Criteria

- Pairing discrete human hand or arm movements with octopus arm movements such that the human action will reliably activate the paired octopus arm action

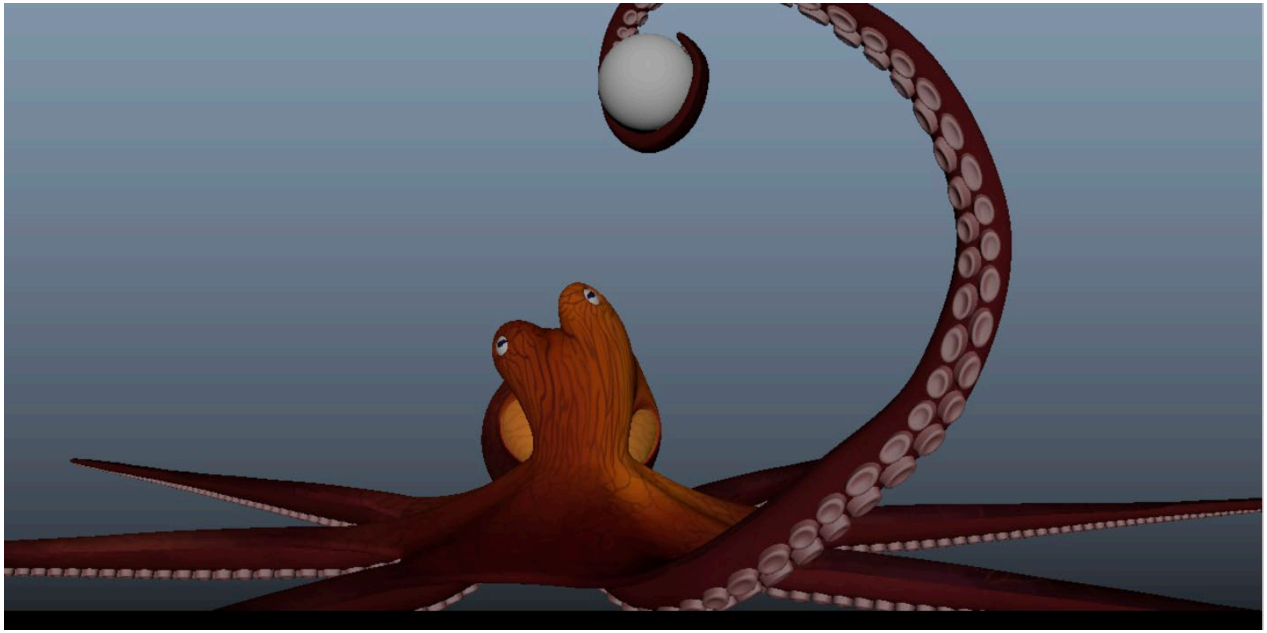
- Pairing known Octopus sensory systems with human sensory systems so that simulated sensory feedback will be accurately perceived by the human controller

Extensions and Stretch Goals

- The ability to adapt this control interface to an actual soft robotic arm
- To translate human EEG signals for control of a soft robotic arm
- Identifying discrete movements that allow a robotic arm to move as an octopus arm.

Required Disciplinary Skill Sets

- Embedded design
- Programming
- Hardware Design
- VR Equipment Familiarity



Energy Efficient Wireless Systems and Sustainability

Nick Buris
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Project Description

- Sustainability is an important aspect of today's engineering and design due to its significant worldwide ramifications.
- Wireless systems have proliferated worldwide and their presence keeps increasing.
- There are great benefits to be had from efforts that eventually reduce the carbon footprint from the usage of wireless devices.
- Various worldwide efforts have been pursued to develop energy efficient wireless communications.
- *This project aims at gathering information about such energy-efficient wireless communications efforts and describing them in a comprehensive report with appropriate and critical comparisons.*

Desired Outcomes and Deliverables

- Literature search
- Report containing:
  - energy efficient protocols and algorithms
  - energy conscious app ideas found in the industry
  - energy efficient network ideas
  - energy efficient electrical components and subsystems
  - chemistry used and recyclability

Design Parameters, Scope, & Performance Criteria

- The sustainability problem is very complex and we are still learning how to calculate things accurately. Connections between energy efficient methods and sustainability are valuable.
- Sometimes, but not always, there are tradeoffs between "product performance" and its "sustainability performance".
  - Quantitative information on such trade-offs would be valuable
  - Identification of approaches were both of these increase would be very valuable.

Extensions and Stretch Goals

- Inspired by the literature search, conceive of new ideas for energy efficient wireless communications and apps

Required Disciplinary Skill Sets

- Good engineering skills
- Ability to handle broad and multidisciplinary problems
- Good understanding of wireless communications and their protocols
- Imagination to conceive of ideas that could eliminate redundancy and increase efficiency

Tell Me More – Next Gen GeoFenced Smart Tools For The Handicapped

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Accenture Liquid Studios.

Inspiration – Haben Girma

https://www.youtube.com/watch?v=RPav7UYO0fs

https://www.youtube.com/watch?v=J2sjWbQYajg

Project Description

Problem Statement - How might we enable better accessibility for to support those with disabilities in college campuses, office buildings, cafeteria & airport.

The current solutions available for visually or hearing impaired are limited and if available are expensive. Can we apply significant improvements in technology like 5G, Computer Vision, Machine learning /AI tooling, Bluetooth way finding to improve the experience for those with disabilities in these controlled environments.

Desired Outcomes and Deliverables

Ability to drive down cost significantly and showcase advances in technology for helping for any one of the areas described below

– Brail to Text and Text to Brail paired devices (e.g.) keyboard if solving for visually impaired

– Sign language to speech or speech to sign language if solving for the hearing impaired.

– Image recognition to audio that can be clipped on a wearable device (glasses) if solving for the visually impaired

Deliverables

Working Prototypes software and hardware built on the AWS or Azure cloud

Design Parameters, Scope, & Performance Criteria

- Small form factor, cheaper than available market alternatives today.
- The actual scope will be defined once we collectively pick one of the three problems defined during the discovery phase of the project
- We would expect the regular collaboration between Accenture Liquid Studios teams including demoes once in two weeks.

Extensions and Stretch Goals

- The final hardware solutions are 3D printed in the form factor that we expect the product to work
- Two different working prototypes for a given problem so we can compare and contrast the solutions.
- Use of public or private 5G network if available to demonstrate the solution ability to work safely and predictably

Required Disciplinary Skill Sets

- Software programming in Python, AWS/Azure
- Embedded design, programming
- Edge computing
- ML /AI knowledge