



UBC ECE Capstone Design Course

2020 Project Catalogue V1

Student Version

Project Selection Considerations

Please see the Capstone course website for more information on the project selection process. A summary of the most important considerations is presented below.

1. Only projects that have enough interest will run. We need typically 5 students to form a project.
2. The catalogue project proposal gives an initial description of how the client imagines the project. The project description is formulated again with the client and the team in Milestone 1 - the project proposal.
3. Do not assume that just because a technology is mentioned in the proposal that this technology will necessarily play a major role in the project. This will be determined as a part of your Milestone 1 project proposal.
4. Consider your own skills and experience, and the "Special Considerations" mentioned in the client proposal. Make sure that you are able to contribute to each team that you include in your project selections.
5. Team allocation is final with very few conditions for exceptions. See the Capstone website for more information.
6. You must be prepared to make a personal commitment to your assigned project, to do independent learning, and to improve your own skills and knowledge as needed, for that project, so that your team can be successful.

Table of Contents

1: Developing a wearable head impact IMU to study sports concussions	5
2: Developing a wearable EEG device to study sports concussions	7
3: Immersio Language Learning Mobile Application	9
4: “Drive-It” Bike Assist – Compact Hybrid E-bike System with highly efficient regen/battery power boost and integrated wireless Smartphone app control system.	11
8: Technique feedback using Video/Sensors (iOS app)	14
11: Design 3D Map and Flight Missions for a passenger Drone	16
12: Ultra-Fast CMOS Failure Test Unit (UF-FTU)	18
13: Semi Automated Testing	20
16: Computational Quantum Chemistry Hardware Accelerator	22
17: Scalable Google AdWords Style Instantaneous Auction for Product Search Rankings in Mobile Shopping App	24
18: IoT Smart Home Presence Detection	27
19: Using iOS AR Quicklook in online shopping	29
20: Machine Learning for Mining equipment condition monitoring	31
23: Smart Advertising Campaign Generator	33
24: A novel system for multimedia discovery in Instagram based on Hashtag optimization	35
25: Development of Arm Cycle Control to use with XBox Racing Games by Disability Communities	39
28: Nestor	43
29: Wireless Data and Visualization for a Handheld Electronics Workbench.	47
30: Automated Traffic Police Signal Recognition System	50
31: Hand-Gesture Controlled Robot Pet	52
35: Deep Learning Artificial Intelligence Algorithm for Solar Electric Renewable Energy Technical Support Functions	55
36: Monitoring of Unoccupied Properties using Cellular IoT	58
37: Build the First Connected Time Capsule (Low-Power Cellular IoT)	60
38: Boat Tracking & Monitoring using Cellular & Satellite IoT	63

39: Virtual 3D Visualization App for Buildings Augmented with Real-Time Sensor Data	65
40: Augmented Indoor Position Tracking App	67
41: USB radio for networking remote health centres	70
42: Search platform for International Food Composition Databases	72
46: Sports Tech Company: IoT Based Stick & Puck Tracking	75
47: The Artist's Auction House	78
48: Satellite Analysis To Promote Community Well-Being	80
49: Picture Messaging over a Wireless Internet of Things (IoT) Network	83
50: Super Spinner Bot for TELUS	85
51: Finding Hidden Buyer Preferences	87
53: Risk Model to Determine the Possibility of Injury of People Utilizing an Engineered Playing Field Adjacent to a BC Hydro 138 kV Overhead Transmission Asset	89
54: Feasibility Study to Determine the Best Design Alternative to Obtain GPR Step and Touch Potential Data during Typical High Power Short Circuit Qualification Testing of Transmission and Distribution Equipment at a Test Facility	92
55: Feasibility Study to Determine the Best Design Alternative to Obtain Arc Flash Related Data during Typical High Power Short Circuit Qualification Testing of Transmission and Distribution Equipment at a Test Facility	95
58: Software Augmentation and Automation for High-Frequency Printed Circuit Board Design	98
59: DIY Multimedia Capture Station	100
61: CheckingIn Data Analysis and Machine Learning	102
63: Hand Tracker	103
64: Virtual Matter Computing	106
65: WhizEra - The ultimate PhD Assistant	108
66: Designing high-speed control FPGA platform for WBG battery charging applications	111
67: Machine Learning Framework for VR Training Data	113
68: Virtual Reality Aid for Virtual Surgical Planning of Mandibular Reconstruction	115
69: Data Acquisition Framework for Physics Experiments using Xilinx SoCs and PetaLinux	117
70: Real-Time Video-Based Oxygen Saturation Measurement	119

71: Integrated interface for real-time non-contact vital sign monitoring	121
72: Build a Game, help a Gran	122
73: Open Loop Directional Comparison Blocking (DCB) Scheme for BC Hydro's Overhead Distribution System Designated as the Gulf Island Loop	125
74: Integrate RFID into seafood manufacturing software	127
75: UBC track and Field Analytics	128
76: Real-time force monitoring with cloud-based data storage for virtual physiotherapy management of Achilles injuries	131
77: Mitigating social isolation through integrated Interest and geo-location matching software	133
78: Measuring cognitive load with Eye Tracking in Mixed Reality Devices	135
79: XR iINTERACT Multiplayer Sports Game	137
81: Bias Detection Algorithm through Natural Language Understanding (NLU) and Natural Language Processing (NLP)	140
82: Linkofile	141
83: Visually Enhanced Lesion Scope (VELscope®) Product Design Update	144
86: Lab-in-a-pack	145
87: 360° Traffic Sensor	147
88: Augmented Reality (AR) for Orthopaedic Surgeries	150
89: Real-time training load monitoring in sports	152
91: Human Anatomy Teaching APP	154
92: Clinical Decision Support Web Application for Oral Mucosal Abnormalities	157
93: Amusement Ride Vehicle Health Monitoring System	158
94: Anomaly Detection in Product Quality Control	160
96: Browser-based preventative technology extensions	162
97: Multi-source Security and Product Information Aggregator	164
98: ED2Foundry Application	167
99: Autonomous Navigation and Mapping of Deep-Space Objects Through Low-Gravity Swarm Technology	170
100: Atmospheric Thermal Sensing for Autonomous Unmanned Aerial Vehicle Navigation	172

104: Reusable Mug Tracking and Exchange Solution for a Circular Sharing Program	
175	
105: LiDAR-assisted 3D modeling for AR-based installation guideline	177
106: LiDAR-assisted Wi-Fi heat map generation	179
108: Automatic Road Deterioration Detection for Smart City Applications	182
110: Monitoring and Optimizing Game Development With Ubiquitous Telemetry	184
111: Volleyball Velocity and Ball Flight Path Tracking	185
113: Automated Camera Switching in Hockey Broadcasting using Deep Learning	187
114: Automated AI Photogrammetry Apparatus	190
116: IoT Enabled Smart Inventory for small and medium sized retailers	192
117: Capturing and Synthesizing UBC's Tree Inventory for Biodiversity Enhancement	
194	
119: Precision electron microscopic imaging to accelerate COVID-19 drug discovery	
196	
120: An Apple Watch app for clinical trial follow-up in congenital heart disease patients	198
121: Control hub for modern food production	200
122: Game Narrative Database and Workflow Tool	201
124: Log Image Classification	203
125: Knowledge Translation Portal – KTP	206
126: Design of an Ultrasound-Augmented Spinal Surgery Drill	209
127: High-Efficiency Smart Lithium Charger using Gallium Nitride (GaN) technology	
211	
128: Software for detection of cancer cells in pathology images using smart phones	
212	
134: AURORA Intelligent Transportation Connectivity System	214

1: Developing a wearable head impact IMU to study sports concussions

Category

improve an existing product

Primary Area

Electrical (low voltage)

Secondary Area

Biomedical

Tertiary Area

Micro-Electronics

Organization

SimPL - <http://simpl.mech.ubc.ca>

Background

Mild traumatic brain injury (mTBI), commonly referred to as concussion, is a major public health concern, with 42 million (0.6%) of the world's population clinically diagnosed with concussions annually. Even more alarmingly, subconcussive head impacts (i.e. without clinically diagnosed concussion) may also cause brain changes, since the accumulation of these impacts are shown to be associated with long-term neurodegeneration. This is a pressing health issue to be addressed, especially for children and youth (with developing brains) in contact sports sustaining repeated head impacts. Wearable head impact sensors have been developed and applied to measure head impact exposures in sports. However, current sensors suffer from poor skull coupling and low sampling rate, resulting in inaccurate measurements.

Objectives

The objective is to develop a miniaturized wireless IMU sensor package that can be mounted on the head for improved skull coupling and high sample rate measurements of sports head impacts.

Deliverables

Due to the changing pandemic situation, the deliverables for the project can be flexible and may involve one or more of the following:

- Schematics and layout from further miniaturization of a previous capstone design (a wireless battery-powered IMU package)
- Virtual simulation, validation, and integration of the device design to bring it to

production-ready state

- Firmware and software development for easy user-selection of versatile sensor data collection modes
- Programming a data downloading and management app
- Hands-on testing and validation of prototypes (if restrictions lift)

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

- Teams with PCB design and microcontroller programming knowledge would be preferred.
 - Past experience with miniaturized, low power PCB design would be helpful for the project.
 - Previous breadboard-based and fabricated PCB prototypes are available for testing..
- This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Concussion, wearable sensors, embedded systems, sports science, brain health, IMU.

Concussion, wearable sensors, embedded systems, sports science, brain health, IMU.

2: Developing a wearable EEG device to study sports concussions

Category

improve an existing product

Primary Area

Electrical (low voltage)

Secondary Area

Biomedical

Tertiary Area

Micro-Electronics

Organization

SimPL lab - <http://simpl.mech.ubc.ca>

Background

Mild traumatic brain injury (mTBI), commonly referred to as concussion, is a major public health concern, with 42 million (0.6%) of the world's population clinically diagnosed with concussions annually. Even more alarmingly, subconcussive head impacts (i.e. without clinically diagnosed concussion) may also cause brain changes, since the accumulation of these impacts are shown to be associated with long-term neurodegeneration. This is a pressing health issue to be addressed, especially for children and youth (with developing brains) in contact sports sustaining repeated head impacts. As such, there is a need to develop wearable sensors that can measure athletes' brain health in their sports play, both for investigating the mechanisms of concussions and also for injury screening. A promising sensor for this application is an electroencephalogram (EEG) sensor that can noninvasively measure brain wave activity. Currently, UBC's SimPL lab has developed initial PCB and software designs for a wearable EEG device. ")

Objectives

The objective is to further develop the current SimPL EEG PCB design into an integrated low-noise wireless EEG headset that could be used during sports events.

Deliverables

Due to the changing pandemic situation, the deliverables for the project can be flexible and may involve one or more of the following:

- Further optimization of a previous capstone EEG PCB design.

- Improvement of device usability through firmware and software updates.
- Virtual validation and integration of the device design to bring it to production-ready state.
- Hands-on testing of device prototype (if restrictions lift)
- Selection and fabrication of suitable electrodes, wiring, enclosure and headset to integrate with the EEG board (if restrictions lift)
- Preliminary testing of device during activity scenarios as a first step towards validation for sports use (if restrictions lift)

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

- Knowledge of PCB design and microcontroller programming would be helpful skills.
- Knowledge in low noise circuit design and digital signal processing would contribute to the project.
- Knowledge in mechanical design using CAD would be helpful.
- Prior experience with OpenBCI or other EEG/EMG devices would be helpful..

This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Concussion, wearable sensors, embedded systems, sports science, brain health, brain activity, neurophysiology. Concussion, wearable sensors, embedded systems, sports science, brain health, brain activity, neurophysiology.

3: Immersio Language Learning Mobile Application

Category

new product development

Primary Area

Software

Secondary Area

Mobile App

Tertiary Area

Artificial Intelligence

Organization

Immersio Learning Incorporated - <https://immersio.io/>

Background

Immersio is a startup company. We are three young and ambitious graduates of UBC's Master for Digital Media program at the Centre for Digital Media who love leveraging emerging technology for teaching and education.

Our goal is to fundamentally change the way that ancient languages are taught by facilitating active learning of them through interactive, contextual conversations and other integrated resources. Imagine using your cell phone as a personalized tutor who can speak with you and immerse you in an ancient world so that you can learn an ancient language from native speakers, as we can best reconstruct the past.

We are currently in UBC's entrepreneurship incubator (<https://www.start.entrepreneurship.ubc.ca/>) and have been prototyping, developing a curriculum, and doing customer and market research for about a year. So, we want to develop a sellable MVP (minimum viable product) to begin our impact in the market and concurrently join the UBC Hatch program to seek investment and scale our business.

Objectives

With our product roadmap and systems architecture broadly established to provide guidance, including a backend server on Azure and the use of Rasa (<https://rasa.com/>) for developing a Contextual AI assistant, our objective is to deploy a fully functional mobile app on both the Google Play Store and Apple's App Store with Python based backend frameworks.

Deliverables

A deployable code base and documentation for front end and back end components of the

mobile application that entails voice synthesis and voice recognition components with Rasa.

Rasa is a well-documented and very actively supported Python framework for developing "Contextual AI assistants" through best practices and new research in Natural Language Processing and Machine Learning.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

a language learning mobile app that uses Natural Language Processing!. NLP, AI, ML, RASA, Android.

4: “Drive-It” Bike Assist – Compact Hybrid E-bike System with highly efficient regen/battery power boost and integrated wireless Smartphone app control system.

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Mobile app

Tertiary Area

Electromechanical

Organization

Geyer Engineering Ltd. - <https://www.linkedin.com/in/paul-geyer-497a347/>

Background

E-bikes have made significant in-roads into the marketplace over the past 10 years and the technology, capability, cost and market penetration have all improved significantly. E-bikes are an attractive option for commuting as well as for both on road and off-road leisure activities and have gained significant market acceptance over the past few years. However, the current solutions only really offer an either/or selection of either a regular pedal power bike OR an e-bike, there is no real middle of the road alternative. You either buy 1) a full-blown e-bike, 2) an e-bike conversions kit that attaches to standard bike or 3) a standard pedal power Road or Mountain bike.

A full-blown e-bike or e-bike conversion kit is great for someone who wants significant pedal assistance all of the time on their rides and is using the assist function a significant portion of the time. It offers excellent power assistance, but adds significant weight to the overall bike, in many cases doubling the overall weight of the bike and thus requiring even more power assist to move the bike uphill etc. Along with the additional weight comes the more significant expense with a good conversion kit costing \$1,500 to \$2,000 and full-blown e-bikes costing \$2,000 to \$6,000. The other option is just a standard pedal power bike, and for many people this is sufficient, but what about the people who want the simplicity, cost, weight and performance of just a regular bike, but also want the occasional boost to help get them up a couple of hills along their journey. Weather it be a commute to work or riding together with friends, each with different physical capabilities,....it sure would be nice to have a “power boost” when needed to allow you to keep up with the pack or make your commute to work that much more pleasant or faster.

Objectives

Main Objectives

The Drive-It Bike Assist system aims to solve the issue of being able to have the best of both worlds when deciding to have a regular pedal bike or an e-bike. It will attach to your standard bike and give you the additional “power boost” when you need it, without adding significant weight, complexity, or cost to your standard bicycle. It will also be easily removable so the bike can be used as either a regular bicycle or with the “power boost” functionality.

Think of Drive-It as an compact e-bike conversion kit which is very easily added and removed from the bike and provides enough power assist to get your up hills faster and easier and make your ride more comfortable at less than half the price of current conversion kits and a price point of about \$500.

The initial concept involves having a compact highly efficient motorized drive system including drive motors/generator, inverter, battery and hardware and software control system all attached to the underside and top of a standard bicycle carry rack. The motors/generators would engage with the side wall of the tires in the same way the old-style bike dynamo light generators did on old bikes. The motors/generators would be able to automatically engage with the sidewall of the tire when the system was in either Assist or Regen mode and would disengage to allow for low resistance freewheeling. The engagement could be done through a spring and servo control mechanism. The Drive-It, could be easily latched into place on the carrier or removed. The carrier frame would be permanently mounted to the bike and would be able to be used as a standard cargo carrier with either the system in place or when the system is removed from the bike.

Specific Objectives:

- Proof of concept design and virtual prototype of Power, charging, storage and electromechanical drive system
- Extensive use of regenerative braking to keep battery size, weight and cost to a minimum.
- Wireless Smartphone app control system.
- Compact size and minimum weight.
- Easy to attach and remove from the bike.

Come to “Drive-It” and live our Moto “Learn Lots.....Have Fun....Do Good!”

Deliverables

Main Deliverables:

- 1) Project Proposal from student Team
- 2) Competitive analysis on current e-bike systems, including motors/generators, power control systems, batteries.
- 3) Conceptual design and draft Performance Specifications which take into account size, weight, input power, output power, range and cost.
- 4) Fabrication ready virtual detailed design including mechanical compatibility and software control system
- 5) Working prototype * (if possible) to demonstrate feasibility of Electronics hardware and software design
- 6) Final Project Report outlining overall project feasibility and all details of the project.

* Additional funds available for and provide hardware design tools and systems enabling students to work from home.

Future Directions:

1) Design for Manufacturing – Sourcing components and contract manufactures and costing to build the first 500 to 1,000 units

Come to “Drive-It” and live our Moto “Learn Lots.....Have Fun....Do Good!”

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Efficient Power, charging, regen, storage and drive system, Compact size and weight Wireless Smartphone app control system Come to “Drive-It” and live our Moto “Learn Lots.....Have Fun.....Do Good!”. Efficient Power, charging, regen, storage and drive system.

8: Technique feedback using Video/Sensors (iOS app)

Category

new product development

Primary Area

Mobile app

Secondary Area

Software

Tertiary Area

Biomedical

Organization

Canadian Sport Institute Pacific - <https://www.csipacific.ca>

Background

Canadian Sport Institute Pacific services the Canadian national team in several disciplines (physiology, nutrition, mental performance, strength & conditioning, biomechanics & performance analysis, data solutions...) to enhance performance in hope to result in medals at the Olympics.

In performance analysis, video has been a traditional tool to provide technical feedback for sports. Recently, there has been integration of Inertia Movement Unit (IMU) to more accurately quantify sports movement for high resolution objective feedback. IMU consists of accelerometer, gyroscope and magnetometer that can be sampled at 400+ Hz. In general, IMU can be streamed live and recorded onto the mobile device or the data can be recorded on the on-board memory chip to be downloaded after. Display of the sensor data are done post analysis which can be time-consuming if it's recorded (due to lengthy downloading time). As informative as sensor data can be, superimpose onto video footage can provide the association to the actual movement to aid more comprehensive understanding.

Currently, this process is done during post analysis stage which takes hours (if not days in some cases) after the recording making it less ideal as an instant feedback, hence it would be a huge advancement to have the visual/sensor data playback in real-time. It would revolutionize the way athletes train.

Currently, we are working with 2 brands of IMU (Movesense and Metawear MMR), they both have its advantages and gaps. We are not set on these IMUs if another IMU can satisfy these features (ability to be able to record data at minimum 100Hz for 3-4hrs, waterproof, and long range live stream ~200m ideally).

Objectives

Movesense and Metawear both have open source iOS app codes for operation of their sensor.

The main objectives are to

- 1) Make revision to the current iOS app code provided by the IMU sensor company (open source) or new iOS app to include video recording capability
- 2) Overlay IMU sensor data onto the video while syncing the times
- 3) Calculate basic metrics (speed, height, distance...) that can be overlaid onto the video

Deliverables

Modify open source app or create an app that have these capabilities

- can connect to both IMU sensors (Movesense and Metawear MMR or others...)
- record video and sensor data with one click
- ability to export data to cloud storage (such as dropbox or google) that allow for post-processing (ie sync time to recreate video overlay sensor data)
- video playback with overlay of sensor metrics

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

none

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

iOS, app, video, sensor, signal, analytics, analysis. Wireless Smartphone app control system

iOS, app, video, sensor, signal, IMU, spots analytics, analysis.

11: Design 3D Map and Flight Missions for a passenger Drone

Category

technology exploration

Primary Area

Software

Secondary Area

Electrical (low voltage)

Organization

Westdrone Inc. - <http://www.westdrone.ca>

Background

Westdrone Inc. is dedicated to changing the way people and goods travel - with electric large-scale drones. Fly within minutes to a remote mountain lake from downtown on a Friday night to flying medical equipment and personnel from a ship into a remote area. The scope of possibilities is unlimited. The environmental footprint is minimal. Low operating costs mean low air fares and freight charges. The X1-8 is essentially an eight-passenger or 2,000lb payload, flying van. The X1-8 is currently at research and development stage with a 1:6 scale working model built and tested.

Objectives

Design a 3D terrain, buildings, and bridges flight map, 105Km (65 miles) in diameter out from Vancouver Airport. Create ten Flight Missions from Vancouver Airport to Victoria, Duncan, Nanaimo, Sechelt, Whistler, Surrey, West Vancouver, North Vancouver and the two ferry terminals. The flight waypoints will optimize distance, altitude and minimize flight over populated areas. Design an iPad app so the pilot, who must be on-board by TCCA regulations, can choose the Flight Mission and send the data wireless to the main controller (MC). Flight data such as speed are also required although take-off and landing data are already coded into autopilot on the MC.

The importance of using Flight Mission over manual piloting is primarily consistency in flight path. It also allows the pilot to concentrate on navigational hazards such as other aircraft, birds, and weather, and to monitor propulsion, motors, rotors, and other systems.

Deliverables

Design 3D terrain, buildings, and bridges map for the target flight area. Design Flight Missions. Create an iPad app. Basic deliverable will produce a 3D map with flight waypoints to optimize Mission Flights. An improved deliverable will add an iPad app. The optimum deliverable will add flight tracking from ADS-B and allow new Flight Missions to be created and optimized.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

Documentation is available from DJI titled Ground Station that used a similar design utilizing Google maps and a laptop. This is no longer used due to Google maps not renewing their license and regulations that required drones to remain in visual line of sight (VLOS). DJI changed to an iPad app but was still restricted by VLOS. Westdrone's passenger drones will always have a pilot on-board and therefore are VLOS compliant.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Westdrone.ca, aerospace, passenger drone, virtual design, autopilot, 3D mapping, X1-8 . way-point navigation, terrain avoidance, mechanical CAD, aero simulation.

12: Ultra-Fast CMOS Failure Test Unit (UF-FTU)

Category

While it is improvement on an existing device, we foresee that the whole thing must be redesigned.

Primary Area

Electrical (low voltage)

Secondary Area

Micro-Electronics

Organization

Ivanov group from UBC SOC labs - <http://www.ece.ubc.ca/~soc/>

Background

Current CMOS lifetime testing methods consist of applying a high stress and temperature to a CMOS device and observe the mean time to failure of that device. These observations are later used to compute the life expectancy of the products that use these chips. Currently, Dr. Ivanov's group has built a testing tool that uses an MCU (Arduino MKR1000), a heater, temperature sensors and an ADC which applies voltages (under high temperature condition) to a CMOS chip and measures the output. You will be building an ultra-fast measurement device on that foundation. Understanding the fundamental physics of device failure requires very fast measurements at the beginning stages of device degradation. While such measurements can be performed by expensive lab equipment, such as GHz oscilloscopes, there is no specialized device that can perform such fast measurements in a high throughput manner.

Objectives

Our aim to design an UF-FTU that features:

- A new FTU that can sample the output voltage at 2 giga samples per second.
- A memory management system to collect this data ($2 \text{ GS/S} * 16 \text{ bits} = 4 \text{ GB per Second}$) and dump it in a hard drive in a timely manner
- An alternative MCU that can handle our sampling rate requirements
- A GUI, which processes all meaningful data collected by the FTU and performs curve fitting and FFT.

Deliverables

A fully functional prototype or fabrication ready design with highest level of simulation and modeling and a good set of test cases (we will provide 16 nm Chips for testing). Documentation enough to allow another engineering team to evolve the design and refine the device.

Contributions Organization is Able to Provide

Financial support, engineering support, access to equipment and education are all available and will be provided if need be.

Additional Considerations

Data collection from such fast samplers may not be possible using an MCU and an FPGA solution may be required. Extra funding is available for this project in order to purchase high performance ADC and FPGA boards, software licenses and, other necessary equipment.

Considering the hardware nature of this project and the current limitations due to the pandemic we provide support in terms of performing measurements on behalf of the capstone students, providing equipment and releasing them to students and provide hardware and software expertise available through the faculty members and grad students within SOC lab.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

High speed sampling, GHz sampling, high throughput data collection. High speed sampling
GHz sampling
High throughput data collection
FPGA

.

13: Semi Automated Testing

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Software

Organization

Icron Technologies/Maxim Integrated - <http://www.icron.com/>

Background

We need a quicker way to troubleshoot our broken boards we get back from customers

Objectives

- 1.) Determine the best way of debugging the PCB
- 2.) Creation of a semi automated testing software that guides the user through the troubleshooting and creates a report at the end
- 3.) Find a methodology that is best suited for troubleshooting the PCBs. Could be test jigs, moving arms, etc.

Deliverables

- 1.) A document that outlines how to debug the board
- 2.) Software that guides the user through the debugging and creates a report
- 3.) Test methodology and implementation to get data from the PCB

Contributions Organization is Able to Provide

All of the above as needed.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Automated testing jig, mechanical and electrical.. Board testing.

16: Computational Quantum Chemistry Hardware Accelerator

Category

idea validation

Primary Area

Electrical (low voltage)

Secondary Area

Computer

Tertiary Area

Software

Organization

Eigen Research Inc. - <https://www.eigenresearch.ca/>

Background

Throughout the past few decades various quantum chemistry methods have been employed in the industry to help with the advent of new molecules and to finetune processes in the fields such as pharmaceuticals, material discovery and, semi conductor industries. Such methods are used as an alternative to wet lab experiments. Most of the accurate quantum chemistry methods suffer from computational cost issues. Recently some scientific groups have you started to improve the efficiency of quantum chemistry computations by means of GPU implementation, threading and hardware accelerators:

<https://pubs.acs.org/doi/10.1021/acs.jctc.0c00290>

We at Eigen research Inc intend to take this a step further and employ FPGA based accelerators to further improve the speed of quantum chemistry simulations (particularly Monte Carlo Methods and Density Functional Theory). This project features benchmarking of an existing quantum chemistry code on different hardware including an FPGA solution developed by the capstone team. The FPGA solution can either be a new processor that performs the whole computation or just a PCI card that performs certain tasks such as FFT.

Eigen research can provide funding for FPGA development boards such as "Intel Cyclone 10 GX FPGA Development Kit" or other boards that the capstone team will choose. This is a great opportunity for any student who wants to expand on their knowledge of hardware design.

Objectives

- Select popular implementations of widely used computational chemistry algorithms such as: Quantum Monte Carlo (QMC), Molecular orbital Density Functional Theory (DFT), Plane wave

DFT*.

- Characterize the bottlenecks of it when executed on GPU and GP-CPU
- Identify aspects that can be accelerated with kernels executed on custom hardware
- Implement custom processors/IP blocks or design a custom processor (along with drivers and/or a compiler) to run specific tasks and speed things up.
- A quantitative benchmark of the new hardware against existing solutions (Multi threaded CPU and GPU)

*Each of these methods have aspects that can be accelerated. Our preference is the Monte Carlo methods. However, we understand that a team of undergraduate students may have difficulties with the multifaceted nature of this work.

Deliverables

A functional prototype of the accelerator with one of the aforementioned quantum chemistry algorithms along with the bench marking tables. Full documentation of the project, design choices, HDL codes, compiler codes such that our team can continue the project later.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

Funding can be provided for the purchase of Intel or Xilinx FPGA boards. The main contact is also a postdoc at UBC-SOC labs and can provide support on both hardware and algorithm design.

This project has a potential to have a very high impact in the fields of drug and material design. It is also an opportunity for the students to work on an advanced field with support from well trained experts.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Quantum chemistry, hardware accelerator, FPGA. Quantum chemistry
Hardware accelerator
FPGA.

17: Scalable Google AdWords Style Instantaneous Auction for Product Search Rankings in Mobile Shopping App

Category

improve an existing product

Primary Area

Web app

Secondary Area

Software

Organization

Amelue Technologies Inc. - <https://www.amelue.com>

Background

What we wish for, is that the students design and build a Google AdWords style auction for both target and complement search results. In other words, brands and retailers will bid for search rankings. It is well known that only 30% of Amazon shoppers make it past the 1st page of search results and competition for a first page search ranking is fierce. We want to foster the same type of competition with our app.

Our app allows users to easily create aesthetically pleasing combinations of products in home decor and fashion using our patent pending visual search. Our product catalog includes brands like Mac Cosmetics, Channel, Kate Spade and retailers like Bloomingdale's and Tom's Shoes. Our catalog size is currently 150,000 products.

Our app returns to users product search results for both a search target, and complements to that search target. For example, if a user searches for "dresses", the app also returns complements to dresses like nail polish, lipstick, handbags, shoes etc. Search results are currently ranked only by how well products match visual attributes like colors and patterns.

For example, if the user searches for dresses in a particular shade of red, the order of dresses returned depends on how well the dresses match that exact shade of red.

As our app has products from various brands and retailers. We would like these brands and retailers to participate in instantaneous auctions for search rankings every time a user performs a product search using our app. The order of products returned will be ranked according to this auction.

The auction will take into account the bid price and a quality score. The quality score will be

based on the closeness of products to the colors and patterns used for product search queries and on how likely users are to purchase certain products and product combinations.

Currently, we are set up to receive commission on product sales through the app. However, our estimates show that a search rankings auction may be more profitable in the long run.

Our app prototype works on both iPhones and Android. It uses a React Native frontend and Node backend hosted in the AWS Cloud. We use Postgres10 for our database. We are planning on extensively testing the app with users starting in late August.

Finally, our website reflects only consulting work we do. It does not mention this project.

Objectives

1. We wish for students to design and build a scalable, stand-alone module that will perform instantaneous auctions for product rankings each time a user performs a product search. In other words, brands and retailers will bid for search rankings. It is well known that only 30% of Amazon shoppers make it past the 1st page of search results and competition for a first page search ranking is fierce. We want to foster the same type of competition with our app.

2. The instantaneous auction will rank products according to a bid price in combination with a quality score that is produced by the app's artificial intelligence. (The app can already provide this score but if students are interested in AI and wish to work on this part too, that would be welcome).

Deliverables

1. A scalable, cloud-based, standalone module able to perform instantaneous auctions for product search rankings each time an app user searches for products. The instantaneous auction will rank products according to a bid price in combination with a quality score that is produced by the app's artificial intelligence. (The app can already provide this score but if students are interested in AI and wish to work on this part too, that would be welcome).

2. A web-based frontend interface for retailers and brands is required so that retailers and brands may set bid parameters and receive feedback and tracking on their bid performance.

3. Since we want to track all bid and auction history, database work is required as well.

4. Our app currently uses a Node backend with Postgres10 but we are open to other languages and architectures. Performance and scalability are most important.

5. We need to set up fake bidders and stress test the auction system.

6. There is an opportunity to assess the business case for this auction system. We plan on running user trials in the fall and it is hoped that the the information gathered will assist in estimating future revenue from this auction system.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Fullstack, frontend, javascript, node, react, e-commerce, mobile app, iOS, Android, AdWords, auction. Webpage position auction.

18: IoT Smart Home Presence Detection

Category

technology exploration

Primary Area

Digital Media

Secondary Area

Software

Tertiary Area

Microelectronics

Organization

iaconicDesign Inc. (Modena Smart Home) - <http://www.modenasmarthome.com>

Background

iaconicDesign is a technology company focused on blurring the line between design and engineering to create beautiful products customers love.

We are currently developing several smart home products under the “Modena Smart Home” brand that merge design and technology to offer consumers smarthome technology with unique aesthetics to drive product adoption.

In the last five years, we have successfully worked with UBC ECE Capstone student teams to develop prototypes of some of our IoT light switches with touch and ambient awareness sensors and integration with voice assistants powered by Amazon Alexa as well as develop mobile app prototypes and a smart garage opener. This year, we would like to focus on developing a simple, low-cost presence detection system that utilizes sound, instead of conventional passive infrared sensors, to detect room occupancy and identify different types of sounds to identify alarm conditions or emergencies.

Objectives

The objective of this year's project will be to prototype and demonstrate a sound-based presence detection system that can be easily integrated into smart home products without requiring any large, intrusive components such as a Fresnel lens with conventional PIR sensors.

The project is expected to entail:

1. Conducting background research on existing presence detection systems and summarizing their pros and cons;

2. Purchasing a few of the most promising presence detection sensors and MEMS microphone-based systems for breadboard prototyping;
3. Developing algorithms, capable of running on low-cost microcontrollers such as the ESP-32, demonstrating the effectiveness of the presence detection system and its ability to differentiate human presence vs. other background noises and comparing its performance to conventional PIR-based systems;
4. Developing machine learning algorithms to enable the system to optimize its ability to differentiate human presence from background sounds and (ideally) be able to differentiate "normal" sounds from "alarm" events such as fall detection or window breaking.

Deliverables

Project deliverables shall be:

- Minimum Level: Breadboard circuit demonstrating MEMS microphone-based presence detection system and algorithms;
- Good Level: 'Minimum Level' functionality above + demonstrated performance (performance criteria to be defined as part of the project) exceeding that of conventional PIR system.
- Excellent Level: 'Good Level' above + machine learning algorithms demonstrating accurate human presence detection.
- Superstar Level: 'Excellent Level' above + ability to differentiate between different types of sounds and send alerts to a cloud server.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

automation, IoT, smarthome, artificial intelligence, machine learning, cloud, Amazon Web Services (AWS), Google Cloud Platform (GCP), Microsoft Azure. sound analysis.

19: Using iOS AR Quicklook in online shopping

Category

new product development

Primary Area

Digital Media

Secondary Area

Mobile app

Organization

ARan Shop Technologies - <https://i-farsh.com>

Background

The Covid-19 pandemic once again showed the advantageous of online shopping. A year ago online shopping was being valued for being hassle free and time saving process. Nowadays, at times, online selling has become the only way to continue business.

It has been few years that we at ARan shop Technologies have moved towards online stores and have introduced augmented reality apps (iFarsh) for both iOS and android devices where clients can virtually try rugs before buying.

One of the barriers we have found is that a high fraction of customers searching for a product through web are reluctant to install new apps. Therefore, we are looking into taking advantage of the newly introduced AR quick look for iOS devices to make shopping one step easier.

Objectives

Employ iOS AR Quick Look for online rug selling

Deliverables

Fully functioning AR Quick Look in i-Farsh.com website

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Students working on this project will be given access to our previous products to facilitate current project and will be mentored on weekly/bi-weekly basis to assure that project is on track.

Since this project would be iOS native, students working on this project are required to bring

their own iOS operating laptop and phone for development and testing.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Augmented Reality, Online Shopping, eCommerce. iOS QuickLook, Augmented Reality, students provide own iOS devices.

20: Machine Learning for Mining equipment condition monitoring

Category

technology exploration

Primary Area

Machine learning

Secondary Area

Software

Organization

Finning International Inc. - <https://www.finning.com>

Background

Finning is the world's largest single Caterpillar dealer. For some mining customers, Finning provides condition monitoring services to guarantee a certain uptime and utilization of their equipment. To aid with detection and troubleshooting of issues, certain mining equipment (e.g. trucks, excavators) has hundreds of sensors (location, fuel, air filters, fluids, carried load, etc.) that report their status often on a second-by-second basis. Today, our condition monitoring teams analyze much of that data manually to provide service recommendations to our customers.

Objectives

We want to help our condition monitoring teams by implementing a level of automation. The goal is to build a set of ML models to detect and determine some of the following:

- Detect anomalies in values and patterns of sensor data that could be used as early warning signs of potential issues.
- Automatically detect what services have been performed on the equipment (e.g. which parts or fluids were changed at what time)?
- Which equipment is likely to suffer an issue or outage in the near future?
- What will be the most likely cause of that predicted issue or outage?
- What action should be taken now to prevent an outage?
- What could be done to prevent such issues or outages in future?

The main value of this project and hence the focus and main goal is on the data analysis, the ML models and the insights they generate. However, the solution should also include a presentation layer that shows the results of the ML models to non-technical users.

Deliverables

Finning will provide several TBs of relatively raw data in a data lake, including some

documentation to aid with the understanding of that data. The project team should provide the following:

- Analyze and understand the available data, then document it on a high level
- Given the project objectives and the available data, document which specific cases can potentially be solved by ML models
- Clean and transform the data for use in ML models
- Train ML models using the available data
- Test the ML models against real data to demonstrate the model accuracy
- Store the ML model results in a data store
- Provide a presentation layer that visualizes the results for non-technical users. This can leverage standard tools like PowerBI.

Finning primarily uses Azure. It would be preferred to build the solution based on Azure big data/ML technologies.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Finning uses primarily Azure and other Microsoft Technologies. Therefore, the preferred cloud technology would be Azure Big Data/ML enablers and PowerBI

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Industrial IoT, Big Data, Machine Learning, Cloud Computing. Data Analytics.

23: Smart Advertising Campaign Generator

Category

new product development

Primary Area

Organization

Adsight - <https://adsight.ca/>

Background

Adsight is a funded start-up disrupting the outdoor billboard market. We are the Airbnb for billboards - empowering small business owners, agencies, and ad buyers/marketers to pick media assets that are the best fit for their campaigns. .

We're reaching out to UBC to help us further digitize this traditional outdoor advertising industry. We built Adsight based on two key industry insights: 1) It's difficult for ad buyers to calculate the return on outdoor advertising because data is not accessible and whatever is currently available is not easy to visualize and act on; 2) The industry is built up of a couple of big media suppliers amidst many smaller ones and across the board, media suppliers don't have effective mapping technology to clearly display the relevant information and locations of billboards to ad buyers

The deliverable we are proposing will continue to build upon those two insights.

Objectives

The main objectives of this project is to increase productivity and efficiency for our users through these key areas:

- 1) Facilitate ad buyers/marketers' decision making process by providing actionable insights
- 2) Streamline ad buyers/marketers' current media buying process by consolidating the process all on one platform

Deliverables

The main deliverable is to create a feature that will provide users a list of recommended advertising spaces based on the criteria they input. Using data provided from our media suppliers and from Stats Canada, we hope to create a questionnaire that small and medium sized businesses can fill out to get a personalized list of media assets they can potentially use for their campaign.

For example, as a bubble tea shop owner, I may be interested in creating an outdoor

advertisement targeting millennials. Using Adsight's platform, I can answer a list of questions including my target market's age and demographics, target amount of impressions, and budget to get a list of recommended billboards that would be able to fulfill my campaign goals. This would be a fully functional prototype with sufficient documentation, ready to enable us to further test and refine.

Students who choose to work on this project will be learning from industry leading engineers that have worked in companies such as Amazon and well-funded startups. Students will be working on one module of a SaaS advertising software already being run in production with active users and that allows you to learn how to integrate and interact with the product, engineering, and business stakeholders. Students will be working on very popular and relevant tech stack such as Node.js, Gatsby, React, GraphQL, Firebase, and Google Cloud. These technologies will result in a significant amount of leverage when seeking jobs in top tech companies in the near future.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

N/A

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Out of home advertising, Software Engineering, B2B, Node.js, Gatsby, React, GraphQL, Firebase, Google Cloud, Design. .

24: A novel system for multimedia discovery in Instagram based on Hashtag optimization

Category

new product development

Primary Area

Software

Secondary Area

Digital Media

Organization

BroadbandTV Corp - <https://www.bbtv.com/>

Background

Summary- In this project, we would like to use state-of-the-art machine learning/deep learning, natural language processing, image processing, computer vision and data mining algorithms to design and implement intelligent solutions for finding the best hashtags for Instagram posts. If you are an Instagrammer, this fun project can be of high interest to you and ultimately we can help millions of creators around the world with the discovery of their content.

Background:

BroadbandTV (BBTV) is an SME Media-Tech company based in Vancouver with 250 FTE globally and 25 FTE in the R&D department. BBTV helps creators become more successful on video platforms, especially by generating more viewership and hence more ad dollars for their content. So far our focus has been mostly on YouTube creators, but we are now expanding our solutions to Instagrammers as well, where this project plays a key role there.

With the power of social media being higher than ever to influence the decisions of users, many brands & businesses have turned to Instagram to help boost their business. In fact, surveys from users indicate that 200M+ Instagrammers visit one business profile on a daily basis and 60% of the products are discovered via Instagram [1]. As such, for more than 25M+ businesses, 500k+ influencers & 150M+ Micro-influencers [2], it is very important to find solutions for their profiles and posts to be discovered. This is a very challenging task as each day, more than 100M images and videos are uploaded to Instagram.

Hashtags are currently the main method of content discovery for Instagram. However, the majority of users don't use hashtags properly. As an example, they use wrong/spammy hashtags or don't use enough hashtags. This significantly impacts the discovery of related content for users and also impacts the discoverability of creators who create high-quality content but don't have enough time to generate the associated metadata properly. As such, automated

solutions are needed to address this issue. This is the goal that we would like to achieve in this project.

In the past decade, BBTv's tech department has launched several solutions under the brand "VISO" for creators, focusing on various topics such as content optimization, actionable insights, brand safety analysis and match-making between creators for collaboration. Our research efforts have also resulted in 13 utility and design patents for the company. The outcome of this project will add another important tool to the proprietary solutions that BBTv provides to creators. Throughout the project, students will get support & guidance from the highly-qualified research team at BBTv as well to better achieve their goals.

[1] <https://www.facebook.com/business/instagram/shopping>

[2]

<https://buffer.com/resources/micro-influencers/#:~:text=According%20to%20a%20report%20by,Wow!>

Objectives

The project is divided into two phases with the Phase 1 being required and Phase 2 being the optimum delivery. As such, Phase 2 is Optional depending on the team's ability.

Phase 1- Hashtag evaluation (Phase-1a) and optimization (Phase-1b): the main goal of this phase of the project is to research, design and develop an intelligent automated solution to assess the quality of the hashtags for a specific Instagram post & suggest enhanced hashtags for that post.

Students may leverage methods such as text processing, image processing, natural language processing, semantic net, machine learning and deep learning to analyze digital media (image and/or video) and text (description of the post).

Students will also measure the accuracy of the system designed by validating the results with the help of human experts.

Phase 2 (Optional): If time permits, we would like to assess the impact of the system designed in Phase 1 on increasing the engagement and views. Here, we need to research, design and implement a system to measure how much more engagement and views the Instagram posts get after hashtag optimization.

Deliverables

At the end of the project, we will be able to deliver the following artifacts for the project:

Phase 1a - A high-accuracy intelligent algorithm for "evaluating" the quality of hashtags. The aim will be to achieve results that are accurate as possible compared to the rating provided by human experts. Here is a rough overview of the expected activities and deliverables for this Phase:

- Literature survey: Research into existing solutions for analyzing image and text and extracting information from them; Review and understanding BBTv's existing content optimization solutions. Main deliverable: a short report.

- Familiarization with Instagram API: Understand how Instagram's API system works for reading and writing data works. BBTv will provide the data.

- Building the Evaluation Algorithm: Research, design and implementation of algorithms for analyzing the quality of hashtags from Instagram posts . Main deliverables: Code & Project report.

- Assessing the performance: Compare the quality of ratings generated by the algorithm to evaluation provided by human experts . Main deliverable: Project report and suggestions for future work.

Phase 1b- A high-accuracy intelligent algorithm for “optimizing” the quality of hashtags and recommending new hashtags . The aim will be to ensure that at least 80% of the suggested tags are relevant to the post based on the assessment of human experts.

- Building the Optimization Algorithm based on Metadata: Research, design and implement algorithms for analyzing “description and hashtags from” Instagram posts and recommend optimal keywords . Main deliverables: Code & Project report.

- Assessing the performance: Assess the quality of hashtags generated by the algorithm by human experts; Main deliverable: Project report and suggestions for future work.

[Optional- if time permits] Building the Optimization Algorithm based on Images: Research, design and implement algorithms for analyzing “images” from Instagram posts and recommend additional hashtags . Main deliverables: Code & Project report.

Phase 2 [Optional; if time permits]- Design and implement a system to measure how much more engagement and views the Instagram posts get after hashtag optimization. For this system, we need to first build the baseline solution and then define the metrics that need to be tracked post optimization.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

The students need to have some knowledge about at least one of the following technologies: machine learning, deep learning, text processing, natural language processing or computer vision. Good coding skills especially working knowledge of Python will be very beneficial.

The benefits of this project for the students will be as follows:

We expect that by the end of this project, students achieve the following:

- Working closely with BBTv's research team and learning from their expertise
- Better understanding of various machine learning/deep learning, natural language processing and computer vision
- Better understanding of product development cycle and how research results are integrated

within a broader product

- Improved knowledge of coding especially in Python
- A good understanding of how API systems work
- Challenges associated with collecting and sanitizing data as well as learning methods for overcoming them

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

instagram, social media, machine learning, natural language processing, deep learning, image processing, hashtags, text processing, computer vision. algorithms, models, semantic text analysis, natural language processing.

25: Development of Arm Cycle Control to use with XBox Racing Games by Disability Communities

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Software

Tertiary Area

Biomedical

Organization

Physical Activity Research Centre (PARC) at ICORD - <https://icord.org/parc/>

Background

If you love gaming and would like to influence the gaming industry while also improving the lives of gamers with disabilities, help us design this arm crank controller to use with the XBox console and games such as Forza Motorsport 7.

Individuals with physical disabilities often have limited options to be physically active and specifically to engage in cardiovascular exercise (exercise that gets the heart pumping!). One popular form of cardio exercise for people with Spinal Cord Injuries and other impairments is 'hand cycling' using an arm crank. At the Physical Activity Research Centre (PARC), we have a 'GameCycle' that allows individuals to engage in upper-body, cardio exercise by playing Nintendo GameCube racing games using an arm crank controller and it's very popular with our community members. However, the cost of the GameCycle is prohibitive for home use and the GameCube is outdated.

The closure of PARC due to COVID-19 has increased our awareness of the very limited options for people with disabilities to engage in home-based exercise, particularly cardio fitness. We are also hearing from community members that they are not excited about exercising at home and that they miss the social aspect of being physically active together. The creation of an arm crank controller for use with Nintendo XBox would solve both these problems - gaming is a fun way for individuals to be more physically active at home while also connecting socially with others on gaming platforms. Microsoft has also released an 'Adaptive XBox Controller' that can accept various modified and adaptive controllers to work with an XBox making this project much more feasible than before.

The development of an open source, arm crank controller to be used with the Adaptive Xbox Controller would create opportunities for people with disabilities to play Nintendo Xbox racing games such as Forza Motorsport 7 and thus engage in home-based cardio exercise.

PARTNERS ON THE PROJECT:

Daniel Feltrin (Microsoft employee and Gaming Expert) - Daniel is a Microsoft employee actively engaged in the gaming industry and gaming culture. He has access to resources such as Xbox One S and One X consoles, the Xbox Adaptive Controller, and partners from different Gaming Studios across the Lower Mainland and from the Xbox Development Team for support and research purposes.

Chad Leaman (Director of Innovation at the Neil Squire Society) - The Neil Squire Society has a large Research and Development team and Chad has extensive experience leading projects pertaining to innovative and accessible technologies for people with disabilities. He has partnered on capstone projects before with stellar results. He has access to 3D printers for producing prototypes parts.

The Physical Activity Research Centre (PARC) - The Physical Activity Research Centre is a gym/fitness centre for people with spinal cords and related injuries housed at ICORD. Ljudmila Zaletelj is the Manager of PARC. She can provide access to the facility (or video conference) to look at the existing GameCycle and existing adaptive physical activity equipment including various hand cycles. Dr. Andrea Bundon is the PARC Faculty Advisor and an Assistant Professor in the School of Kinesiology (UBC). She can provide context on physical activity guidelines and recommendations for people with disabilities. The community members at PARC are also very engaged and would love to talk to students about this project including providing feedback on design and useability!

Objectives

MAIN OBJECTIVES

- *Develop an open source, arm crank controller to be used with Microsoft Adaptive *Controller to play at least some racing games, like Forza Motorsport 7.
- *The arm crank controller should be easy to attach to different locations - big tables, small tables, stands, etc.
- *The arm crank controller should be able to be "cycled" to be a "gas" function but also have some joystick abilities "turn left and right"
- *Develop Instructables-style documentation so that switch can be made by a moderately skilled "Maker"
- *Develop an easy-to-follow start-up guide and user guide
- *Deliver a complete report outlining design, assembly, calibration, maintenance, and reliability
- *Stretch objective: "paddling backwards" movement, whereas it should be used to break

SCOPE

- *Develop, test, and document an open source hand crank steering wheel for adaptive gaming:
- *Research functional requirements.
- *Research mechanical gears and sensing methodologies.
- *Determine what functionality is feasible within the constraints of being low-cost and maker friendly.
- *Design electronics and circuit boards - or use existing microcontrollers and add-ons.
- *Design mechanical enclosure and mounting interface.

- *Optimize design and assembly method for maker manufacturability (i.e. commercially available parts, 3D printed parts).
- *Assess reliability.
- *Create awesome documentation.

NOTE: Due to the challenges of created by Covid-19 and working remotely, the partners would suggest the focus be on 'fabrication ready deliverables' if it is not possible to deliver a working prototype. This could include: 3D animation of mechanical design, complete and ready PCB design, etc.

Deliverables

DESIGN AND ANALYSIS

The intention here is that people would be able to bring the device home, attach it to their table or stand, and be able to exercise using games as an interactive and motivational resource. Thinking about racing games, like Forza Motorsport 7, users would control the amount of speed up by paddling forward (like the RT button on their Xbox controller, that increases the acceleration force the more you press the button) and the amount of breaking by paddling backwards (like the LT button on their Xbox controller, that increases the breaking force the more you press the button). Like the original GameCycle cited in the introduction, it would be great if the arm crank could tilt a few degrees to the sides to give the players the turning control in the same device. With all of those controls in the same unit, it is expected that a self-contained unit could be fabricated by other student groups and volunteers, for use in the homes of people with disabilities.

A great design will require application of mechanics, electronics and PCB design, mechanical enclosure design, user-centered design, and design for manufacturability. The selected group of students will have the chance to work with users including experts in the gaming industry and community members with disabilities to gain real feedback on prototypes. For an example of a comparable open source, maker-manufacturable assistive technology design, please see: <https://github.com/makersmakingchange/LipSync>

RESOURCES AVAILABLE

The partners will provide an Adaptive Xbox Controller and Xbox (value approximately \$500). PARC will provide up to \$500 purchase of additional materials.

Access to view existing GameCycle and other adaptive exercise equipment on site at PARC can be arranged (or virtual visits).

Neil Squire Foundation has 3D printers that can be used to produce prototype parts.

The partners on this project are committed, engaged and resourceful! We understand that this school year may be a bit different and access to University labs and equipment will be limited. We are prepared to work with students to find solutions to the challenges posed by working remotely and online - this could include, for example, shipping students necessary parts or facilitating the 'field/user verification' by video conferencing with students while our gaming experts and community members test the product.

EXPECTED TECHNICAL BACKGROUND

This project is a good fit for students who are looking to improve and combine their knowledge

of mechanics, physics, electronics, mechatronics, and user-centered design.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

Expected technical background

This project is a good fit for students who are looking to improve and combine their knowledge of mechanics, physics, electronics, mechatronics, and user-centered design.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

arm cycle control, Xbox adaptive controller. arm cycle control,
Xbox adaptive controller
mechatronics,
3D print .

28: Nestor

Category

new product development

Primary Area

Biomedical

Secondary Area

Electrical (low voltage)

Tertiary Area

Software

Organization

Nestor (SpawnLab Technologies Corp.) - <https://getnestor.webflow.io/>

Background

Summary:

Affordable, Real-Time & Locale Independent Wearable Device for Patient Vital Signs Monitoring with fully integrated Analytics and Notifications.

Background:

We have all seen videos and articles on the web about how healthcare systems in major developed and developing nations fell face-first in the wake of the COVID-19 pandemic. Overworked healthcare workers, neglected primary healthcare needs of patients in several communities are the theme of news related to the pandemic.

All the so-called "smart" health tracking devices such as Fitbit and Apple Watches have failed to deliver. Telemedicine is on the rise but there is no way for doctors to have physiological data from the patient from far away, and the pandemic has made physical visits a rare ordeal and something to be avoided.

However, we do have the technology to slightly alter our perspective and use the age old physiological indicators, the vital signs, to provide some glimpse into the state of an individuals mind and body in order to provide better management within our communities.

People with underlying health conditions and the ones affected by the viral infections during the pandemic need continuous healthcare in order to better manage their symptoms and pave their way to recovery. In order to do this healthcare providers need reliable remote access to patient data with minimum overhead. Nestor solves this!

Vision & Mission:

Imagine a future where technology could help predict and prevent cardio pulmonary conditions, respiratory issues and other sudden onset medical conditions, and could help manage associated symptoms. We believe that the future is now. It has been widely shown in studies that changes in physiological conditions among individuals which manifest themselves through vital signs are good indicators for general health of an individual. Vital health metrics for patients both in hospitals (except some ICUs) and home are currently rarely monitored in real-time. Most products on the market currently measure patient specific metrics which are aggregated hourly at best and there is no way to integrate feedback from health care providers for better health management. Our mission is to change that. Nestor is an affordable, real-time and local independent wearable sensor providing an integrated end-to-end cloud solution for reliable and meaningful access to patient health data, equipped with analytics and notifications.

Objectives

The main objective of this proposed capstone project is to help develop a minimum viable product prototype for our finger based non-invasive vital signs monitoring device. This will help us validate our original proof-of-concept prototype and provide us with a head start into the pilot testing stage, where we will further refine the device before clinical trials, regulatory approval and eventual market launch.

Deliverables

**** Special COVID-19 Considerations:**

- We understand the current uncertainty and difficulty being associated with the global ongoing pandemic situation. Our utmost priority is the safety of our team and the students that we work with.
- We are very open to remote work and collaboration with the student teams, and will make every possible adjustment to make sure that our project team is comfortable with the collaboration.
- We understand that it impossible to do any extensive physical prototyping, assembly and lab testing, hence most of the project deliverable will be limited to the fabrication ready simulation validated designs (we just need some kind of proof to make sure the designs will work, that's why we need you!). We will be providing the fabrication services along with the fully-assembled PCBs with help from our industry partners.
- We will procure and deliver any materials ourselves to you that might be needed for some basic prototyping and programming tasks (like micro-controllers, jumper wires, breadboards, usb cables etc.), since we understand that this will be close to impossible for the students to do from home themselves.
- For any programming tasks standard software collaboration tools such as GitHub/GitLab will be used to maintain the progress of the project while the members work remotely and even in different time-zones, since we acknowledge the fact that some international students might be finishing the last year from their home country.
- All the project communication/management will be done via online collaboration tools and video conferencing software. We will also be available via email and phone in case of any issues being faced by our student teams. We guarantee a typical response time of within 24hrs. You will be working directly with a dedicated person from our team for this project.

- We understand that the scope and depth of deliverables might change keeping in view the current pandemic situation, and are very open to suggestions and possible alterations from our student team.

Proposed Deliverables:

(1) Fabrication Ready PCB design, simulated testing and virtual integration for the Minimum Viable Wearable Hardware (this can be based off of the extensive proof-of-concept prototypes & designs that we have developed or something better! We are open to suggestions from experts!) - preferably a design that can be implemented on a flex board or at least is easily transferable to that stage if a modular rigid board design is delivered instead. At this stage no physical fabrication/testing is required, hence a properly validated fabrication-ready design will suffice, with some proof that it will function as expected.

(2) Embedded software program that will provide the required vital signs data from the sensors on the PCB via Bluetooth Low Energy (BLE). This for the most part includes low-level manufacturers specific API implementation and porting of the proof-of-concept code that has been developed so far. Major component is the porting of a MATLAB algorithm to the embedded stack and implementation of a manufacturer specified hardware API to the embedded stack. We will be providing all the necessary micro-controllers and sensors for the development and testing of the embedded software.

(3) (Optional) Design and implementation of the mobile phone app that can read vital signs data from the wearable sensor prototype via BLE. This again can be based off of our very simple proof-of-concept android app. The main functionality is the relaying of data from the wearable sensor to the cloud via the smartphone.

(4) (Optional) Design and implementation of the server side data ingestion back-end code (cloud-based & real-time) and front-end visualization interface for the vital signs data being relayed from the wearable sensors. We have a proof-of-concept setup which can be used as a starting point if necessary.

(5) (Optional) Design concepts & virtual simulated 3D implementations of the wearable finger sleeve that can hold the PCB and is functional, aesthetic & comfortable. No physical fabrication/testing is expected, but their needs to be a proof that the design will work.

Contributions Organization is Able to Provide

We will be providing additional financial support (anything on top of the regular capstone budget), access to our prototype designs that have been developed so far, support with PCB manufacturing and programming implementations, the primary contact would be available on every weekend during the whole project and will be actively participating in the development sprints with your students

Additional Considerations

n/a

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

biomedical, wearable, healthcare, non-invasive, IoT, embedded programming, PCB design.
biomedical, wearable, healthcare, non-invasive.

29: Wireless Data and Visualization for a Handheld Electronics Workbench.

Category

operational application with add-on components

Primary Area

Mobile app

Secondary Area

Electrical (low voltage)

Organization

Gentiam Canada ULC - <https://gentiam.com>

Background

ARCIMUSE is a cost-effective, portable, diagnostics board with the key functionality of a voltmeter (or other meters for flux, temperature, light, etc. using mountable sensors), a UI panel, an LED panel, waveform analysis features (similar to an oscilloscope), and allows for bi-directional data transfer with an external microcontroller, enabling rapid run-time and in-situ debugging (without a computer). The overall goal of the tool is to provide the key functionality typically needed in an electrical workstation, so that an under-funded industry group, a startup, someone working on a DIY project, or undergraduate engineering students may continue hardware development activities for an affordable price point without the need of a lab. In an effort to maintain an affordable price point, ARCIMUSE was designed with a hexadecimal display and without wireless functionality, limiting its ability to show measured, logged, or post-processed data in a graphical way. Learn more at: <https://gentiam.com/electronics.html>

We look forward to working with team members with backgrounds in mobile app development, bluetooth communication, CAD design, and/or 3D printing. The ideal team will consist of members with different strengths (e.g. mechanically inclined for CAD design and builds, electrical testing, code development, user interface design, etc.) excited to work together and bring the project to life. Excellent team members and candidates may be considered for future employment upon graduation.

Objectives

The main objective of the project is to create an "ARCIMUSE Unit" kit, which includes the ARCIMUSE board, an Arduino UNO R3 board, a bluetooth module, all necessary connectors (e.g. BNC, screw terminal, etc.), any other types of PCBs (or "shields") that may be required, all contained in a custom-designed enclosure.

The project's objectives can be organized into 3 main components:

1. Design an ARCIMUSE Unit enclosure that securely houses and mount all components contained in an ARCIMUSE Unit, can be 3D printed, and has connectors for users to easily access IO ports and UI elements of ARCIMUSE.
 2. Enable communication between Arduino and a mobile device (preferably iPhone), allowing user commands to be transmitted to the ARCIMUSE Unit, and measured or post-processed data from the ARCIMUSE Unit ("system data") to be sent back to the mobile device.
 3. Design a mobile device app configured to send and receive data with an intuitive UI, with data visualization and logging capabilities.
- All project components are highly flexible and remote work such as CAD work and software design can be a heavy focus due to the need of social distancing as a result of Covid-19. All hardware units will be provided.

Deliverables

The main deliverables will consist of:

1. A completed ARCIMUSE Unit, containing the components mentioned above (incl. a 3D-printed enclosure).
2. A completed mobile app, containing an intuitive UI interface to send user commands to the unit, monitor unit parameters, and a graphical display displaying system data waveforms.
3. Demonstrated bluetooth wireless functionality, showcasing the ability to send control commands from a mobile device to the ARCIMUSE Unit, and the ability to send system data at a reasonable sampling rate to the mobile device.
4. All associated software files, including (but not limited to) CAD models and any associated files for the enclosure, mobile app and source code, comprehensive project, technical, and end-user documentation (incl. progress updates), any other software files generated in association to the project.

Contributions Organization is Able to Provide

All of the above to some extent, as needed. Additional funds available on an as needed and pre-approval basis. Virtual access to 3D printers, access to ARCIMUSE equipment and PCBs, support for software used internally, support for testing processes and test plan development, access to in-house Requirements Management Tool, access to internal Project Management tools, weekly reviews and mentorship, etc.

Additional Considerations

Although our organization does not formally have many paid employees, our team consists of several independent contractors and a core team with over 68 years of combined experience; the team will engage with Dr. Omar Laldin (PhD), the company Director, who is a member of the IEEE, was formerly the Director of Powertrain Engineering at an electric aircraft company, and (prior to that) the Head of Electromagnetic Motor Design Group at an electric vehicle company. His previous experience also includes working at GE, ABB, Infineon, etc.

Since our inception a year ago, we have been heavy proponents of remote working technologies, especially pertaining to hardware development. We are quite capable of executing hardware development efforts during the Covid-19 crisis. For objectives 2) and 3), emphasis will be placed on software, code, and user interface development. For objective 1), CAD models will be heavily utilized, 3D printed, and shipped to the person responsible for physical integration (also receiving all external ordered components). A nested testing plan will be developed for and executed by each team member (on their target objectives) and overall testing will be conducted

by the “integration” member. We are aware and will support all available options under the Covid-19 during the project duration.

To assist the team, we can provide access to various resources and tools, such as virtual access to our 3D printers, support for software used in-house, ARCIUSE boards and other similar tools, etc. We are willing to take a very hands-on guided approach, using and teaching industry standard best-practices (e.g. Requirements Management, V-Model Development Cycle, etc.). We are also willing to incorporate the team into our project planning and management workflows, including regularly scheduled meetings to discuss progress to provide guidance.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Flexible with targets and for Covid-19, remote work, CAD design, mobile app design, Bluetooth communication, diagnostic tool, cost-effective solution, Arduino, 3D printers, software support, mentorship, additional fund availability, potential employment opportunity.. Flexible with targets and for Covid-19, remote work, CAD design, mobile app design, Bluetooth communication, diagnostic tool, cost-effective solution, Arduino, 3D printers, software support, mentorship, additional fund availability, potential employment opportunity..

30: Automated Traffic Police Signal Recognition System

Category

technology exploration

Primary Area

Machine learning

Secondary Area

Computer

Tertiary Area

Electrical (low voltage)

Organization

Huawei Technologies Canada Co.,Ltd. - <https://www.huawei.com/ca/>

Background

There are many challenges hindering deployment of full-fledged self-driving car technology, and it is critical to find ways to anticipate a large variety of situations. One of the situations which autonomous car technology needs to be able to operate in is following the instructions of a police officer on the road under special conditions. For example, when a police officer steps up to direct traffic and pedestrians at a busy intersection. Or, when a car is found to be disobeying traffic rules and the cop signals the car to pull over. These might be unanticipated tasks that the car must be prepared for. It is a multi-dimensional problem, as the car needs to detect, recognize and respond to these signals accurately and in time.

Currently, self-driving researchers are motivated to replicate human response to hand signaling, to aid communication between cars and law enforcement personnel and reduce risk of accidents. In this project, we will be building a traffic hand signals recognition module for a model self-driving car. The details of the system are provided below.

Objectives

In order to build a simulation of the vision-based modules of this system, we need to first build a Remote-Controlled (RC) car model that is able to perform its maneuvers at a model road intersection scenario. The car needs to respond to the signal delivered by recognizing the body pose (static) of a human traffic controller corresponding to a signal. This would involve firstly detection of the human controller, understanding their direction of attention (looking towards car or away), and recognizing their body pose as a signal to follow. The entire Computer Vision

(CV) application is to be implemented on the Ascend 200DK AI platform. The board must be mounted on the RC car platform, as well as a battery power supply to ensure continuous power supply to the board.

Deliverables

The key hardware components of the system:

- Ascend 200DK with Raspberry Pi camera interfacing
- RC car
- Power Supply

The key CV modules to be implemented:

- Human traffic controller detection (identification by color of uniform or other salient features)
- Head pose/gaze detection
- Pose detection
- Signal classification using detected pose (e.g. turn right or left, go straight, stop)

A fully functional model RC car prototype, which can be demonstrated as a model road intersection setup with a human controller for demo.

Supporting hardware, models for implementation of the CV modules, as well as guidance for using the board, can be provided as required.

All design documents, plans and code will be open-sourced on Github.

Contributions Organization is Able to Provide

necessary financial support and technology support

Additional Considerations

development on Atlas 200 DK AI platform

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

computer vision, robotics, edge computing, deep learning, Artificial Intelligence. .

31: Hand-Gesture Controlled Robot Pet

Category

technology exploration

Primary Area

Machine learning

Secondary Area

Electrical (low voltage)

Tertiary Area

Computer

Organization

Huawei Technologies Canada Co. Ltd - <https://www.huawei.com/ca/>

Background

Consider having a pet that is smart, responds to your instructions and even takes pictures for you! This could be a dream come true for those craving an animal companion but cannot afford the maintenance or caretaking as required for real pets. Robot pets are one example of how technology can assist in scenarios where companionship and fun is needed, but the handling and upkeep of real pets is forbidding, especially in a healthcare or senior home facility.

Robot pets have already captured the imagination of the many. When Sony introduced Aibo, an interactive robotic dog the size of a Chihuahua, it immediately gained unanticipated popularity. Apart from doing normal dog things, like bark and perform a few tricks, it could also do robot things, like capture photos with the camera in its nose. It signaled its mood with a color-coded lighting system on its head (green: happy; orange: angry) [Source Article: <https://www.wired.com/story/the-second-coming-of-the-robot-pet/>].

In an application scenario where such a “smart robot pet” is capable of responding to human gestures and performing assistive tasks such as capturing video or photos at the user’s command from a distance, advanced computer vision technology can be leveraged. If the robot pet can receive input in the form of a hand gesture (and/or other mode of input such as voice command) from the user, it can track, recognize and ultimately perform a task such as following the user while video capturing, etc. The user is thus able to control the pet from a distance, enabling full autonomy in this scenario.

Objectives

In this project, we need to build a simulation of this gesture-controlled robotic pet system that is

able to respond to a detected hand gesture seeing through its mounted camera “eyes”. The Computer Vision (CV) modules that would enable the model to follow instructions include primarily hand detection and tracking and subsequently identifying the gesture. The entire application is to be implemented on the Ascend 200DK AI platform. The board must be mounted on a moving platform, as well as a battery power supply to provide continuous power supply to the board. The Raspberry Pi camera can be interfaced with the board to pick up the visual gesture signals. The key objectives of the project will be to deliver a system that performs both

- Entertaining “pet” tasks such as responding to gesture or voice commands, expressing “happiness” signals, etc.
- Assistive tasks such as clicking a picture, starting or stopping video recording, etc.

Deliverables

The key hardware components of the system:

- Ascend 200DK
- Power Supply
- 2 servo motors to allow camera movement in horizontal and vertical axes for target (hand) tracking
- Peripherals

The key CV modules that may be implemented:

- Hand detection and tracking
- Hand pose detection
- Gesture Recognition
- Algorithm for assigning priorities to task execution

Supporting hardware, models for implementation of the CV modules, as well as guidance for using the board, can be provided as required. A fully functional model robot pet prototype, which can be demonstrated as a setup with gesture-controlled navigation and tracking. Robot may additionally rotate to track a user’s detected hand to keep it within its view range. Recognition of the detected hand gesture to execute a gesture-based command such as “follow”, “take a picture” or “sit (stop)”.

All design documents, plans and code will be open sourced on Github.

Contributions Organization is Able to Provide

necessary financial support and technology support

Additional Considerations

development on Atlas 200 DK AI platform

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

computer vision, autonomous driving, deep learning, Artificial Intelligence, Edge Computing, Robotics. .

35: Deep Learning Artificial Intelligence Algorithm for Solar Electric Renewable Energy Technical Support Functions

Category

new product development

Primary Area

Software

Organization

Jarmos Solar Tech Support - <http://www.jarmos.ca>

Background

From the beginning of the computer era, there has been an on-going search to create a computer system which has Artificial Intelligence. Such a system needs to be able to perceive visual, text or other information, reason or “think” about the meaning of that information and provide an output analysis. Over the years, with advances in computing power and algorithm development, these systems have evolved from simple symbolic knowledge-based systems, to expert systems and very recently to deep learning systems.

This project proposal is that of creating an artificial intelligence system for the specific purpose of providing technical support for installers and end-users of renewable energy solar electric systems, for use by technical support personnel in our organization.

Objectives

The core function of technical support personnel in high tech companies is to listen to the customer describe a technical or functional problem with their equipment and from that, determine the cause and offer a solution. Currently this requires specially trained individuals who have good technical knowledge, a large knowledge base of the products they support and good communication and deductive skills, (not to mention patience).

The current generation of Artificial Intelligence, Deep Learning Systems are now capable of performing this function and our organization wants to embark on developing such a system for our use.

The objective of this proposal is to create a deep learning artificial intelligence algorithm for our solar electric renewable energy technical support functions.

Deliverables

The deliverables for this proposal are:

1. Deliver VER 1.0 of the Artificial Intelligence Tech Support System
3. Provide a description of the system design and operating principle
4. Provide a review of the design choices and reasons for choices made during development

FUTURE DEVELOPMENT OBJECTIVES BEYOND THE SCOPE OF THIS PROPOSAL:

This proposal is specifically that of designing and developing an Artificial Intelligence Deep Learning Network which can perceive a technical problem description for a Renewable Energy Solar Electric System and provide a possible solution to that problem. This system will be used by tech support personnel.

From our point of view, this Capstone Project, is in the least an exploration of the technology for us and interested students, or hopefully the beginning of development and/or even early use of such a system. It is expected that work will continue in developing, improving, expanding and enhancing this system.

Farther in the future, work will also be undertaken to develop human-machine input and output interfaces for the above network:

An INPUT Human-Machine Interface Network:

A Human-Machine input interface consisting of a deep learning network which parses textual and/or visual input information and generates the input data for the deep learning problem analysis.

An OUTPUT Human-Machine Interface Network:

A Human-Machine output interface consisting of a Generative Adversarial Network to generate human output information.

Contributions Organization is Able to Provide

Access to information, education/training, Financial Support

Additional Considerations

I have been in the solar electric industry since the late 1980's. Much of my career has been in sales application and customer support roles, which I am currently doing part time. It is my intent to develop the proposed AI deep learning network system and to start a Solar Tech Support Company.

I have decades of personal knowledge with regards the questions presented and specific functions of tech support for solar electric systems and can and will provide a multitude of case examples with known outcomes, with which we can train/challenge the system.

Here is one typical tech support customer case example:

"Customer e-mails that his solar system worked well since installation in March, but since April, on some days, it has produced power only before 10 am in the morning and after 5 pm in the evening. Other than that, the system works fine"

ANALYSIS BY DEEP LEARNING NETWORK

The deep learning AI network, should have been taught the basics of ohms law, how solar modules work, how inverters work, etc., (basic rules of electronics and solar systems).

With the problem description and the "electronics rules" it knows, it should be able to reason and come up with likely causes.

For those interested, this a fairly common trouble call in the spring and given knowledge of electronics, solar cells and inverters, a person or AI system should be able to find or learn to propose the most likely solution or solutions.

If you have questions or want further clarification/information, please contact me by e-mail: venalainen.jarmo@gmail.com or cell: 250-957-7808

Jarmo Venalainen M.A.Sc. Electrical Engineering UBC

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

artificial, intelligence, symbolic, knowledge-based, systems, expert, deep, learning, generative, adversarial, networks, regression, classification, clustering, dimensionality, supervised, unsupervised, learning, Solar, Electric, Renewable, Energy, Technical, Support, Human, Machine, Interface. natural language processing, contextual analysis.

36: Monitoring of Unoccupied Properties using Cellular IoT

Category

new product development

Primary Area

Software

Secondary Area

Mobile app

Tertiary Area

Electrical (low voltage)

Organization

Sierra Wireless (Richmond, BC) - <https://www.sierrawireless.com>

Background

This project solves a real problem in the industry and implements a real business case.

If you were an entrepreneur with a team of IoT experts, this is one project that could lead to a very successful business. With this project, get ready to tackle a real industrial problem with the help of the engineers from the global leader in cellular IoT solutions: Sierra Wireless (Richmond, BC).

The monitoring of unoccupied properties (from houses to industrial buildings) is a major issue that most solutions deployed on the market today are hardly solving because they mainly focus on detecting human intrusions instead of considering the problem from a wider perspective. Indeed, unoccupied properties are facing many other issues like power supply interruptions, insects' invasions, flooding, smoke/fire, animals' intrusions, moisture development, etc.

This product aims at replacing a human presence onsite that can detect all sorts of issues based on multiple senses (abnormal sounds, changes in lighting, temperature, humidity, vibrations, air particles analysis, power outage, etc.) and report anomalies through the cellular network, while being resilient to power supply interruptions.

The newest technologies provided by Sierra Wireless: Octave™ edge-to-cloud data orchestration platform, and mangOH Yellow open-source industrial-grade expandable cellular IoT board, will allow the team to provide a real running prototype in a really short time, leaving time for experiments, enhancements, and studies of various possible solutions and features.

Note: as no IP is claimed by Sierra Wireless, this project is free to continue beyond the scope of Capstone program (including through a real business)

Objectives

Phase 1: Preliminary Study: Define the scope and features of the product based on the expression of the need, technical constraints and time constraints for the project. The study will define the sensors to be used as well as a first assumption on the application logic to be run on the device as well as on the cloud, the need and features of a phone app, etc. with the help of Sierra engineers. Note: the team may decide to use machine learning features for a better result: although we believe it is not mandatory for the product, we'll support such initiative if the team decides to go that path.

Phase 2: Iterative Prototyping: build a prototype with the help of Sierra engineers based on the assumptions made in the study. Test the solution and try multiple sensors and various applicative logic/analysis to converge to the best solution.

Phase 3 (if enough time): Present a final prototype including an enclosure (can be 3D printed for instance) and a mobile phone application.

Deliverables

Main deliverables: Study & Prototype of a monitoring box (based on mangOH Yellow & Octave) for unoccupied properties, with multiple sensors (for example: sounds, power outage, humidity, light, air quality, temperature, ...), battery, cellular connectivity.

Optional deliverables: Mobile phone application, Machine Learning, 3D printed enclosure.

Code & study to be provided under an open-source business-friendly license.

Contributions Organization is Able to Provide

For the duration of the project, Sierra Wireless will provide all technical materials required for the project including mangOH Yellow boards, Octave platform account, cellular connectivity; and any financial support based on project needs and following organization's approval.

Additional Considerations

Sierra Wireless will provide familiarization materials and training sessions on Octave and mangOH prior to the start of the Capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

IoT, cellular, monitoring, sensors, open source, smart building, house, unoccupied properties, business. IoT, cellular, monitoring, sensors, open source, smart building, house, unoccupied properties, business.

37: Build the First Connected Time Capsule (Low-Power Cellular IoT)

Category

technology exploration

Primary Area

Software

Secondary Area

Electrical (low voltage)

Tertiary Area

Mobile app

Organization

Sierra Wireless (Richmond, BC) - <https://www.sierrawireless.com>

Background

This project solves a real problem in the industry.

Are you ready to take up the challenge and build the first connected Time Capsule buried with some great souvenirs from our era (of your choice) for the future generation to discover in many years, while solving one of the biggest challenges in the IoT industry today at the same time?

1) The Industrial Challenge – lifetime of battery powered IoT objects

IoT solutions involve more and more battery-powered solutions with no possibility to charge the battery once the object is deployed on the field. The object has to operate (e.g. monitor sensors and report/communicate wirelessly) for its whole life on a single battery charge and the current consumption becomes one of the main success factors – especially when the object is buried into the ground. Radio signals attenuation implies more energy to be used for the communication and/or innovative cellular antenna connection methods are utilized.

The latest improvements of cellular networks address the “Low Power Wide Area” networks needs in the IoT industry (e.g. smart metering, smart buildings, etc.) and Sierra Wireless, the global leading cellular IoT company based in Richmond, BC, provides the latest technology in that domain (LTE-M, NB-IoT modules with advanced features) to answer the strong demand from the industry: enable multiyear-lifetime connected objects on a non-rechargeable battery.

This project aims at showcasing how long an IoT system can last on a single battery charge, while monitoring and reporting on a regular basis, with the latest cellular technologies.

2) The Use Case – Connected Time Capsule

A Time Capsule is a historic cache of goods or information and a method of communication with future people. So far, about 10,000 to 15,000 capsules are buried worldwide. The most famous one in BC is the British Columbia Time Capsule in Victoria, created on Dec 31, 1967, planned to be opened 100 years later during the Canada's bi-centennial celebrations.

With today's technology, it is now possible to add a "wireless little electronic guardian" to that time capsule. This technology will keep an eye on the health of the time capsule, and alert someone if something goes wrong along the way. For instance, depending on the content of the capsule, it may be important that humidity stays within an acceptable range to preserve its content. As well, the capsule might be dug up too soon by accident, or even stolen; the device should be able to detect these occurrences and send an alarm.

The newest technologies provided by Sierra Wireless: Octave™ edge-to-cloud data orchestration platform, and mangOH Yellow open-source industrial-grade expandable cellular IoT board will allow the team to provide a real running prototype in a very short time, leaving time for experiments, enhancements, and studies of various possible solutions and features.

Objectives

Phase 1: Design: Define both the physical aspect, the location, and the content of the time capsule. Define the monitoring features (humidity? light? temperature? vibrations? flooding? etc.) and the main usages (who to alert, how, etc.). Constraints: the device must monitor at least one sensor and communicate its battery level every month. It must be able to detect an intrusion and send an alert.

Phase 2: Prototype and energy study: build a prototype of the device with the help of Sierra engineers. Test the power consumption and determine the main impacting factors (how many communications per month, radio signal strength, etc.). The study must conclude on a maximum lifetime per Wh of the battery (or determine what battery size is required to last 10 years, 30 years, 50 years, etc) based on these factors.

Phase 3: Enhance the prototype with the help of Sierra engineers, build the connected time capsule, declare the time capsule to the International Time Capsule Society and bury it during a ceremony with UBC and Sierra Wireless representatives!

Deliverables

Main deliverables: Study & Prototype of a connected time capsule (based on mangOH Yellow & Octave) powered on battery, with health monitoring (at least one sensor like humidity) and tempering detection and alerting capabilities.

Optional deliverables: Finalized time capsule buried during a ceremony with representatives of UBC and Sierra Wireless.

Code & study to be provided under an open-source license.

Contributions Organization is Able to Provide

For the duration of the project, Sierra Wireless will provide all technical materials required for the project including mangOH Yellow boards, Octave platform account, cellular connectivity; and any financial support based on project needs and following organization's approval.

Additional Considerations

Sierra Wireless will provide familiarization materials and training sessions on Octave and mangOH prior to the start of the Capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

IoT, low power, cellular, LPWA, LTE-M, NB-IOT, monitoring, sensors, open source, time capsule.
IoT, low power, cellular, LPWA, LTE-M, NB-IOT, monitoring, sensors, open source, time capsule.

38: Boat Tracking & Monitoring using Cellular & Satellite IoT

Category

new product development

Primary Area

Software

Secondary Area

Mobile app

Tertiary Area

Electrical (low voltage)

Organization

Sierra Wireless (Richmond, BC) - <https://www.sierrawireless.com>

Background

This project solves a real problem in the industry and implements a real business case.

If you were an entrepreneur with a team of IoT experts, this is one project that could lead to a very successful business. With this project, get ready to tackle a real industrial problem with the help of the engineers from the global leader in cellular IoT solutions: Sierra Wireless (Richmond, BC), and the engineers of the satellite communication start-up Kineis (Argos next generation).

The monitoring of mobile assets (like boats) everywhere on earth including in areas not covered by cellular networks (like in the open sea) is a real problem in the industry with no satisfying solution so far.

This project aims at prototyping a boat tracking & monitoring product (GPS location, battery level, bilge activity, temperature, humidity, accelerometer, gyroscope) that can be used as an SOS system as well. The product must use the cellular connectivity when available and the satellite connectivity (Kineis) otherwise.

The newest technologies provided by Sierra Wireless: Octave™ edge-to-cloud data orchestration platform, and mangOH Yellow open-source industrial-grade expandable cellular IoT board, as well as Kineis satellite communication IoT card for mangOH, will allow the team to provide a real running prototype in a very short time, leaving time for experiments, enhancements, and studies of various possible solutions and features.

Note: As no IP is claimed by Sierra Wireless, this project is free to continue beyond the scope of

Capstone program (including through a real business)

Objectives

Phase 1: Preliminary Study: Define the scope and features of the product based on the expression of the need, technical constraints and time constraints for the project. The study will define the sensors to be used as well as a first assumption on the application logic to be run on the device, as well as on the cloud, the need and features of a phone app, etc. with the help of Sierra engineers.

Phase 2: Iterative Prototyping: build a prototype with the help of Sierra engineers based on the assumptions made in the study. Test the solution on both cellular and satellite communication, explore battery power options and try multiple sensors and various applicative logic/analysis to converge to the best solution.

Phase 3 (if enough time): Present a final prototype including an enclosure (can be 3D printed for instance) and a mobile phone application.

Deliverables

Main deliverables: Study & Prototype of a boat monitoring box (based on mangOH Yellow & Octave & Kineis IoT card for mangOH), with GPS and multiple sensors (for example: sounds, power outage, humidity, light, air quality, temperature, ...), battery, cellular connectivity.

Optional deliverables: Mobile phone application, 3D printed enclosure.

Code & study to be provided under an open-source business-friendly license.

Contributions Organization is Able to Provide

For the duration of the project, Sierra Wireless will provide all technical materials required for the project including mangOH Yellow boards, Octave platform account, cellular connectivity; and any financial support based on project needs and following organization's approval.

Additional Considerations

Sierra Wireless will provide familiarization materials and training sessions on Octave and mangOH prior to the start of the Capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

IoT, monitoring, sensors, open source, smart boat, tracking, satellite, cellular. IoT, monitoring, sensors, open source, smart boat, tracking, satellite, cellular.

39: Virtual 3D Visualization App for Buildings Augmented with Real-Time Sensor Data

Category

idea validation

Primary Area

Mobile app

Secondary Area

Electrical (low voltage)

Organization

Delta Controls Inc. - <https://deltacontrols.com/>

Background

Delta Controls is one of the largest manufacturers of building automation systems in the world and recently received the AHR Innovation award for the O3 Sensor Hub. The Sensor Hub combines multiple sensors including humidity, temperature, motion and light in a single device. Sensor data from the hub is used by the Building Management System to control all aspects of the building control system including HVAC, security and energy optimization.

An interactive interface to view live sensor readings in the area surrounding a Sensor Hub would allow building and maintenance engineers to remotely inspect live data and review performance metrics of a monitored building.

The project proposes to use the gaming engine Unity Reflect to visualize the BIM model augmented with data from the Sensor Hubs. The user can view and manipulate the 3D model to select a room to inspect. Upon selection of the room, the user can get a visualization of the current conditions reported from the sensor hub.

Regarding pandemic restrictions, Delta is fully setup for remote engineering allowing for home-based development. All team members will get a Sensor Hub and when networked, remote updates and integration is seamless. Access to Delta engineering via Slack makes communication and collaboration easy and flexible.

Delta is looking to build its IoT strategy and are always looking to recruit talented Computer and Electrical Engineers. Recruitment opportunities as well as post graduate referrals are possible.

Objectives

As a result of the high interest of this project, we would like 5 capable and passionate students to choose this project as rank 1. We're looking to assemble an award winning team as results from

this projects will be viewed globally through our worldwide partnership and parent company Delta Electronics.

The primary objective is to create a mobile app using the gaming engine Unity Reflect to view data from Sensor Hubs distributed throughout a building.

Using MQTT, live data can be retrieved from the sensor hub and synced with the 3D Unity visualization. Students are open to use their creativity to create different visualizations to provide an interesting yet informative delivery of sensor data.

Building engineers and maintenance crew are often onsite and can use the BLE Beacon built into the sensor hub to indicate the approximate position of the user within the virtual BIM model. This would allow a remote building or maintenance engineer to view occupancy, noise levels, lighting, indoor environmental conditions and building performance metrics.

Deliverables

- Mobile App using Unity Reflect.
- Sample BIM model of a building imported into Unity Reflect
- Augment Unity Reflect interface with live data from sensor hubs
- Demonstrate use of mobile phone or tablet touch controls to navigate model

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

All aspects of the project can be performed remotely, all team members will get a Sensor Hub and when networked can fully collaborate with each other.

Recruitment possibilities as well as post graduate referrals are possible.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Unity, Reflect, Sensor Hub, IoT, Gaming, Building Automation, Controls, BIM, BAS, MQTT, 3D Visualization, energy optimization, HVAC, app, iOS, Android, React Native, . Unity Reflect, Sensor Hub, Building Automation, Controls, BIM, BAS, MQTT, 3D Visualization, energy optimization, HVAC, mobile app.

40: Augmented Indoor Position Tracking App

Category

technology exploration

Primary Area

Mobile app

Secondary Area

Electrical (low voltage)

Organization

Delta Controls Inc. - <https://deltacontrols.com>

Background

Delta Controls is one of the largest manufacturers of building automation systems in the world and recently received the AHR Innovation award for the O3 Sensor Hub. The Sensor Hub combines multiple sensors including humidity, temperature, motion and light in a single device. Sensor data from the hub is used by the Building Management System to control all aspects of the building control system including HVAC, security and energy optimization.

Recent pandemic related global events have prompted new technologies to assist with crowd control, social distancing and people tracking.

The sensor hub uses Bluetooth beacons to broadcast identifiers to BLE enabled smartphones allowing smartphones, tablets and other devices to use for indoor position tracking.

This project focuses on the application of providing indoor people tracking and identification so someone can visualize what areas are in use and where people are within an office or campus building. It also allows maintenance staff to sanitize and maintain areas that were previously occupied.

This proposal is an extension from a project in 2019 where the team used Google Indoor Maps technology to locate people within a floor plan. Last years project was very successful where all group members achieved top grades. All project design details, notes and code are available to share as well as a full briefing from Delta to give the team a head start.

Regarding pandemic restrictions, Delta is fully setup for remote engineering allowing for home-based development. All team members will get a Sensor Hub and when networked, remote updates and integration is seamless. Access to Delta engineering via Slack makes communication and collaboration easy and flexible. A simulated building can be created with sensor hubs located in your homes and superimposed on a Google Maps Indoor floor plan. The entire network can be virtualized and accessed over the cloud.

Objectives

The primary objective is to track a users physical location relative to a Google Indoor Maps floor plan. Using the sensor rich O3 Sensor Hub, superimpose details of instrumented spaces on the floor plan including occupancy, temperature, RH, ambient noise, lighting and user rating based on their preference for comfort and social distance requirements.

Mass deployments of the Sensor Hub on University campuses, hospitals and shopping malls will allow users to navigate indoor spaces and view real-time indoor environmental conditions.

Sensor Hubs can be programmed to interact with users as well announcing when social distance parameters are not met or give alternative suggestions of a less occupied space. These UX design considerations will be left to the creativity and discretion of the student group.

Delta is looking to build its IoT strategy and are always looking to recruit talented Computer and Electrical Engineering students. Recruitment opportunities as well as post graduate referrals are possible.

Deliverables

Android App with the following base functionality:

- App with UI with Google Indoor Maps Floor Plan
- App will synchronize hub beacons over MQTT to a cloud based server
- Augment App UI with sensor data from sensor hubs via cloud based server
- Include UI to allow users to create criteria for preferred spaces

Secondary deliverables (time permitting):

- Allow sensor hubs to interact with users through sound and light ring to reflect current social distance restrictions or alarms based on occupancy
- Share sensor hub data in conjunction with user reviews with Google Indoor Maps Review platform.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

All aspects of the project can be performed remotely, all team members will get a Sensor Hub and when networked can fully collaborate with each other.

Recruitment possibilities as well as post graduate referrals are possible..
This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Google Indoor Maps, HVAC, Sensors, MQTT, Augmented, App, Android, Apple, iOS, IoT,

pandemic, COVID, social distance, UI, UX, database, firebase, . Google Indoor Maps, HVAC, Sensors, MQTT, Augmented, App, Android, Apple.

41: USB radio for networking remote health centres

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Computer

Tertiary Area

Software

Organization

Signalytic - <https://signalytic.ca>

Background

In regions where power and communication infrastructure are limited communication and keeping records is done on paper. This makes communication of shortages or outbreaks very slow, and wastes the time of health care workers. We have witnessed instances where a critical medicine is not available, while a neighbouring facility has plenty, unused, on its shelves.

We work in Eastern Africa and other regions to provide health data networking using solar batteries and low-cost hardware. In many places we can use cellular data to connect our "microservers" to each other. But there are health centres where a cellular signal is not available. We want you to find a solution for this.

Objectives

We would like you to design a USB-connected dongle or interface that provides a data connection between two microservers. By connecting microservers together they can form a mesh network, solving the problem of connectivity. An external antenna is permitted, probably necessary. The networking can be for moderate speeds (1Mbps). Distances up to at least 10km should be attainable. Power consumption is a concern. Latency (the time it takes for a data packet to travel the distance) is not very important.

Some examples of what a solution could look like:

- use an existing 2.4 GHz WiFi transceiver, possibly with increased power output, but select or design a new directional antenna to optimally focus energy delivery and efficient reception;
- use multiple low-cost solar powered radio transceiver nodes with limited range to bridge a 10 kilometre distance;
- use digital short wave radio;

- something completely different!

Deliverables

A good deliverable: A documented design that explains what options were considered, and what solution was chosen. Some selective prototyping work is done on key parts of the technology to show that the design concept is sound and feasible.

A great deliverable: In addition to a documented design: a working prototype that connects two of our microservers and establishes a connection. Data on the performance characteristics of the prototype. If the design is sound we are very likely to adapt it for production, which is our ideal outcome.

Contributions Organization is Able to Provide

We will budget an additional \$1000 for this project, with additional financial support as needed and with approval. We can provide embedded server devices and mentoring.

Additional Considerations

The project supervisor (Willem Atsma, PhD) is the company CTO has an electrical engineering background. He will be one of the resources available to you for this project. You will have access to our other technical team members too and it is our aim to support you as well as we can, both in terms of know-how and materials.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

digital radio, mesh networking, low power, antenna, health data. digital radio, mesh networking, low power, signal processing, antenna, RF link budget, linux health data.

42: Search platform for International Food Composition Databases

Category

new product development

Primary Area

Digital Media

Secondary Area

Software

Organization

Fillet - <https://getfillet.com>

Background

The food industry is the largest industry in the world by market size. It is also the most fragmented industry in the world. Historically, it has been neglected by the tech industry: software and hardware options were limited, expensive and unintuitive. Today, with the advent of mobile apps in kitchens, the food industry is experiencing rapid change. Yet, the majority of the global food industry still relies on pen and paper. This is partly due to venture-backed startups selling to food industry customers, and then leaving them unsupported when the startup fails. This trend continues today, but we are not them.

Our company, Fillet, is an app that is used in more than 100,000 commercial kitchens around the world. Food businesses use Fillet to manage their operations, including food and labour costing, inventory management, nutritional analysis, waste tracking, and ordering ingredients from small local suppliers.

We are an international team, and we design our products for the international market. This means, at all times, we must be mindful of many differing, sometimes conflicting, factors such as language, cultural and religious practices, regional norms — each of these factors have significance in the global food industry.

▷ “Each country has its own consumption pattern resulting in country-specific foods, recipes and brand-name foods [commercial foods with the same brand-name can have varying composition due to taste or fortification regulations across borders]...Therefore, each country has specific data needs as they have different compositions of their foods, even if some people think that foods have similar composition among countries due to globalization.”
(<http://www.fao.org/nutrition/food-composition/en/>)

We are in a unique position because we have our users’ trust, and they are receptive to new ideas. We also have an exclusive machine readable data set, which is useful because of the rapid

progress of machine learning during the past few years. We utilize an open source search engine to develop products that bring concrete utility to our passions: nutrition, traceability, sustainability. The best part is, our users share these passions.

When we began, our app provided a basic nutrition module. It included the USDA Nutritional Database as a reference. However, the database quickly became outdated. It was also only available in the English language, and was targeted towards North American users. Today, our user base is global. Our users expect our apps to reference their own regional nutritional databases, provided in their language, and localized for their use context.

Every country has their own standards and lab testing procedures. Add to that political and linguistic nuances such as right-to-left writing, pluralization rules, or differences in units of measurement (e.g. imperial vs metric).

For this project, we will focus on the databases compiled by the UN FAO: INFOODS.

▸ “FAO coordinates the International Network of Food Data Systems (INFOODS), a worldwide network of food composition experts aiming to improve the quality, availability, reliability and use of food composition data.” (<http://www.fao.org/nutrition/food-composition/en/>)

Even after this project concludes, this database will continue to serve our users’ real life needs. Our users will use Fillet to calculate nutritional information, to make informed decisions about the food products they sell, and to share that knowledge with their customers.

Future versions of this database will build on the groundwork laid by this project. Our users will gain knowledge about how different regions analyze and understand food: macro- and micro-nutritional composition, food safety standards, and more.

Objectives

(1) Preliminary goal is to select the external databases that will be included in our internal repository of databases.

- Identify a subset of databases from UN FAO that would adequately represent the complexity and variety of the entire data set and serve as a reasonable start for the first version of the product.
- This subset of databases will be used to develop the Standard.

(2) Main goal is to develop the Standard.

- Propose a universal data standard or a set of standards to store and transmit nutrition data across our platform.
- The Standard is the way (format) that the data is stored in our own server.
- There will be major clusters of databases which have similarities, but outliers who do not fit into any major cluster. We need to identify these major clusters because there is a strong likelihood that they should be included into our repository of databases. The Standard will be designed to accommodate major clusters.
- For example, USDA database is a food industry standard that should/will be (a) accommodated by the Standard and (b) included in our repository. We hypothesize that the USDA cluster will include similarly structured databases from Canada, UK, and Australia.
- We need to identify the outliers and explain what makes them an outlier, i.e. why they do not fit into any major cluster.
- Then we need to consider if we can develop a methodology for including an outlier into the

repository. This is an exercise in assessing the complexity and ensuing effort required to accommodate an outlier.

- The Standard will dictate design of our future API, which will transmit the data to Fillet apps.

(3) Bonus goal is to architect and deploy a flexible system that can be integrated into our platform.

- Any foreign data that makes it into the underlying search engine must come out in a standard format that our platform can understand;

- Ability to update our data based on new releases or updates of databases which we reference;

- Ability to process changes in data format, so that the data ultimately results in our standard format.

Deliverables

(1) Compile list of databases, selected from UN FAO INFOODS. (Use to establish the Standard.)

(2) Establish a data Standard based on JSON. (Or set of standards, if applicable.)

(3) Build a search engine that can be deployed on Linux. This consists of (a) Functioning prototype, (b) Source code (and tests), and (c) Documentation.

(4) Front end (e.g. web, desktop, terminal) for demonstration purposes. This is to demonstrate how user can select a database, enter a query, get a list of search results (ingredient names), select a result, and get the data for that result displayed in human readable HTML format.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

We are a 100% remote team from all over the world.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

food, nutrition, database, search engine, elastic search, solr, java, internationalization, united nations, software. .

46: Sports Tech Company: IoT Based Stick & Puck Tracking

Category

improve an existing product

Primary Area

Software

Secondary Area

Computer

Tertiary Area

Machine learning

Organization

Drive Hockey Analytics, Inc. - <https://drivehockey.com/>

Background

The Sports analytics industry is exploding with the advent of IoT, big data and block-chain technologies. Drive Hockey Analytics is a Canadian sports tech startup leading innovation with its stick and puck tracking technology that collects player performance stats in real-time, automatically. Drive Hockey combines IoT hardware sensors, edge computing, machine learning and block-chain technologies to make it easy and affordable for all levels of hockey to develop a smarter, stronger game using hard data to guide the way.

We are a small, easy-going team of product marketing, technology and sports professionals who has built an early market release system around UWB tracking technology. Our hockey stats tracking technology is getting interest from the university teams, local and international leagues and even the NHL.

This project is aimed at retrofitting our existing tags, boards and gateway to utilize a time-difference of arrival (TDOA) firmware, which will allow us to track 10x more objects during hockey games and practices. This upgrade would mainly focus on firmware, but also would require some PCB hardware design considerations and data handling considerations on a linux based edge device. We have the ability to produce PCB boards, and we have complete development kits available for the team.

If you are passionate about hockey and enjoy working with cutting edge IoT and machine learning technologies, we would love to have you involved!

Objectives

Today, our system uses time-of-flight UWB signal processing and a two-way ranging (TWR) method to determine location. We are open to exploring the use of other sensors or 9DOF IMU devices to offer additional data value, but the main purpose of this project is to upgrade our signal processing method. Other methods such as TDOA or RTDOA offer an ability to multiply our data collection rates and number of trackable devices. The challenges will be to manage synchronization amongst all the sensors, and maintain data accuracy.

This project would focus on building a new firmware stack (written in C, C++) and retrofitting the hardware and gateway device to handle the upgrades and sensor data. We would need to test everything and review the calibrations to provide best chance of meeting FCC regulations. There is a lot of existing code, world-class expertise, support and resources available. Drive Hockey will supply the team with development kits to build and test solutions and is available to assist on key challenges wherever the team requires. Objectives are:

- 1) Increase data collection rates for total system and individual tags
- 2) Reduce the number of missed measurements from current ranging method
- 3) Increase the signal processing range
- 4) Receive data and interact with hardware through an MQTT pub/sub feed on a Linux based gateway
- 5) Considerations, documentation for security, flashing, upgrading, etc..
- 6) Maintain the same ease-of-use deployment as existing system
- 7) Maintain an ability to operate within FCC, Canadian signal regulations

Deliverables

Main deliverables would be:

- 1) Firmware source and .hex file for devices, gateway controller source code
- 2) Test data outlining specifications
- 3) PCB design modifications, if required
- 4) Documentation

Contributions Organization is Able to Provide

Financial support AND things like PCB manufacturing, access to a demonstration kits, servers

Additional Considerations

C, C++ programming language

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Hockey analytics, sports tech, UWB, IOT, firmware, TDOA, gateway, MQTT . Sports tracking, signal processing, IoT
firmware development, Linux, interactive MQTT, pub/sub API

C, C++ programming language.

47: The Artist's Auction House

Category

operational application

Primary Area

Software

Secondary Area

Web app

Organization

Art Vancouver Productions Inc. - <https://www.artvancouver.net>

Background

We wish to work with UBC to design and build an online artists' auction app. We have seen online auction sales continue to climb. We have a tremendous amount of market research to support this trend. Please see the following UBS article for further information (note #3): <https://www.ubs.com/global/en/our-firm/art/2019/art-basel.html>

With the advent of COVID-19, we see more and more buyers accessing online auction platforms. Art Vancouver is an established operator in the art world with regard to art fairs. Our website is www.artvancouver.net.

Art Vancouver operates a number of satellite events aside from its once-a-year fair at the Vancouver Convention Centre. As demand increases for artists to get exposure for their artworks, we feel that creating an online auction house for Art Vancouver would benefit both the artists, buyers of art, the galleries that support the artists, as well as the economy in general.

Objectives

The main objective is somewhat the same as what is mentioned above. The goal is to end up with a finished, operational product – an online auction house for artists from around the world. There are numerous online auction houses operating now, either a Google search will provide examples or we are happy to send you a few links of the larger online artists' auction houses. As mentioned above, this will increase sales for artists, provide an overall and greater exposure for artists as well as galleries that participate.

Deliverables

An operating, fully functioning art auction website/app, to be accessible worldwide. Ideally, this might incorporate pictures that go beyond being static images, to give viewers more realistic and

aesthetically interesting images of 3D art.

Contributions Organization is Able to Provide

Volunteer assistance and covering hard costs/expenses if need be.

Additional Considerations

Art Vancouver is willing to participate and assist in any possible way, understanding that Art Vancouver doesn't have the technical expertise that UBC does.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Online artists auction house. online auction.

48: Satellite Analysis To Promote Community Well-Being

Category

idea validation

Primary Area

Digital Media

Secondary Area

Machine learning

Organization

UBC - <https://www.ubc.ca/>

Background

Indigenous communities face enormous challenges on many fronts: food security, energy security, high unemployment rates, low life expectancy, intergenerational trauma are but a few. The root of these challenges is past and present colonial policies (such as the creation of the reserves, Residential Schools and The Indian Act) which were created by Canadian governments to assimilate Indigenous people into white society. In the process, Indigenous people lost their territories, waters, languages, children, laws and governance systems.

The disparity in well-being between indigenous and non-indigenous communities is aggregated in the Government of Canada Community Well-Being Index (<https://www.sac-isc.gc.ca/eng/1100100016579/1557319653695>). However, available research falls well short of offering solutions or identifying specific factors which influence community outcomes. A transdisciplinary research group seeks to improve our understanding of factors that benefit indigenous communities and, in so doing, improve the wellness of the residents of those communities.

This research project aims to perform quantitative analysis of dissimilar data sources to identify actionable projects that could benefit indigenous communities and provide a scientific basis for policy changes.

Earth observation satellites offer one possible source of quantifiable information about the communities of interest. Datasets such as the US Geological Survey's LANDSAT program provide publicly available imaging across visible and invisible spectra.

Objectives

Students will undertake a pilot project to determine whether it is possible to correlate features

from publicly available satellite data with government supplied measures of community well-being.

The team will need to select input data from multiple publicly available datasets. Raw data may require preprocessing, both to locate specific communities on satellite images and for some datasets to stitch together multiple satellite passes into a contiguous image. If data from multiple satellites is used, further preprocessing may be needed to align dissimilar images and analyse them in a consistent framework.

The team will research and apply image classification techniques to identify features in the satellite imagery and, using statistical measures, correlate these features to aspects of wellness recorded for each community. Considerable freedom in the image analysis is encouraged, as both high resolution aspects of community (e.g. number and orientation of structures or the existence of roads) and lower resolution characteristics (vegetation and topography) are worth considering.

The analysis process may employ both classical image analysis algorithms or may involve machine learning, particularly convolutional neural networks.

As both wellness and satellite imaging are available over at least 25 years, the ideal solution would identify trends in the time series data that are useful predictors of community outcomes.

We anticipate that all work can be conducted remotely. No aspects of this undertaking should require face to face interaction or presence at a particular location.

Deliverables

- 1) A report identifying correlations between satellite-observable features and measures of well-being as derived from government data. The report should also include thorough discussion of which image classification techniques were useful or not and what data was explored
- 2) Datasets that express image features in quantifiable terms, such that the data would be useful to future analysis or correlation with other measures of well-being
- 3) Source code and associated documentation used in the analysis

Contributions Organization is Able to Provide

None

Additional Considerations

The capstone team will work with a group of faculty (Ellis and Low) and practitioner (Gooch and Isaac) on this project. This is a part of a larger project of Indigenous wellbeing and artificial intelligence.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Remote sensing; Geographic Information System (GIS); Image classification; Machine learning; Neural networks; Community development. satellite image processing, identification of features, structures to support correlation to standard versions.

49: Picture Messaging over a Wireless Internet of Things (IoT) Network

Category

idea validation

Primary Area

Electrical (low voltage)

Secondary Area

Software

Tertiary Area

Computer

Organization

Aurora Wireless Networks - <http://www.aurorawirelessnetworks.com>

Background

Aurora Wireless Networks provides RF solutions for the Internet of Things (IoT). Our MLink900 product is a long-range radio for the energy- and cost- efficient collection of data from sensors. When a remote situation triggers a sensor, our customers' situational awareness could be massively improved by pulling a picture from the remote site.

Students can expect to develop skills in embedded software, RF engineering, UI design, IoT sensors, hardware integration and image compression.

Objectives

Note: Aurora will support our Capstone team in working from home due to Covid-19. We will supply radio hardware and will be available for technical support. This project requires 1 – 5 km distance (see further below) during the testing phase and is therefore well suited to students working off campus.

The main objective is to investigate the feasibility and technical challenges associated with on-demand remote imaging over the low data rate MLink900 wireless network. The network should be set-up to mimic a production IoT environment; ie: regularly scheduled collection of sensor data.

MLink900 users guide: <https://bit.ly/30Xyiuo>

Deliverables

The main deliverables include:

1. Hardware device that collects data from sensors (for example temperature, wind speed) and forwards collected data to a base station over a MLink900 wireless network. For ease of portability this device should be battery operated.
2. Camera integrated with item 1 above.
3. A user interface on iOS, Android or Windows that controls the base station and provides (i) display of sensor data (ii) button to request remote image and (iii) display of remote image.
4. Characterize the performance of image transfer at a various ranges; eg: 1 km, 2 km and 5 km. Students may experiment with image parameters such as image size, resolution, update rate, etc. This study should be provided in a feasibility report.

A suggested approach is to leverage hardware ecosystems and software libraries. An Arduino could serve as the platform for items 1 and 2 above and C# as the language of choice for item 3 above.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Internet of Things, IoT, radio, RF, wireless, sensors, images, remote sensing, compression, microcontroller, graphical user interface, GUI, security, iOS, Android, C#, .Net. Internet of Things, IoT, radio, RF, wireless, sensors, images, remote sensing, compression, microcontroller, graphical user interface, GUI, security, iOS, Android, C#, .Net.

50: Super Spinner Bot for TELUS

Category

technology exploration

Primary Area

Software

Organization

TELUS - <https://www.telus.com/en/internet/fibre>

Background

There is a generational shift happening right now for telecommunications companies. TELUS in the midst of transition from a twisted-pair copper network to pure fibre optic networks.

The major constraint when building a network is labour. Significant portions of our telecommunications network are very rural, and because the density is so low in rural areas, it would cost huge amounts of capital to reach with fibre to the home. This applies both for aerial as well as buried telecommunication lines. It is very costly and challenging to reach rural communities.

The Canadian Government has a focus on connecting rural communities and TELUS wants to help. In alignment with this goal, Telus' Goal is to bring fibre to everyone, including communities that are currently inhibited by cost/placing difficulties.

This is your opportunity to be part of solving a Real-World challenge, directly contribute to the utility industry, work with leading professionals, and learn how to work through actual industry problems.

We need a new way to get the network built!

Objectives

Our question is: Using any existing pole infrastructure, can a robot independently (no constant manpower needed) attach the fibre cable to any existing cabling on that pole structure? This can be existing telecommunication infrastructure, but also power or any other utility pole infrastructure where there is no telecom infrastructure currently (tertiary, rural, deep into the homes).

The last kilometre is of particular interest to us, the current technology is mainly designed for High Voltage power lines, we are looking for the smaller poles, the final stage to the home. The Robot should be able to pass poles and other obstacles independently and carry the cable placed.

This is a very large problem statement, and any sub-project of this overall problem can be an option. One can think about:

- Feasibility Study
- Robot Design
- AI component of it in a virtual environment (AI with scenario based logic). This can be conventional AI or Deep learning.

Attached is an example of the principle, but you are not limited to using high voltage power cables, rather any other pole structure with less heavy duty cables that TELUS has access to is available (also called the 'Last Mile').

(<https://www.youtube.com/watch?v=Skrp2XNgZBM&feature=youtu.be>)

Deliverables

This project is a multi-year project and it would propose, design and test a robot/AI platform to place fibre cable to all reaches of our aerial network at a reasonable or reduced cost. Focus this year will be on one of the sub-projects as indicated in the objectives section, chosen by the project team (robot, feasibility study, AI, etc).

Ending with a presentation to TELUS Planning and Engineering leadership.

Contributions Organization is Able to Provide

All of the above, depending on capital approval in combination with project's success.

Additional Considerations

Project team is between AB and BC. Trialing may require special skills/training.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Robotics, AI, Machine Learning / Deep Learning, Construction Infrastructure Innovation, Utility Networks, Fibre to the Home/Node/Curb. SkyWrap.

51: Finding Hidden Buyer Preferences

Category

new product development

Primary Area

Software

Secondary Area

Machine learning

Organization

Drive CX - <https://drivecx.com>

Background

Drive CX is a customer experience management platform that uses insights to drive sales and profits. We specialize in getting sales, marketing, employee and customer statistics and feedback at point of payment on intelligent terminals.

As we emerge from Covid 19, AI technology plays a critical role in new and profitable business models. We are interested in understanding the underlying patterns in the data we have collected. We have applied some statistical analysis and have made some successful observations of data correlations.

This project is for cohorts that are curious and keenly interested in exceeding our expectations by uncovering the hidden relationships in our data. Is that you?

Objectives

Our wish list would be to understand the relationships between customer sentiment, loyalty, team sentiment, marketing, and purchase data as it relates to consumer behaviour. We would be interested in the team exploring various use cases and lines of investigation beyond this scope as aspirational goals.

For example in a restaurant, what employee behaviours may or may not influence buyer preferences. Can we establish a relationship between employee happiness, engagement and actions as it relates to improvements in the restaurant experience for both customers and employees. Can we better understand the relationship between different types of marketing actions and return visits and spend. We think there are hidden patterns that we haven't considered that may be uncovered as part of this project by the successful cohort.

Deliverables

Data visualization and data architecture for segmenting customers based on purchase

behaviours, and an understanding of the relationships between manager, employee and marketing actions that can predictably improve the customer and employee experience resulting in increased sales and profits.

Contributions Organization is Able to Provide

funding & access to a graduate student who specializes in data visualization/architecture & AI

Additional Considerations

Required expertise/skills:

Database structures and business analytics

Data analytics and visualization

Data modelling and artificial intelligence

Project management

Self motivated and directed.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

big data, analytics, AI, machine learning, intelligent marketing offers, data visualization, data architecture. .

53: Risk Model to Determine the Possibility of Injury of People Utilizing an Engineered Playing Field Adjacent to a BC Hydro 138 kV Overhead Transmission Asset

Category

operational application

Primary Area

Electrical (high voltage)

Secondary Area

Electrical (low voltage)

Organization

BC Hydro - <https://www.bchydro.com>

Background

Approximately 10 years ago BC Hydro discovered that the City of Langford on Vancouver Island had built the Westhills Stadium within one of BC Hydro's overhead transmission line double circuit 138 kV Right of Ways. In fact, the double steel pole, Structure 28-1, which carries circuits 1L143 and 1L146 associated with this Right of Way incursion is within 2 metres of the engineered playing field associated with the Westhills Stadium. To date only the Ground Rise Potential (GRP) risk associated attendees to stadium events gather in the areas on either side Structure 28-1 under the 138 kV lines have been assessed on an annual basis. The possible risk of injury due to electric shock caused by GRP to athletes and others utilizing the playing field has not looked at in detail, due to availability of qualified resources and because the risk to event by-standers was assumed to be greater.

However, the number of sporting and other events utilizing the stadium's playing field has continuous grown over the last 10 years, and therefore it is thought that it was time to review the possible risk of injury to the field's users also. There is also a concern that the risk of injury to users of the playing field will only increase as the City of Langford population grows due the increase in electrical power usage, which causes the fault level associated with the transmission lines to increase towards the electrical system's ultimate levels.

BC Hydro has recommended that the line should be relocated at the expense of the City of Langford. This line relocation is estimated to cost in the \$4 to \$7 million range, but to date no funding is in place.

Therefore, these are the reasons why this proposed study is so important.

BC Hydro will supply the following:

1. A project liaison and sponsor for the Capstone project team.
2. Access to knowledgeable BC Hydro staff.
3. BC Hydro Standards and other reference material available.
4. A copy of a report template.

5. Copies of the BC Hydro IP and ND agreement documents.

Objectives

The main objectives of this project are to:

1. To determine a resistivity model of the engineered playing field utilizing IEEE 80 – “Guide for Safety in AC Substation” and based on the playing field’s design drawings or typical design methodologies used for such facilities, so Ground Rise Potential (GRP) calculation can be undertaken.
2. Determine a method to account for non-uniform single phase to ground fault current distributions over time, which can occur in many fault event scenarios.
3. Using a grounding software acceptable to BC Hydro or supplied by BC Hydro, determined the acceptable touch and step potential voltages associate with up to six fault event scenarios so a Zone of Exclusion around Structure 28-1 associated with the playing field can be determined for the present day and ultimate fault current levels.
4. Determine a people distribution model for the Zone of Exclusion around Structure 28-1 due to GRP for the various stadium events from sporting events, such as soccer, football and rugby, plus concerts, farmer’s markets and beer gardens, which may utilize the playing field area.
5. Determine the risk of fibrillation of individuals in the Zone of Exclusion using software supplied by BC Hydro.
6. Determine the impact of other parameters such as probability of local generation being in-service and the probability of circuit breaker failure, both of which could impact the level and length of fault event.

Deliverables

The main deliverables of this project are:

1. Completion of the IP and ND agreements.
2. Monthly meetings with the BC Hydro Capstone project liaison or sponsor or both of these individuals. All meeting shall be virtual until further notice.
3. A copy of a working model or tool developed. All software used or developed shall be based on Microsoft Office tools, such as Excel and Word.
4. Documentation of the process followed and the results obtained in a formal report. This report will have an executive summary, an introduction, of summary of the effort undertaken with results obtained, a conclusion and recommendations. This document should also include, but not be limited to, a list of references and copies of any spreadsheets, calculations, cost estimates, models, sketches, drawings or tables used to obtain the final results, plus any operating instructions and maintenance manual of tools produced, as required.
5. Final report documentation in the required format.

The suggested approach is to:

1. Obtain all available data and reference material from BC Hydro.
2. Undertake a literature search on the subjects of safety grounding, engineered playing fields and group or team distributions in defined areas.
3. Create a detailed investigation plan, complete with schedule, showing all tasks and key dates.
4. Discuss results with the BC Hydro Capstone Project liaison and sponsor on a regular basis.
5. Report findings in the required format.

Contributions Organization is Able to Provide

Possible site visits

Additional Considerations

The signing of the IP and ND agreements. See email to Paul Lusina.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Ground Rise Potential (GRP), resistivity model, risk, engineered playing fields, IEEE 80, safety grounding, fibrillation, group or team distributions.. feasibility study, Ground Rise Potential (GRP), short circuit qualification testing, voltage sensors, data acquisition system, distribution and transmission equipment. touch and step voltages.

54: Feasibility Study to Determine the Best Design Alternative to Obtain GPR Step and Touch Potential Data during Typical High Power Short Circuit Qualification Testing of Transmission and Distribution Equipment at a Test Facility

Category

idea validation

Primary Area

Electrical (high voltage)

Secondary Area

Electrical (low voltage)

Organization

BC Hydro - <https://www.bchydro.com>

Background

The High Power testing facility of PowerTech Labs, which is a wholly owned subsidiary of BC Hydro, undertakes short circuit qualification testing of Transmission and Distribution equipment. The scope of this project is to determine the feasibility of adding voltage sensors, and interconnecting them with the existing test data acquisition system to obtain Ground Rise Potential (GPR) Step and Touch voltage data when a piece of equipment under test fails during a high power short circuit qualification.

This data will be used to validate results from Engineering software or calculations used within BC Hydro or by BC Hydro's contractors or suppliers.

BC Hydro will supply the following:

1. A project liaison and sponsor for the Capstone project team.
2. Access to knowledgeable BC Hydro staff.
3. BC Hydro Standards and other reference material available.
4. A copy of a report template.
5. Copies of the BC Hydro IP and ND agreement documents.

Objectives

The main objective of this project are:

1. To undertake a feasibility study to determine best alternative to create a preliminary design for to meet the project's objectives.
2. To create a preliminary design of the best alternative complete with a cost estimate and project schedule for its installation, plus a list of any foreseen risk in regard to the alternative's implementation with proposed mitigation.
3. Creation of project report.

Deliverables

The main deliverables for this project are:

1. Completion of the IP and ND agreements.
2. Monthly meetings with the BC Hydro Capstone project liaison or sponsor or both of these individuals. All meeting shall be virtual until further notice.
3. A preliminary design of the best alternative determined from the feasibility study complete with a cost estimate and project schedule for its installation, plus any foreseen risk in regard to the alternative's implementation.
4. A copy of a working model or tool developed. All software developed shall be based on Microsoft Office tools, such as Excel.
5. Documentation of the process followed and the results obtained in a formal report. This report will have an executive summary, an introduction, of summary of the effort undertaken with results obtained, a conclusion and recommendations. This document should also include, but not be limited to, a list of references and copies of any spreadsheets, calculations, cost estimates, proposed schedules, models, sketches, drawings or tables used to obtain the final results, plus any operating instructions and maintenance manual for any products produced, as required.
6. Final report documentation in the required format.

The suggested approach is to:

1. Obtain all available data and reference material from BC Hydro.
2. Undertake a literature search on the subjects of GRP, voltage sensors, high power short circuit qualification testing and data acquisitions systems.
3. Create a detailed investigation plan, complete with schedule, showing all tasks and key dates.
4. Discuss results with the BC Hydro Capstone Project liaison and sponsor on a regular basis.
5. Report findings in the required format.

Contributions Organization is Able to Provide

Possible site visit

Additional Considerations

Signing of the IP and ND agreements. See email to Paul Lusina.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

feasibility study, Ground Rise Potential (GRP), short circuit qualification testing, voltage sensors, data acquisition system, distribution and transmission equipment.. feasibility study, Ground Rise Potential (GRP), step and touch poreentials, short circuit qualification testing, voltage sensors, data acquisition system, distribution and transmission equipment..

55: Feasibility Study to Determine the Best Design Alternative to Obtain Arc Flash Related Data during Typical High Power Short Circuit Qualification Testing of Transmission and Distribution Equipment at a Test Facility

Category

idea validation

Primary Area

Electrical (high voltage)

Secondary Area

Electrical (low voltage)

Organization

BC Hydro - <https://www.bchydro.com>

Background

The High Power testing facility of PowerTech Labs, which is a wholly owned subsidiary of BC Hydro, undertakes short circuit qualification testing of Transmission and Distribution equipment. The scope of this project is to determine the feasibility of adding appropriate heat and pressure sensors, and interconnecting them with the existing test data acquisition system to obtain arc flash heat and pressure data when a piece of equipment under test fails during a high power short circuit qualification.

This data will be used to validate results from Engineering software or calculations used within BC Hydro or by BC Hydro's contractors or suppliers.

BC Hydro will supply the following:

1. A project liaison and sponsor for the Capstone project team.
2. Access to knowledgeable BC Hydro staff.
3. BC Hydro Standards and other reference material available.
4. A copy of a report template.
5. Copies of the BC Hydro IP and ND agreement documents.

Objectives

The main objective of this project are:

1. To undertake a feasibility study to determine best alternative to create a preliminary design for to meet the project's objectives.
2. To create a preliminary design of the best alternative complete with a cost estimate and project schedule for its installation, plus a list of any foreseen risk in regard to the alternative's implementation with proposed mitigation.
3. Creation of a project report.

Deliverables

The main deliverables of this project are:

1. Completion of the IP and ND agreements.
2. Monthly meetings with the BC Hydro Capstone project liaison or sponsor or both of these individuals. All meeting shall be virtual until further notice.
3. A preliminary design of the best alternative determined from the feasibility study complete with a cost estimate and project schedule for its installation, plus any foreseen risk in regard to the alternative's implementation.
4. A copy of a working model or tool developed. All software developed shall be based on Microsoft Office tools, such as Excel.
5. Documentation of the process followed and the results obtained in a formal report. This report will have an executive summary, an introduction, of summary of the effort undertaken with results obtained, a conclusion and recommendations. This document should also include, but not be limited to, a list of references and copies of any spreadsheets, calculations, cost estimates, proposed schedules, models, sketches, drawings or tables used to obtain the final results, plus any operating instructions and maintenance manual for any products produced, as required.
6. Final report documentation in the required format.

The suggested approach is to:

1. Obtain all available data and reference material from BC Hydro.
2. Undertake a literature search on the subjects of GRP, voltage sensors, high power short circuit qualification testing and data acquisitions systems.
3. Create a detailed investigation plan, complete with schedule, showing all tasks and key dates.
4. Discuss results with the BC Hydro Capstone Project liaison and sponsor on a regular basis.
5. Report findings in the required format.

Contributions Organization is Able to Provide

Possible site visits

Additional Considerations

The signing of the IP and ND agreements. See email to Paul Lusina.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

feasibility study, arc flash, short circuit qualification testing, heat and pressure sensors, data acquisition system, distribution and transmission equipment. feasibility study, arc flash, short circuit qualification testing, heat and pressure sensors, data acquisition system, distribution and transmission equipment.

58: Software Augmentation and Automation for High-Frequency Printed Circuit Board Design

Category

technology exploration

Primary Area

Computer

Secondary Area

Software

Tertiary Area

Electrical (low voltage)

Organization

Alpha power lab - UBC - <https://www.martinordonez.com/>

Background

Power conversion and battery charging technologies keep continuously striving toward more efficient and higher power density designs. This trend has been accelerated significantly by the recent penetration of Wide-bandgap (WBG) devices within the semiconductor market. The incorporation of WBG devices in high frequency and high power density applications is a demanding challenge for printed circuit board (PCB) designers of such complex systems. The aforementioned integration surfaces complex challenges within a wide range of problem domains, including electrical, magnetic, and thermal management. Therefore, a need arises to support designers in coping with these complex challenges with design augmentation and automation. The leading software vendors in the scope of PCB Design and multiphysic simulation are Altium and Ansys. Unfortunately, these software behemoths do not support a native and easy-to-use interface with each other until today...

Objectives

Within this project, a software solution shall be developed which interfaces Altium (the leading printed circuit board (PCB) design software) and the Ansys environment (the leading multiphysics simulation software) in order to support PCB designers in the process of developing high frequency and high power density power conversion for battery charging applications. On the one hand, the software should be able to perform multiphysics simulation including pre- and post-processing using the Ansys environment for a given PCB layout/ geometry, coming from Altium. On the other hand, it should be able to provide feedback based on simulations, models, and quality criteria to the Altium user for a given PCB layout. A successful realization of the project may include machine-learning as a final layer of the project.

Deliverables

The main deliverables include, but are not limited to 1). Altium interface (Implemented as Altium script) 2.) Main software (written preferably in Python) which utilizes the Altium interface and performs necessary functionalities in Ansys. 3.) Software documentation

Contributions Organization is Able to Provide

Option 2,3 and maybe 4 - option 1 is TBD

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Programming, Automation, Augmentation, Multiphysics analysis/simulation, Altium, Ansys.
Programming, Automation, Augmentation, Multiphysics analysis/simulation, Altium, Ansys.

59: DIY Multimedia Capture Station

Category

improve an existing product

Primary Area

Digital Media

Secondary Area

Computer

Tertiary Area

Software

Organization

UBC IT Studios - <https://ubcstudios.ubc.ca>

Background

The One Button Studio was a concept studio idea developed by the University of Pennsylvania. Using a variety of 3rd party parts from manufacturers and custom built software, the system allowed users to plug in a USB to the system which triggered lights and an on camera feed. A button would be pressed to start the recording and pressed once again to stop. Files are then saved and copied over in the background to the USB - with easy to read status updates in the application while doing so. <https://onebutton.psu.edu/>

Installed at UBC Studios for many years and many other institutions, the system is reaching end of life- it had to be on Apple Pre-Mojave system, updates for many of the 3rd party parts were no longer supported and there were much too many components and wires that needed to be run around. There were always some features that we think could be added and used.

Objectives

The main objective of the project is to improve on and develop an up to date system that will make it easier for faculty and staff to record and process video for training, lecture and educational purposes. The system if successful, will be implemented in our current offerings of DIY studios, replacing our current One Button Studio with the possibility of expanding across campus. This technology will also be shared with other institutions and could be widely adopted within the educational or corporate sphere if successful.

Deliverables

An easy to use box that has all the necessary components in one packaged system - easy to use, setup and transport with a simple user friendly application that would power the setup. The

main functionalities of the One Button should still exist - plug in a USB stick to trigger multiple studio lights and the button (or some type of controller deck to start and stop the system with perhaps more features than the one button)

The second component is a basic software that can gives the users a preview of what's being shown in the program, indicating that the recording is currently running with a timestamp and the status of the audio levels. Current open source programs may be re-developed for our use purposes if this is found to be the most efficient avenue.

While not necessarily part of the main scope of the project, a few additional features to think about such as - the ability to plug in a second source into the system and it automatically being recognized by the system (eg. switch to slides or have a picture in picture view with the press of a button on the controller deck). Ability to use the system as a virtual webcam and/or live stream. Ability to pause the recording. All while being as foolproof as possible - eg. one or two button presses to access each thing, or a few textboxes to fill out for livestreaming.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

PCB Manufacturing and knowledge of how software and camera parts work together a plus. Experience in software programming with Python and other relevant languages a plus (for the software development side of the system).

Due to the current COVID - 19 pandemic, work will be primarily done from home. Gear and equipment can be picked up from UBC Studios, or if needed shipped/delivered to a project team members home/area. Final assembly if possible can be done at UBC Studios with social distancing adhered by project team members- however if not possible, UBC Studios personnel can pick up the final gear and software, and put it together through guidance over online communication.

A robust contingency and project fund will be provided to cover additional costs of equipment needed that goes over the amount set by Capstone ECE. UBC Studios also has equipment available that may help with the process including - a professional grade 3d printer, variety of camera equipment and software as well as access to technical experts.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Media, technology, innovation, digital. education . Media, technology, innovation. .

61: CheckingIn Data Analysis and Machine Learning

Category

new product development

Primary Area

Software

Organization

CheckingIn - <https://www.checkingin.co>

Background

We are a mental health app that is focusing on empowering users to tune into their emotions and feelings in order to help detect and prevent mental illness.

Users tune into their energy levels and emotions and subsequently provided with a reflection question to help them to reflect on their daily lives. We are building a community of people that believe in pausing and taking a moment to look inside themselves in order to understand the underlying emotions/behavioural sources of those feelings. In time, we present them with trends and insights into their patterns and behaviours allowing them to learn more about themselves.

We have a team internally with significant experience in ML capabilities, a PhD from MIT in ML and PhD from Stanford in NLP along with a Post doc at U of T in ML. These two team members would be able to help guide and inform the students of how to set up a successful project to which the code would be embedded in the application and deployed into our production environment upon completion.

Objectives

Let me first start by saying this project and task will be hard. We are looking for students who are keen to learn, but also understand that the problem we are solving is cutting edge and will be difficult. It is a problem that is increasingly important to solve for this world, but is technically difficult to do so.

To establish a system to collect additional contextual data from users to help inform data sets that will be used to develop pattern recognition and behavioural trend analysis.

Over time, users will be given smart insights from their data that can help them to see patterns and trends to help them live healthier happier lives.

Deliverables

Phase I: To cleanse and organize the data. At this point we have significant data from over 30,000 check ins and several reflection entries to help with the research.

Phase II: Build meaningful and insightful trend analysis of the data at an individual level.

Phase III: To make recommendations and considerations for additional contextual data we could capture to present more useful correlating insights for users. To design basic algorithms for introductory ML+Algorithms to be applied.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Someone who is passionate about the intersection of mental health and technology would be ideal for this project. We have a team of dedicated developers, designers, and data scientists working on the project all of which are passionate about this intersection.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Data, Analysis, Data Science, Algorithms, Machine Learning, App Development, Mental health, Self Awareness, Emotional Intelligence. ML, NLP, Data Science.

63: Hand Tracker

Category

improve an existing product

Primary Area

Software

Secondary Area

Machine learning

Organization

Infusion Systems Ltd. - <https://infusionsystems.com>

Background

Fully articulated hand tracking promises to enable fundamentally new interactions with virtual and augmented worlds, but the limited accuracy, efficiency and reliability of current consumer-level systems has prevented widespread adoption.

Objectives

Our aim is to implement a fully articulated hand tracking technique that is efficient enough to run in the Unreal gaming environment on low power devices such as phones and tablets and can track up to several meters from the camera to provide a large working volume for interaction, even using the noisy data from current generation depth cameras.

To achieve a high level of accuracy of the fully articulated hand, today's dominant paradigm uses machine learning for initialization and recovery followed by iterative model fitting optimization to achieve a detailed pose fit. The aim is to follow this paradigm, but make several improvements to the model fitting, namely using:

- a more discriminative objective function
- a smooth surface model that provides gradients for nonlinear optimization
- joint optimization over both the model pose and the correspondences between observed data points and the model surface.

Student will have the opportunity to work with advanced machine learning for practical computer vision based interfaces such as found in Microsoft's HoloLens and Oculus' Quest.

Infusion Systems invites applications from those independent minds who are able to work autonomously, looking for a challenge in the exploration of new research frontiers in human-centred computing.

Deliverables

A fully functional camera based fully articulated hand tracking prototype that can be used in Unreal, with a good set of test cases. The level of testing and functionality should be sufficient to allow beta testing.

Documentation sufficient to allow our company to evolve the design and refine as well as package the software as plugin or other software module.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval. Access to technology and / or information supporting the project. (special equipment, data, test facilities). Support for engineering processes. (PCB manufacturing, software licences, fabrication tools).

Additional Considerations

None

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Fully articulated hand tracker VR AR MR. .

64: Virtual Matter Computing

Category

new product development

Primary Area

Organization

Infusion Systems Ltd. - <https://infusionsystems.com>

Background

The availability of parameters that describe the state, shape and motion of simulated fluids and gases have the potential to fundamentally change interaction in virtual and augmented worlds. Computation of these parameters is best done on the GPU but in gaming environments like Unreal it can only be done on the CPU. This significantly limits computations and/or results in increased performance latency.

Objectives

Our aim is to implement a computational technique and method that can operate on the entire array of particles as needed, is efficient enough to run on the GPU in Unreal on low power devices such as phones and tablets and can compute in real-time (~ 1ms) at least a handful of parameters that describe the simulated fluid or gas in terms meaningful to a human – examples are density, visual transparency, overall dynamics, boundary curve.

These parameter values are then to be transferred to the CPU, for instance using a method like described in

<https://stackoverflow.com/questions/14086926/get-results-of-gpu-calculations-back-to-the-cpu-program-in-opengl> so that they are available to Unreal Blueprints and can be used in the game logic. The computations may involve advanced machine learning as the student sees fit.

Infusion Systems invites applications from those independent minds who are able to work autonomously, looking for a challenge in the exploration of new research frontiers in human-centred computing.

Deliverables

Fully functional software code that can be used in Unreal, with a good set of test cases. The level of testing and functionality should be sufficient to allow beta testing.

Documentation sufficient to allow our company to evolve the design and refine as well as package the software as plugin or other software module.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval. Access to technology and / or information supporting the project. (special equipment, data, test facilities). Support for engineering processes. (PCB manufacturing, software licences, fabrication tools).

Additional Considerations

None

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

GPU computing VR AR MR fluid simulation. .

65: WhizEra – The ultimate PhD Assistant

Category

new product development

Primary Area

Software

Secondary Area

Digital Media

Organization

UBC - <http://www.ubc.ca>

Background

Professors, PhD, and Master's students read hundreds of papers during their tenure. They need to attack these papers with pens and highlighters and ultimately assimilate and organize information in a way they can easily access and reference important points in the future. Additionally, in our current pandemic situation, Professor's and TAs are now scrambling for better resources to create a "lecture like" feel to online learning, but there is no single good electronic solution to accomplish all of these tasks.

In a hybrid between applications like Mendeley, Citavi, Zotero, GoodNotes, and Notability, the project will help to develop an application that can be used on Apple's iPad, Windows future Surface Neo, and future colour e-ink products to attack PDFs with a paper-like feel, organize thoughts/quotes from the content, and track references for students and professors.

The ideal application will eventually be able to be used on future colour e-ink technology to help researchers move their office outside (preventing eye strain) and make their work more portable while commuting by transit.

The project is two pronged with a software and a hardware component and the project team will choose to focus either on developing the software or figuring out the hardware, with an aspirational option to pursue development in the other area should time allow.

Identified gaps: Application

None of the above applications are capable of doing all of these things:

1. Track references as easily/simply as Mendeley
2. Organize information and papers into buckets, tag and reference quotes directly to create an annotated bibliography like Citavi. Citavi also has a very cumbersome GUI.
3. Pull reference info like Zotero, and auto-name papers correctly in the application.
4. Have on-screen writing capability like Goodnotes or Notability. There are tradeoffs and

gaps for both of these applications here, specifically they don't look like they can write on top of, or manipulate, pdf lecture notes very well:

<https://www.youtube.com/watch?v=f3qLtQAVZwc>

<https://www.youtube.com/watch?v=SxUHpi1uqAo>

Is it possible to build the functionality of items 1-3 on top of Goodnotes and/or Noteability using SDK files? Or is it best to build these applications from the ground up, rather than depending on another product?

Identified gaps: Hardware

There is a PaperLike screen protector product that is trying to solve the screen glare issue on tablets so there is an obvious need for these applications to be used on e-ink technology. Is there any e-ink technology capable of running these applications and writing pen and paperlike? If so, do we need to source and assimilate the parts ourselves or is a solution already available that can launch a writing and reference management application directly?

E-ink is coming out with a colour screen that will eventually be adopted into e-readers such as Kindle and Kobo.

The issue with the existing hardware is that most e-readers available on the market today do not have the capabilities needed for this functionality.

There are some products that are getting closer. However, we need writing solution on e-ink technology.

<https://www.youtube.com/watch?v=w7g3BpefUSA>

<https://www.youtube.com/watch?v=N1BAYfzCzu4>

<https://www.eink.com/reading-writing.html?type=application&id=1>

E-ink is also developing flexible paper-like technology:

<https://www.eink.com/flexible-technology.html>

Objectives

Aiding the R&D of a hybrid application to support research.

Deliverables

A working prototype (hardware or software).

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

application Paperlike e-reader Mendeley GoodNotes Noteability. .

66: Designing high-speed control FPGA platform for WBG battery charging applications

Category

technology exploration

Primary Area

Electrical (low voltage)

Secondary Area

Computer

Tertiary Area

Software

Organization

UBC Martin Ordonez Lab - <https://www.martinordonez.com/>

Background

As power conversion and battery charging technologies evolve toward high-efficiency and high-power density design, advanced semiconductors with good dynamic performance are penetrating into this emerging market. Wide-bandgap (WBG) switching devices are known for the excellent high-frequency switching characteristics which lead to good thermal performance, high efficiency, and low-profile design. The demand for the controller of such power conversion and battery charging technology is steadily rising as the switching frequencies increase and their functionality is becoming more versatile. Thus, execution speed and the complexity of the control are becoming of paramount importance. Field programmable gate array's (FPGAs) are highly flexible for implementing complex functionalities while processing signals in parallel, which is suitable for the implementation of the high-speed controller for megahertz WBG battery chargers. Considering the COVID-19 situation, the main activities regarding the hardware part will be carried out using an FPGA development board that allows for capstone students to conduct low voltage/ current tests remotely.

Objectives

The main objective of this project is to develop an FPGA-based controller and platform for driving a smart battery charger that achieves the constant current and constant voltage regulations. The FPGA along with the platform, surveyed by the capstone students, shall be designed in a versatile manner, in order to cover a wide application range from a USB charger to an electric vehicle (EV) battery charger. This project covers a wide range of practical design and implementation problems, including system architecture definition, analog & digital circuit design & simulation, FPGA programming, component selection, and high-frequency

printed-circuit board (PCB) design. Prerequisites of this project include experience in programming, circuit-level simulation, pulse-width modulation (PWM), analog-to-digital, and digital-to-analog conversion (ADC and DAC). Preferably, knowledge in the area of hardware language, PCB design, linear control theories, and software design/ architecture as well as attendance to lectures CPEN 311 or EECE 379 would be a plus. This project will be Co-supervised by two Ph.D. students.

Deliverables

The main deliverables include, but are not limited to 1). schematic diagrams; 2) PCB design files ; 3) system simulation files and report; 4) FPGA/ controller source code.

Contributions Organization is Able to Provide

Support for engineering processes. (PCB manufacturing, software licences, fabrication tools)

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

FPGA, High-frequency PCB design, Hardware Development, GaN/SiC wide-bandgap device, battery chargers. FPGA, High-frequency PCB design, Hardware Development, GaN/SiC wide-bandgap device, battery chargers.

67: Machine Learning Framework for VR Training Data

Category

new product development

Primary Area

Machine learning

Organization

Motive.io - <https://www.motive.io>

Background

Virtual Reality is proving to be a transformative technology for industrial and enterprise training purposes. VR is unique compared to other training methodologies in its ability to collect high volumes of data from a training scenario--imagine the difference in data available from a learner watching a web video vs. what can be tracked up to 90 times per second with dozens of sensors attached to the learner's body.

The learning industry uses XAPI--a standard, structured data format for capturing learning data. At Motive.io we are leveraging this standard to collect both scenario-driven data (user started a scenario, user completed a task, etc.) as well as biometric and interactive data (user gazed at an item, user picked up an object, etc.) in our VR training modules. We are currently in the late stages of deploying a solution with these data tracking capabilities to BC Women's Hospital (and potentially other health authorities in the province) to help train doctors and nurses for how to safely don and doff personal protective equipment (PPE). This has become a major challenge for health care workers in the current Covid-19 pandemic.

Providing assessments for this training is a major hurdle for adoption and in general will only use a small percentage of the data collected. The goal of this project is to develop a framework that can apply modern machine learning approaches to this structured XAPI data to accurately assess the performance of the learner using the wealth of data that we collect throughout the training scenarios.

Objectives

The main objective of this project is for Motive.io to take a leading role in the training industry as it applies to machine learning and data collection. Many companies are keen to adopt XAPI, but are still unclear on the best ways to use it. Currently the training industry is only offering basic approaches to taking advantage of the data-basis visualizations, tracking completion of training modules, etc.

By integrating machine learning into our current product suite, Motive.io will be able to establish a clear leadership position in the immersive training market.

Deliverables

The primary deliverable of the project is to develop an ML framework that can be integrated into our current product suite and give our customers straightforward tools for analyzing and building assessments using their own XAPI data streams.

The deliverable will ideally be validated by analyzing anonymized XAPI data collected from our current VR PPE training module in use by BC Women's Hospital. If this data set does not prove to be viable, we will look for other alternatives (i.e. other training modules in deployment or running training with a group of student volunteers).

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

VR, Machine Learning. xAPI.

68: Virtual Reality Aid for Virtual Surgical Planning of Mandibular Reconstruction

Category

new product development

Primary Area

Biomedical

Secondary Area

Computer

Tertiary Area

Software

Organization

Division of Otolaryngology, Department of Surgery, Faculty of Medicine, University of British Columbia - <https://www.vchri.ca/researchers/eitan-prisman>

Background

Patients with cancer of the oral cavity often require surgery to remove the disease and reconstruct the resulting defect. Pre-planning of these surgeries have been shown to reduce operating time and hospital stay. Currently at Vancouver General Hospital, virtual planning is performed using an inhouse surgical planning platform. Using the planning platform, the surgeon defines the cutting planes that are used to resect the defect. The resulting reconstruction is then planned, and models of cutting guides are generated. The cutting guides are 3D printed and used during the surgery. Planning with the fibula is currently fully automated, while planning with the scapula requires manual positioning of the scapula segments. Manual positioning is an iterative process and is therefore cumbersome and time consuming in the platform. Virtual reality represents an opportunity to create an intuitive platform that surgeons can use to accurately and quickly position scapular segments.

Objectives

We anticipate the development of a virtual reality program that will allow the surgeon to manually plan a mandibular reconstruction. This will require that the program is:

- Is compatible with standalone VR headsets (such as the Oculus Quest)
- Can load polygonal mesh models and perform constructive solid geometry operations (difference, union, intersection, etc) on them
- Can cut polygonal mesh models with arbitrary planes
- Ability to export polygonal mesh models and text documents

This project is an exciting opportunity for students interested in surgical technology and/or has

previous related coursework, co-op/internship experience or general interest in virtual reality integration. We understand there may be obstacles arising from working remotely, and we are committed to supporting the Capstone team to carry out the project to the best of our ability.

Deliverables

A fully functional prototype, with a good set of test cases for requirements described above. The level of testing and functionality should be sufficient to allow beta testing. Documentation should be sufficient to allow our group to evolve the design and refine the device. There will be an opportunity to evaluate the prototype on medical residents.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Virtual reality; surgical technology; virtual surgical planning. Virtual reality; surgical technology; virtual surgical planning.

69: Data Acquisition Framework for Physics Experiments using Xilinx SoCs and PetaLinux

Category

new product development

Primary Area

Computer

Secondary Area

Electrical (low voltage)

Tertiary Area

Software

Organization

TRIUMF - Canada's national laboratory for particle and nuclear physics - <https://www.triumf.ca/>

Background

There are many physics experiments being carried out at TRIUMF in collaboration with many research institutes around the world. Those projects have many common electronics subsystems, in particular, the Data Acquisition (DAQ) subsystem. This subsystem digitizes waveforms that are output by detectors using ADCs (Analog to Digital Converters), and those digitized waveforms are processed in FPGAs in real time, and then further analyzed by software over a longer period of time in order to investigate subatomic physical phenomena. This project will produce a generic, reusable, configurable DAQ framework for such physics experiments.

Objectives

This project will develop a data acquisition framework for physics experiments. The framework will be based on a Xilinx SoC, written in SystemVerilog and running the PetaLinux operating system as embedded software on the ARM hard processor inside the Xilinx FPGA. The framework will provide data acquisition functionality, including DMA of acquired data to memory, transmission of acquired data via UDP over Ethernet, and ADC support. The framework will be well documented and easily configurable, via GUI and/or scripts. This framework will provide a starting point for development of data acquisition electronics for many physics experiments in which TRIUMF will participate for years to come, and will therefore have a big impact on physics experiments in Canada and around the world.

Deliverables

- SystemVerilog based FPGA HDL system defining the Xilinx SoC DAQ system, compiled in Vivado
- Configurable PetaLinux software framework for data acquisition control and processing

running on the ARM hard processor inside the Xilinx FPGA

- DMA to acquire ADC data and send it at high speed via UDP over Ethernet
- Custom configurable IP component for Xilinx Vivado in order to receive data from LVDS-type ADCs
- Documentation
- Scripting and/or GUI tools to easily customize this platform.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Applicants must have Petalinux experience, SystemVerilog experience, Vivado experience

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Data Acquisition, PetaLinux, LVDS, SystemVerilog, Xilinx, Vivado. Data Acquisition, PetaLinux, LVDS, SystemVerilog, Xilinx, Vivado.

70: Real-Time Video-Based Oxygen Saturation Measurement

Category

combination of idea validation, tech exploration and ultimately new product development

Primary Area

Biomedical

Secondary Area

Electrical (low voltage)

Tertiary Area

Software

Organization

Aberrant Designs Inc - <https://www.aberrantdesigns.ca>

Background

We have previously worked on non-contact monitoring of heart rate and respiratory rate using radar and computer vision to augment temperature in the clinical decision making process. We are now looking into monitoring of oxygen saturation levels based on exciting recent literature that use video cameras. This is called remote photoplethysmography. Oxygen saturation is a key metric (vital sign) for many medical conditions such as COVID-19 where low oxygen saturation is one of the most common signs that may even be present before other symptoms appear. As such, being able to monitor oxygen saturation without contact will greatly improve the screening process. It could also be used in many other situations such as monitoring patients in hospital waiting rooms, seclusion rooms or those in custody.

All of us at Aberrant Designs Inc work in the medical field as ER physicians and Chris Yoon is a current medical student with a UBC computer science background.

Objectives

The objective of this capstone is to replicate findings in the literature to measure oxygen saturation using video.

Objective 1 - Familiarizing with the literature on using video to measure oxygen saturation levels.

Objective 2 - Using a contact-based pulse oximeter to obtain baseline oxygen saturation levels to compare with the video based method.

Objective 3 - Reproducing the findings based on a reimplementation or via an original method

Deliverables

We expect the following deliverables for each objective.

Objective 1 - An aggregate of related papers and brief summaries

Objective 2 - A pipeline to use a contact-based pulse oximeter to measure and save baseline oxygen saturation levels

Objective 3 - We understand reproducing results from the literature is challenging and can be met with unforeseen difficulties. It would be fantastic if the team can reproduce results of measuring oxygen saturation using video that is comparable with contact-based measurements. However, the project would still be a great success if the team can document what has been attempted and potential reasons for negative results.

We fully appreciate the difficulties students will encounter this year as a result of COVID-19 restrictions and the lack of access to UBC facilities and in-person group meetings. We have been involved in previous years' Capstone projects and are happy to provide "bridging support". This includes increased communication with us to support and guide you as well as potential access to medical equipment, facilities and meeting space. There will undoubtedly be roadblocks along the way that we will endeavour to help overcome and will be flexible in our scope and approach.

Contributions Organization is Able to Provide

can provide some financial support and access to special medical equipment

Additional Considerations

very novel technology with huge potential in medicine

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

remote photoplethysmography, oxygen saturation detection using video, . remote photoplethysmography, oxygen saturation detection using video, .

71: Integrated interface for real-time non-contact vital sign monitoring

Category

new product development

Primary Area

Biomedical

Secondary Area

Web app

Tertiary Area

Software

Organization

Aberrant Designs Inc. - <https://www.aberrantdesigns.ca>

Background

Emergency waiting rooms, safe injection sites, airports, and COVID-19 screening centers are just a few examples where non-contact monitoring of vital signs can have tremendous life saving potential. Being able to monitor heart rate and respiratory rate provides a much more complete clinical picture compared to temperature alone. Through a combination of radar and video we are working on a non-contact monitoring solution for heart rate, respiratory rate and temperature to detect medical abnormalities. We are looking for a capstone team to help us integrate everything into a web interface.

All of us at Aberrant Designs Inc work in the medical field as ER physicians and Chris Yoon is a current medical student with a UBC computer science background.

Objectives

The objective of this capstone is to develop a unified web interface to display real-time vital signs. We will work with the capstone team to codesign the specifications and requirements of the interface.

The key features we anticipate are:

- streaming and visualizing real-time video
- streaming and visualizing heart rate, respiratory rate, and temperature of individuals in the video
- alerting users when a medical abnormality is detected

Deliverables

The main deliverables are the code and documentation for the interface. We hope to be able to continue building on the hard work achieved by the capstone team so the ideal deliverable will:

- use modern web frameworks
- be modular and flexible to allow adding new vital signs or views
- be well-documented to facilitate continuation of the project

We fully understand the difficulties this year's Capstone group will have in relation to the barriers that COVID-19 has imposed. We are happy to work with the group to help problem-solve to overcome issues that may arise.

Contributions Organization is Able to Provide

financial support, access to tech for remote vital signs detection (radar modules etc)

Additional Considerations

Project with large potential impact on healthcare.

This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

GUI for non-contact vital signs monitoring, . Website, AI, Artificial Intelligence, Machine learning, Image recognition.

72: Build a Game, help a Gran

Category

technology exploration

Primary Area

Web app

Organization

AssistList - <https://www.assistlist.ca>

Background

The AssistList Capstone Project will be in the form of a game where a user will upload an image and the AI gives a guess on what type of equipment the image is of (wheelchair, bed, etc). The user will then answer yes or no depending on if the guess is correct. The game will train the AI models to become better and better at identifying an image. AssistLists' database already has thousands of images with an appropriate equipment label to seed the models, making the initial data sets strong from the start.

AssistList is a charitable non-profit who's mission is to assist disabled, seniors and low-income persons in Greater Vancouver and surrounding regions acquire or exchange home health medical equipment such as wheelchairs and hospital beds. AssistList encourages the re-use and re-homing of equipment that would otherwise have been discarded, empowering the community to do something positive with their equipment, thus prolonging its usable lifespan and diverting potential waste from landfills to reduce environmental strain.

The "Build a Game, help a Gran" project will help train AI models with information that will help users put up their used equipment without having to lookup or measure details like the diameter of a wheel chair.

Objectives

The AssistList Capstone Project will be in the form of a game where a user will upload an image and the AI gives a guess on what type of equipment the image is of (wheelchair, bed, etc). The user will then answer yes or no depending on if the guess is correct. The game will train the AI models to become better at identifying an image. AssistLists' database already has thousands of images with an appropriate equipment label to seed the models, making the initial data sets strong from the start.

Develop phase 1 of a 4 phase approach towards having on demand image recognition that will correctly determine the medical equipment make and model when a user is creating a post.

Phase 1: Data collection and model training for type

Phase 2: Data collection and model training for equipment models

Phase 3: Processing and attributing information to existing posts

Phase 4: System that recognizes equipment when creating the post

Similar to Craigslist, users create a post and manually input information about the equipment, however, AssistList only allows certain types of equipment to be sold on it and we actively remove posts that do not meet our requirements. Due to this, we have a very specific list of equipment types that need to be scanned for.

In phase 1, we would like the system to differentiate between equipment types only. For example, to tell the difference between a wheelchair and a hospital bed. This will build the base for future improvements to the model for recognizing specific manufacturer details based on an image which will reduce the amount of fields the user will have to enter.

Deliverables

The main component of the site includes a Game where users can upload pictures into the site and get it to guess what equipment type it is, and then mark it as correct/wrong. This information is then fed back into the confirmed dataset by crowd sourcing pictures. The also includes a portion where administrators of the site can bulk upload pictures of equipment and tag it appropriately to add to the confirmed dataset for all equipment types provided. The site should start with data for all equipment types and models preloaded into the system as provided by the thousands of pictures in our current database. Site should be created in a modern webdev framework like React. Utilize AWS Rekognition or equivalent toolset.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

This non-profit was founded by UBC alumni and has grown to 50+ volunteers. Experience and mentor-ship gained by past volunteers have helped establish their careers. We have AWS grants that allow us to help pay for utilizing cutting edge tools that are now available in industry

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Website, AI, Artificial Intelligence, Machine learning, Image recognition. .

73: Open Loop Directional Comparison Blocking (DCB) Scheme for BC Hydro's Overhead Distribution System Designated as the Gulf Island Loop

Category

technology exploration

Primary Area

Electrical (high voltage)

Organization

BC Hydro - <https://www.bchydro.com>

Background

BC Hydro has implemented an advanced protection scheme for its Distribution underground system known as the Open Loop Directional Comparison Blocking (DCB) scheme. This protection utilizes fast communication between SEL relays over fibre and goose messages to achieve clearing of the fault and isolation before feeder head protection trips. A similar scheme is envisioned for the parts of the overhead (OH) system, i.e.: the Gulf Island Loop.

BC Hydro will supply the following:

1. A project liaison and sponsor for the Capstone project team.
2. Access to knowledgeable BC Hydro staff.
3. BC Hydro Standards and other reference material available.
4. A copy of a report template.
5. Copies of the BC Hydro IP and ND agreement documents.

Objectives

The main objective of this project is to design the OH DCB protection scheme for the Gulf Island Loop. BC Hydro presently has a peer to peer loop control system between the automated reclosers of the Gulf Island Loop. The current solution has served BC Hydro well, but the control system devices of the loop are reaching their end of life. The new solution shall replace the existing system, and utilize the advantages of better telecommunications, plus new control features. The new solution will also enable BC Hydro to expand the existing loop by adding more devices to further improve reliability of the circuits of the Gulf Island Loop.

Deliverables

The main deliverable for this project are:

1. Completion of the IP and ND agreements.
2. Monthly meetings with the BC Hydro Capstone project liaison or sponsor or both of these individuals. All meeting shall be virtual until further notice.
3. Investigate and report on the current control capabilities of SEL recloser control and future EATON recloser control for application in the proposed advanced protection scheme.
4. Analyse the telecommunications requirements of the Gulf Island Loop, and recommend a telecommunication solution to enable the use of an OH DCB system, i.e.: cellular, wimax or fibre, taking performance, latency, use of goose messaging, and the IEC 61850 protocol, and other design parameter, which may arise, into consideration.
5. Provide high level cost estimate, and a proposed implementation schedule.
6. Documentation of the process followed and the results obtained in a formal report. This report will have an executive summary, an introduction, of summary of the effort undertaken with results obtained, a conclusion and recommendations. This document should also include, but not be limited, to a list of references and copies of any spreadsheets, calculations, cost estimates, proposed schedules, models, sketches, drawings or tables used to obtain the final results, plus any operating instructions and maintenance manual for any product produced, as required.
7. Final report documentation in the required format.

The suggested approach is to:

1. Obtain all available data and reference material from BC Hydro.
2. Undertake a literature search on the subject of Open Loop Directional Comparison Blocking (DCB) for Distributions Systems and look for examples of implementation of this system to situations similar to what BC Hydro is envisioning.
3. Create a detailed project plan, complete with schedule, showing all tasks and key dates for the Capstone Project.
4. Discuss results with the BC Hydro Capstone Project liaison and sponsor on a regular basis.
5. Report findings in the required format.

Contributions Organization is Able to Provide

Possible field trips

Additional Considerations

The need for IP and ND agreements using UBC modified documents.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Open Loop Directional Comparison Blocking (DCB), reclosers, telecommunications, i.e.: cellular, wimax or fibre, latency, goose messaging, and IEC 61850.. Open Loop Directional Comparison Blocking (DCB), reclosers, telecommunications, i.e.: cellular, wimax or fibre, latency, goose messaging, and IEC 61850..

74: Integrate RFID into seafood manufacturing software

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Software

Tertiary Area

Micro-Electronics

Organization

This Fish - <https://this.fish>

Background

ThisFish Inc. is a leader in seafood traceability and production software that improves business efficiency and increases trust and accuracy in supply chain data. Our mission is to improve the social, environmental and financial sustainability of the seafood industry.

We currently integrate our software with weigh scales, digital scanners and label printers - and would like to expand our offering to integrate with RFID tags on the production line to help track productivity and improve traceability inside the factory.

Objectives

- Research into recommended RFID hardware for factories to use
- Comparison of RFID / NFC effectiveness
- Ability to write data to a RFID tag from our software
- Ability to read data from a RFID tag from our software
- Work with our team to integrate seamlessly into softwares configuration
- Testing and documenting integration for expansion

Deliverables

Software integration to read/write data to RFID tags

Documentation on recommended hardware and integration setup for future use

Working integration in a test factory

Contributions Organization is Able to Provide

All of the above

Additional Considerations

ThisFish is committed to providing support to ensure project feasibility during the global pandemic by encouraging remote work, providing required hardware and collaboration with our on site engineers across multiple timezones.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

RFID, Python, Integration, Traceability, NFC, IoT, Research, Sustainability. RFID, Python, Integration.

75: UBC track and Field Analytics

Category

technology exploration

Primary Area

Software

Organization

UBC Track and Field - (No Website)

Background

UBC Track and Field is one of the top programs in the country and had 7 olympians in 2016 in Rio. If you are interested in sport, performance, and a challenge that can provide excellent reference skills this project may be for you. We are looking to develop and recruit athletes whom fall along the spectrum of the podium pathway. We will create a concrete recruiting and analytical tool to enhance our recruiting and development across all track and field events to attain and develop the best student athletes in Canada to compete for national titles and olympic qualifications every year.

Objectives

To create a dashboard and web scraping tool to analyze 10s of thousands of results of high school athletes and compare them to Usports/ NAIA results to empower our coaches to make more informed recruiting decisions.

Deliverables

Online dashboard that is statistically reliable and valid. Web-scraping tool for continued dashboard development year over year along with some smaller offshoot projects that would be event group specific.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Analytics, Data, Recruiting, Podium Results Tracking. Data Analytics.

76: Real-time force monitoring with cloud-based data storage for virtual physiotherapy management of Achilles injuries

Category

Mixture of improvement of existing tech and novel tech development

Primary Area

Mobile app

Organization

UBC Tendon Injury Prevention and Rehabilitation Laboratory -

<https://physicaltherapy.med.ubc.ca/2013/09/16/tendon-injury-prevention-and-rehabilitation/>

Background

Achilles tendinopathy (AT) is a common musculoskeletal condition which presents as chronic activity-related soft tissue pain. The tendon injury prevention research group at UBC has demonstrated that Achilles tendon biomechanical properties improve with an exercise protocol that incorporates real-time force monitoring to ensure optimal exercise dose. Rehabilitation of the Achilles tendon using real-time force monitoring could be further enhanced by integrating a home-based Achilles tendon loading device with a Bluetooth-enabled force sensor, which communicates with an application that (1) provides biofeedback and (2) monitors progress towards exercise targets.

Objectives

This project aims to develop an exercise-monitoring and data-capture system while also providing visually appealing real-time biofeedback to the user via an app interface. Key project objectives will be modified according to progress:

- Primary Objective: Using established bluetooth-enabled load-monitoring hardware available in the lab (<https://tindeg.com/product/progressor/>), develop open-source app software (Android and IOS preferred) to display exercise goals to the user, log progress such that a clinician can monitor progress remotely, and also allow for remote tailoring of the exercise program (e.g. change in number of sets, reps, target load, etc.) by a clinician.
- Aspirational Objective: Depending on primary progress, interest, and skill composition of the team, use the apps previously developed and the functionality of the Tindeg hardware platform for inspiration to design and develop a novel hardware package to monitor tensile loads in real-time. Hardware package should communicate through Bluetooth and encompass similar features to the Tindeg in terms of load-monitoring.

Deliverables

Fully functional apps. The level of testing and functionality should be sufficient to allow for rollout to end-users in a randomized prospective clinical trial assessing clinical status over time in individuals with unilateral AT. Documentation sufficient to allow our lab to evolve the design and refine the device/app interface.

If applicable, a hardware platform capable of meshing with the aforementioned software and sufficiently finished to rollout to end-users. Documentation sufficient to reproduce the design in larger quantities and evolve the design as needed should accompany.

Contributions Organization is Able to Provide

Financial support as needed; Access to tech and lab facilities; Access to information; Education in tele-rehab as needed

Additional Considerations

Project oversight will be administered by Kohle Merry (RHSC PhD Student, EIT), Dr. Alex Scott (PhD, PT), and Vivian Chung (P.Eng).

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Tele-rehab; mHealth; Achilles Tendinopathy; Rehabilitation Device; App Development. Bluetooth, React?.

77: Mitigating social isolation through integrated Interest and geo-location matching software

Category

new product development

Primary Area

Mobile app

Organization

Proximity Technologies Inc. - <https://www.proximity.ca/>

Background

This project has difficult aspects which will cater to and challenge the depth of student's technical knowledge, specifically focused in web and app development. Proximity can and will provide great in-house technical and development support to ensure the group reaches the desired project outcome. Proximity will encourage the ECE team to be inspired by their own ideas and innovations in order to provide flexibility of the final product while simultaneously solving the problem of social isolation as stated below.

Proximity is a social network designed to help end social isolation and empower individuality. We help people find new connections and social activities in their area in a proactive way, we use an algorithm created by a user's location and selected interests. Thus, users will see real-time activities and people in their proximity which increases their likelihood of fostering genuine social connections around them.

Objectives

We're currently enhancing the way we present our idea, for this our needs consist of taking our existing web-based platform and transitioning smoothly into a native app, as well as setting up measurable data points to analyze user data more efficiently providing meaningful insights into the company mission, product and optimization.

Deliverables

Students will be assigned to help with front end design and back end development for the native application. Design mock-ups will be prepared for students in advance to ensure work efficiency, that said we do encourage design ideas. We plan to have a functioning mobile app the upcoming months for an initial product roll out, students will be able to see how their creation has an effect on the real world. It is highly encouraged that the students chosen are open-minded and bring new ideas to help improve the application.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Proximity is ambitiously solving the problem of social isolation, an issue that existed before COVID-19, and amplified during the pandemic. Due to the lack of funding secured and the complexity of the project, our team understands the importance of work efficiency and proper guidance to complete project scope with students as a part of our team. Our team is confident of the great industry experience and will provide exceptional mentorship to make sure students understand the technology.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Challenging, Exciting, Mobile Development, IOS, Android, Java, GIS Positioning, React Native, Start Up, Future Employment, Technology, Innovation, Network, Global Solution, Flutter. React.

78: Measuring cognitive load with Eye Tracking in Mixed Reality Devices

Category

technology exploration

Primary Area

Software

Secondary Area

Computer

Tertiary Area

Digital Media

Organization

MacDonald Dettwiler & Associates Corporation - <https://www.mdacorporation.com/corporate/>

Background

3D visualization systems provide enhanced contextual awareness and reduce human information processing, which improves focus and retention, and have the potential to reduce cognitive load significantly when compared to existing 2D systems, which require the user to synthesize and integrate information cognitively from multiple displays. Similarly, the recent increase in the ease of access to modern high-fidelity head mounted displays such as Mixed Reality (MR) and Virtual Reality (VR) has re-emerged the interest for using immersive technologies. The interest in MR for simulated training in Command and Control applications, for example, has increased with the rise of devices like HoloLens [1]. Nevertheless, there is currently little evidence in the scientific literature that using modern MR equipment provides qualitative or quantitative benefits [1]; therefore, there is a high value in advancing tools that support an assessment of the perceived benefits of MR devices. Eye tracking, for example, can be used to prioritize symbology rendering to reduce the cognitive load, and simultaneously assess the same factor through eye pupil measurements [2]. We foresee benefits in further exploring the eye tracking feature available in devices like HoloLens 2 as a means to assess an operator cognitive load from a quantitative perspective.

Objectives

- Review state-of-the-art methods that use eye tracking to assess an operator's cognitive load, including works currently under investigation by the scientific community.
- Understand eye tracking capabilities that the MR device has available.
- Propose methods for cognitive load assessment based on the literature review and MR device features.

- Discuss a suitable and representative scenario with MDA experts (e.g. increasingly demanding for an operator) for implementation and cognitive load assessment.
- Design, Implement, Test (with MR device emulator) and Deliver scenario with eye tracking metric collection capability, according to MDA Systems Engineering guidance.
- Stretch goal: Prototype the scenario on a real MR device at MDA's facility and perform a few experiments to collect metrics results, analyze results and provide conclusions for the experiment (this activity is to be further coordinated with MDA).

Deliverables

- Report summarizing state-of-the-art methods that use eye tracking to assess an operator's cognitive load and recommendation of the methods that could be applied to this project (considering the use of HoloLens 2 and Unreal Engine).
- A prototype scenario implementation (tested on an MR device emulator) based on Unreal Engine (UE4) and HoloLens 2.

Contributions Organization is Able to Provide

MDA might be able to provide some financial assistance pending the project scope

Additional Considerations

Requirements

- To be able to develop the scenario, the UBC students will need access to computers that meet system requirements for UE4 and HoloLens 2 emulator installation:

- UE4
 - o Minimum requirements:
 - 📖 Operating System: Windows 10 64-bit
 - 📖 Processor: Quad-core Intel or AMD, 2.5 GHz or faster
 - 📖 Memory: 8 GB RAM
 - 📖 Video Card/DirectX Version: DirectX 11 or DirectX 12 compatible graphics card
 - o Recommended specs:
 - <https://docs.unrealengine.com/en-US/GettingStarted/RecommendedSpecifications/index.html>
- HoloLens 2 Emulator
 - o 64-bit Windows 10 Pro, Enterprise, or Education
 - o 64-bit CPU
 - o CPU with 4 cores (or multiple CPUs with a total of 4 cores)
 - o 8 GB of RAM or more
 - o In the BIOS, the following features must be supported and enabled:
 - 📖 Hardware-assisted virtualization
 - 📖 Second Level Address Translation (SLAT)
 - 📖 Hardware-based Data Execution Prevention (DEP)
 - o GPU requirements
 - 📖 DirectX 11.0 or later
 - 📖 WDDM 1.2 graphics driver or later (1st gen)
 - 📖 WDDM 2.5 graphics driver (HoloLens 2 Emulator)
 - 📖 The emulator might work with an unsupported GPU, but will be significantly slower
 - o Link to the specs:

<https://docs.microsoft.com/en-us/windows/mixed-reality/using-the-hololens-emulator>

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Augmented Reality, Virtual Reality, 3D Visualization . Augmented Reality, Virtual Reality, 3D Visualization .

79: XR iINTERACT Multiplayer Sports Game

Category

new product development

Primary Area

Computer

Secondary Area

Software

Organization

Texavie Technologies Inc - <https://texavie.com/>

Background

* iINTERACT: Fingers and arm tracking wearable device

* iNSHAPE: Full body motion tracking wearable device

The goal of the XR iINTERACT sports game project would be to develop PlayStation/Nintendo/Xbox applications that create engaging experiences and potentially influence purchasing decisions of gamers and game developers. Potential ideas include developing mini-games, adding connections to social networks, and developing unique multi-player game experiences. Familiarity with UFC, boxing, FIFA, or NBA 2K20 and skill sets in Unity, VR development, 3D art, 3D animation, experience in UI/UX designers would be desired.

The project is to leverage the Texavie iINTERACT and iNSHAPE to co-construct an Extended Reality (XR) prototype that will bring a console sports game into an immersive environment. When the user wears the Texavie iINTERACT and iNSHAPE, the device will collect the body movements (fingers, hands and arms for iINTERACT and whole-body for iNSHAPE) and bring the data into the game environment. In the game, the user can enjoy playing the game within a predefined game mode. Together with the Texavie iINTERACT and iNSHAPE, our goal is to prototype a XR pipeline to show one or more ways that virtual games can be presented in different types of body movements.

Link of the flyer:

https://drive.google.com/file/d/1p8Czg8qAAaq0DOZCl6EF9bLwZY-vVuo_/view?usp=sharing

Objectives

The majority of console video games are using controllers to play games. Texavie iINTERACT and iNSHAPE will replace the traditional gameplay experience by using the physical body tracking system into the game environment. Once game players start the game in the console game platforms, such as PlayStation, Nintendo Switch, or Xbox, the game will track players' body movements in real-time. The primary beneficiaries are those interested in the immersive sports

game experience. The game should have a minimum three levels, each level has a minimum one body movement, which shows the strength Texavie iNTERACT and iNSHAPE.

Deliverables

The goal is to provide a VR/console sports game prototype that Texavie can further develop and a demo video for the body form. The UBC student team will, at minimum, work on developing the hands, boxing glove, sports field, sandbag modeling, basic animation for hands, and hand movements, and VFX system for the effect (including speed, punch, miss-punch, sandbox swing) in real-time.

1. Real-time physical movements (for example boxing with different gestures and movements)
2. Simple but fun experience
3. Platform (Console game, VR, AR, MR)

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

1. Students will need to collaborate with Texavie team
2. Unity experience
3. C# experience
4. Python experience
5. Database experience
6. Game development experience
7. XR (VR, AR, MR) experience
8. 3D environment development experience

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

. Game platform, sensor devices, game application.

81: Bias Detection Algorithm through Natural Language Understanding (NLU) and Natural Language Processing (NLP)

Category

improve an existing product

Primary Area

Organization

Swae - <https://swae.io>

Background

We've designed a SaaS platform and decision-making workflow to allow teams, corporations and smart cities around the world include more people in the decision making process and reduce bias in their decisions by creating a competition to select the best ideas from.

Swae's AI algorithms are similar to Grammarly. They're designed to help employees and citizens turn their half-baked opinions into well written proposals. Users enter ideas on the platform anonymously and our AI editor proof reads the ideas, summarizes the text, and suggests improvements in grammar, tone, readability, and subjectivity. Increasing the volume and diversity of good ideas to choose from from diverse sources is an unaddressed problem with most ideation, innovation or participatory decision-making processes or platforms.

We believe that if more people inside an organization, irrespective of their background or communications skills could better express their ideas we would have more and different ideas to select from for decisions.

Swae's collaboration, debate and voting features help the crowd add their expertise to proposals, uncover risks, and improve the content to make ideas more decision-ready.

The combination of an AI editor, collective intelligence, and a configurable merit-based workflow, Swae brings more voices to the table, helps organizations and government entities hear brilliant ideas from its people and grow and debias those ideas into winning decisions efficiently.

Objectives

A possible next step for us in our AI journey is looking into the feasibility of an AI bias detection algorithm to help users be aware of the biases in their written proposals and ideas.

The bias detection algorithm intends to classify the 16-20 different well understood and documented cognitive biases that originate from the behavioural science research field, and to build a strong and clean database of tagged examples of biases in writing. The algorithm would then run passages of texts against this database to identify the presence of various cognitive biases in a user's writing sample or argumentation logic, and would suggest editorial improvements removing biases to help sanitize passages and writing pieces so they can be made more objective and persuasive.

Deliverables

- Retrieve and Classify data to be used for feeding the algorithm
- Developing a working prototype of the algorithm against real proposals and written language
- Deploying an API that is functional and ready to be used for core Swae application
- Developing Detailed documentation (README of a Git repository) of the API

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Deep learning, AI Editor, Bias Detection, Natural Language Understanding, Natural Language Processing, Collective Intelligence. .

82: Linkofile

Category

technology exploration

Primary Area

Software

Secondary Area

Web app

Tertiary Area

Machine learning

Organization

LinkMe Technologies Inc. - <https://www.linkofile.com/>

Background

Our project is to take marketing to the next level by removing frictions and barriers that make it difficult for people to exchange data frictionlessly and on real-time basis.

Objectives

Our main objective is to provide our clients (i.e. realtors and auto dealers) with the an online platform (web/app) where they can link up their business cards, brochures, one pager advertisements so that people can simply save and further review and advertisement by taking a picture of it. Furthermore, every time a linked up content is looked up by a user, the advertiser client will receive a notification. In turn, it allows our clients to gain more control over their hardcopy advertisements and use them as a gateway to reach out to people on digital world and make connects that can potentially turn into sale leads.

Deliverables

Our project is mainly around further advancing the current version by integrating image processing systems so that rather than entering information of an advertised materials manually users will be able to automatically save the advert by simply take a picture of it and having it saved categorically in accordance to the nature of the advert item. For example, if it is a piece of property then it will be saved under the real estate tab and if it is a vehicle then it will be saved under the vehicles tab and so forth and so on. Likewise, to make this process easier, it'd be required that our clients will be able to link up a hardcopy marketing material by simply taking a picture of it.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

Full-stack Developers make up for ideal candidates for our R&D..
This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Image Processing, Frictionless Data Exchange, Information Technology, File Sharing. cloud, webbaps, ML/image recognition & classification.

83: Visually Enhanced Lesion Scope (VELscope®) Product Design Update

Category

improve an existing product

Primary Area

Biomedical

Secondary Area

Electrical (low voltage)

Tertiary Area

Micro-Electronics

Organization

LED Dental Inc. - <https://apteryx.com/velscope/>

Background

The VELscope® is a handheld scope that uses natural tissue fluorescence to enhance the way clinicians visualize oral mucosal abnormalities that might not be apparent or even visible to the naked eye. The VELscope® is an adjunctive device that is intended to accompany a conventional oral examination. VELscope® Vx is the third generation of VELscope® and LED Dental Inc. would like to explore the future of the product with a major redesign to optimize its usability and potentially introduce new features to grow the VELscope® market.

An ideal project team would consist of members that have backgrounds in electrical hardware and firmware design, biomedical applications and basic mechanical engineering. We encourage individuals with keen interests in LED system design and optics to consider our project.

This project will be supported by LED Dental Inc throughout the year by providing:

- VELscope® Vx samples to team members to evaluate and propose design updates.
- Rapid prototyping and small-batch PCB printing services.
- Access to LED Dental's Optical Power Meter for validation testing.
- Courier services and additional financial support as required.

This project will be managed by Michaela Ragoonath, a biomedical engineer at LED Dental Inc. and former ECE Capstone student.

Objectives

The main objective of the project is to review the current VELscope® Vx design and make design

updates to the device based on the stakeholder and market feedback provided by LED Dental Inc. These areas of improvement include:

1. Redesigning the LED ring to use more efficient LED's while maintaining the optical power density specification at a fixed working distance.
2. Optimizing the thermal management system of the device to remove the need for a fan.
3. Improving the reliability and life of the rechargeable battery.

For a highly capable team and time permitting, the following additional goals may be challenged at your option:

4. Introducing a white light visualization mode to support clinicians in their conventional oral examinations.
5. Exploring possible filter switching mechanisms to allow LED Dental Inc. to encourage near-simultaneous image acquisition of blue light and white light images with the existing VELscope® Vx image acquisition solution.

Deliverables

Good: a fully functional alpha prototype of a fourth-generation VELscope® handpiece that addresses the three areas of improvement identified.

Exceptional: Good deliverable above plus successfully implement the new white light visualization mode in a seamless user workflow.

Outstanding: Exceptional deliverable above plus functionally implement solutions for the two mentioned optional goals.

Since the VELscope® is a Class II medical device, an alpha prototype should be accompanied by relevant design documentation required to continue development.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

N/A

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Biomedical/Dental application, LED Assembly, Thermal Management, Semiconductor Device, Fluorescence, Clinical Decision Support. Biomedical/Dental application, Semiconductor Device, Fluorescence, Clinical Decision Support.

86: Lab-in-a-pack

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Software

Tertiary Area

Computer

Organization

Sudip Shekhar (UBC) - (No Website)

Background

Small, portable devices such as Raspberry Pi, Arduino, and Intel DE boards have revolutionized high school and undergraduate programs in CSE, ECE, robotics, etc., and impacted many industries and research. On the other hand, our EE undergraduate labs, with their need for equipment like power supplies, oscilloscopes, signal generators, look the same as they did 20-30 years ago! Electronics as a hobby among high school students is dying, because building, debugging and testing electronics has become an expensive and complicated business. COVID-19 pandemic has now led to curtailment of on-site lab activities globally. Even when these institutions open, including UBC, social distancing will continue to limit laboratory interactions among students and instructors. Electronics/electrical/mechatronics/physics hardware labs will be especially impacted. So the state of EE and other applied science education will only be worse, unless we make this pandemic an opportunity to innovate.

Electronics labs in schools and universities have workbenches containing multiple power supplies, signal generator, oscilloscope, multimeters, logic analyzer and spectrum analyzers - costing > \$3000. Though there are multiple compact carry-on alternatives to a lab workbench, they continue to be significantly expensive, lack in capabilities and are not easy to use.

Objectives

We need a small device that has all the capabilities found in electronics labs of schools and universities - multiple power supplies, signal generator, oscilloscope, multimeters, spectrum analyzers - but costing <\$100 instead of few hundreds of dollars. The device should ideally build on top of a Raspberry Pi, such as a Pi HAT (Hardware Attached on Top), making use of the Pi's vibrant ecosystem as well as hardware capabilities, and be supported by an easy, intuitive graphical user interface (GUI) for students and teachers to use the device to aid experiments at

home and school. The device will cater to novice students, but also have advanced capabilities that makes it controllable through Python for college and university students. The application programming interface (API) will be made open-source, so that instructors, students, engineers, hobbyists and tinkerers can share their learnings online. The software will also provide the remote abilities needed for automatic evaluation to provide a positive feedback and reinforcement learning model for students, and automatic grading for instructors.

Deliverables

1. Identify commercial off-the-shelf integrated circuit (IC) components that can be bought and designed together to realize a device that can sell for less than \$50 and be compatible with Pi.
2. Research and develop the compatibility of such ICs, design a printed circuit board (PCB) to assemble all the components without introducing significant noise, crosstalk and thermal challenges while still keeping the power consumption low so that it can be powered by PI USB cable.
3. Develop a GUI, using python, that is easy and intuitive for novice users
4. Develop a JupyterLab interface for advanced features through the open APIs, and provide an auto-feedback and auto-grading feature to aid teachers and instructors.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

We will provide a lot of background research on the project on the hardware and software side, as well as oscilloscopes for student(s) to take home for measuring/debugging their hardware. The students working on the hardware development will need their DE0/DE1 board, breadboard and Raspberry Pi. If they don't have a Pi, we can provide that as well.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Hardware, software. Hardware, software, lab instrumentation, analog, digital, circuits and system.

87: 360° Traffic Sensor

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Software

Tertiary Area

Computer

Organization

Breeze Labs Inc. - <http://www.breezetraffic.com/>

Background

Breeze Labs is building a solution that helps cities reduce CO2 emissions by optimizing traffic flows at intersections in real-time based on current conditions on the roads. At this time we are using existing cameras and radars at intersections to identify and track road users. The problem with this approach is that we need to retrain our AI models for each type of sensor we encounter. Therefore, there is a need for an universal device to detect cars, buses, trucks, bicycles, etc.

This project would be a great fit for students with an interest in a computer vision and/or who plan to start their career in the self-driving industry. Due to COVID19 we expect to send each student a package with a full kit required to assemble the device at their home including cameras, radars, servo motors and other components per design defined at the first phase of the project. The budget for the kits and delivery will be provided by Breeze Labs Inc.

Objectives

To develop an affordable, robust and easy-to-install solution for object perception and tracking at intersections by combining different types of sensors. At a high level, the traffic sensor is a device composed of a control board, a set of video cameras supplemented by various sensors, e.g. radars. The design as a whole comprised of mechanical, electronic and software parts in a single enclosure and at minimal it should be featuring:

- + Multiple cameras with a narrow field of view pointing in different directions, together providing a full view of an intersection. A suitable off-the-shelf camera module will need to be chosen. A good reference and starting point could be something similar to the Panasonic i-Pro Extreme

(https://security.panasonic.com/products_technology/products/wv-x8570n)

- + Pan and tilt gimbal mechanism controlled by stepper motors adjusting the angle of every single camera in order to minimize blind spots

- + Single board computer as a platform for embedded software that allows two-way TCP/IP communication with the ability to adjust and configure sensor parameters as well as encoding and transmitting video from cameras

Only if time permits and students as a team decide that they have enough capacity to bring this project to the next level we would like to see some or all of the following features:

- + Additional type of sensors such as radars, lidars, infrared, ultrasonic, etc. to allow for object detection that works day and night in all weather conditions

- + Adequate radar technology working in Ka-band to allow simultaneously determine the speed, position, direction of movement, and distance of many objects in a range from 5 to 200 meters

- + Data communication protocols between the traffic sensor and data consumers to allow supplementary data from additional sensors

- + Power provided over Ethernet

Deliverables

A prototype of the traffic sensor at the level of functionality that is sufficient to allow beta testing on a street. Blueprints and other documentation including electrical, mechanical and software designs sufficient to allow our company to evolve and refine the device.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

- + As our computer vision software stack follows the latest developments in self-driving technology, we would like to use similar types of sensors to the ones currently being used in autonomous vehicles (e.g. Waymo & Tesla)

- + Electronic components chosen for the solution should meet minimal climate/environmental requirements to allow the solution to be used outside year-round. The degree of protection against humidity, temperature and vibration provided by mechanical casings and electrical enclosures will be defined at the later stage.

- + ESD/EMI requirements are minimal at this stage.

- + We can provide additional support to students by facilitating sessions with our principal engineer who has 15 years of extensive hands-on experience in electronic hardware design and embedded software development at Ericsson, Broadcom and Cypress Semiconductor Corporation.

+ Based on the outcome of this project we will consider a future employment of students after graduation.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

sensors, computer vision, self-driving. sensors, computer vision, imaging, radar, power over Ethernet.

88: Augmented Reality (AR) for Orthopaedic Surgeries

Category

technology exploration

Primary Area

Digital Media

Secondary Area

Biomedical

Tertiary Area

Computer

Organization

Surgical Technologies Laboratory, UBC - <https://stl.mech.ubc.ca>

Background

Serious pelvic fractures are usually treated surgically. Even though these surgeries are complex, surgeons currently do not use any extraneous visualizations, or use simple computer monitor-based visualizations as an aid. Augmented reality (AR) systems such as head-mounted displays (HMDs) have become widely available and could be used to present the necessary spatial information to surgeons in a more intuitive manner, which in turn could make surgeries safer and more efficient. There is a need to understand and quantify the potential benefit of AR devices in orthopaedic surgeries.

Objectives

Our aim is to develop and validate an AR system suitable for orthopaedic surgeries that has the following features:

Works on both Microsoft HoloLens (HMD) and the Looking Glass (tabletop holographic display)

Is compatible with NDI Vega (hardware), Slicer (software) and PLUS (software)

Visualizes the surgical plan overlaid on the patient, in real-time. The surgical plan includes the CT image, surgical tools and trajectories, and surgical targets.

Can be used to both plan surgeries and in pre-planned surgeries

Provides multiple visualization options, such as a bullseye display, 3D overlay, etc.

Is validated on a limited set of participants

Deliverables

A fully functional prototype, whose feasibility has been validated on a limited set of potential users (surgeons or 'novices').

Documentation sufficient to allow our group to evolve the design and refine the device.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Augmented Reality, Image-Guided Surgery, Human Computer Interaction. .

89: Real-time training load monitoring in sports

Category

new product development

Primary Area

Mobile app

Secondary Area

Electrical (low voltage)

Tertiary Area

Software

Organization

Canadian Sport Institute Pacific - <https://csipacific.ca>

Background

There are 7 Canadian Sport Institutes/Centers across the country servicing the national sport teams in several disciplines (physiology, nutrition, mental performance, strength & conditioning, biomechanics & performance analysis, data solutions...) to enhance performance in hope to win or medal at the Olympics.

Monitoring load of training sessions is a key component to ensure athletes are physically stressed appropriately to optimize gains. Common practice in load quantification is through subjective questionnaire on their perceived rating of the session on a scale of 1 to 10. GPS/HR monitor,/power meter are sometimes used to provide objective load measurements. The load quantifications are done at the end of the day when data from different daily training sessions are processed allowing coaches to make changes to training plans as required. However, this practice can be improved if the training load can be monitored in real-time, when decisions to end practice can be made if individuals have reached a threshold before the session is over. This real-time feedback can prevent over stressing athletes to a point of potential injury.

Recently, there has been integration of Inertia Movement Unit (IMU) to more accurately quantify sports movement for high resolution objective feedback. IMU consists of accelerometer, gyroscope and magnetometer that can be sampled at 400+ Hz. In general, IMU data can be streamed live and recorded onto the mobile device. It would be possible to process the live streamed data to provide real-time training load quantification of the session.

Currently, we are working with 2 brands of IMU (Movesense and Metawear MMR), they both have its advantages and gaps. The reasons that we've gone with these sensors are because of its ease of use through mobile app and the apps are open source for custom build extension (like this project). We are not set on these IMUs if another IMU can satisfy these features (ability to be

able to record data at minimum 100Hz for 3-4hrs, waterproof, and long range live stream ~200m ideally). The proof of concept of the project will be for indoor sport (ie more controlled environment) and then expand to outdoor sports.

Objectives

The main objective is to track basic metrics in real-time.

Examples:

- volleyball, able to track number of jumps an individual have done
- Wheelchair basketball, able to track number of hard effort pushes on the wheel
- gymnastics, track number of high impact landings

Deliverables

create an iOS app (from scratch or modification to existing open source app) or dashboard on laptop that can display several athlete's load in real-time (or with minimal lag)

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

n/a

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

sensor, sports training monitoring, iOS app, dashboard. sensor, sports training monitoring, iOS app, dashboard.

91: Human Anatomy Teaching APP

Category

improve an existing product

Primary Area

Mobile app

Secondary Area

Software

Tertiary Area

Biomedical

Organization

UBC Faculty of Medicine - <https://www.med.ubc.ca>

Background

After a curricular survey and a social media poll, several hundred UBC students requested a true-to-life cadaveric Anatomy APP specific to their curriculum, as presently available apps are not meeting student need. We, with the help of a group of Capstone students, could develop a teaching cadaveric based app for iOS and Android last year. With the current COVID-19 pandemic situation, the only resources that we can use for our fall term teaching is any digital resource that we have been able to create and our current app is one of them.

We are offering the Human Anatomy Teaching APP this year to add more options to the current app. These options are included, but not limited to, adding full zoom able option of the images in the flash card section of the app, adding short answer format questions to the quiz section of the app, adding data collection section to the app with full function, etc. We are also willing to leave the complete re-design option of the APP to this year cohort should they decide to do so.

Objectives

Our aim is to improve anatomical sciences competency for all allied health students at UBC through an app that features:

- ✦ Curricular-specific database of labeled cadaveric photos
- ✦ Easy-to-use interface to navigate different systems and parts of the body
- ✦ Zoom able flashcard-like mode for accessible student self-testing
- ✦ Quiz mode to test secondary knowledge of anatomy for student self-testing
- ✦ iOS and Android compatibility

It is not a requirement that all photos and question bank are included in the final project. We expect students to focus on making the app functional using a small database to work with first. Knowledge of human anatomy is not required.

Deliverables

The outcome of this Capstone project for stakeholders is the free publication of the student-requested, curricular-specific, innovatively high-resolution, true-to-life cadaveric Anatomy Teaching App for iOS and Android.

Documentation should be sufficient to allow the faculty to continuously update the database and refine the app.

Contributions Organization is Able to Provide

None

Additional Considerations

Knowledge or experience in app development for iOS and Android is appreciated.. This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Resource development, infrastructure development, pedagogies for student learning and engagement, teaching roles and training, anatomy. Resource development, infrastructure development, pedagogies for student learning and engagement, teaching roles and training, anatomy, mobile app.

92: Clinical Decision Support Web Application for Oral Mucosal Abnormalities

Category

operational application

Primary Area

Biomedical

Secondary Area

Web app

Tertiary Area

Mobile app

Organization

LED Dental Inc. - <https://apteryx.com/velscope/>

Background

The VELscope® is a handheld scope that uses natural tissue fluorescence to enhance the way clinicians visualize oral mucosal abnormalities that might not be apparent or even visible to the naked eye. The VELscope® Vx can be fitted with an image acquisition attachment that allows users to document areas of abnormality using an iPod Touch. LED Dental Inc. offers the VELscope® userbase a clinical decision support service in which images acquired with the VELscope® can be reviewed by an expert in oral mucosal abnormalities. Due to the demand for the service, LED Dental Inc. would like to formalize this service in a web application.

This project will be supported by LED Dental Inc. throughout the year by providing:

- VELscope® Vx Image acquisition samples to team members to evaluate and propose design updates.
- Access to existing VELscope® Vx support cases for testing and troubleshooting.
- Courier services and additional financial support as required.

This project will be managed by Michaela Ragoonath, a biomedical engineer at LED Dental Inc. and former ECE Capstone student.

Objectives

The main objective of this project is to develop a seamless web-based application for VELscope® users to request and receive clinical decision support. Similarly, the application should provide the clinical decision support providers with a seamless portal to access their assigned cases to review and provide feedback.

For a highly capable team and time permitting, an additional goal may be challenged, at your option, of bridging the gap between the VELscope® Vx Image acquisition iOS App and the new web interface, to provide users with a simple way of getting support from within the app.

Deliverables

Good: a functional website that contains:

1. A login portal for customers to create an account and submit cases to be reviewed.
2. Since each case will be accompanied by images, a mechanism for uploading photographs and renaming them such any patient identifying information that may be included in filenames are removed.
3. A login portal for support providers to receive a queue of cases to be reviewed.
4. Appropriate email notifications to alert customers and support providers when updates have been made or actions are required.

Exceptional: Good deliverables above plus successfully implement a method of submitting cases to the service from the VELscope® Imaging iOS App.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

N/A

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Biomedical/Dental application, Clinical Decision Support, Web Development, Database, iOS App Development. Biomedical/Dental application, Clinical Decision Support, Web Development, Database.

93: Amusement Ride Vehicle Health Monitoring System

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Software

Organization

WhiteWater West Industries - <https://www.whitewaterwest.com/>

Background

Current amusement ride vehicles used on water ride-type attractions are typically unpowered and strictly mechanical in nature. Vehicle maintenance tracking and health monitoring is primarily done through manual records keeping and inspection procedures. There is a need to design a system for onboard data collection to aid operation and maintenance of the vehicles.

Objectives

Design a system for gathering data on ride vehicles using stored onboard electrical power and sensors. Examples of parameters to monitor include:

- Vehicle accelerations
- Vehicle location
- Bladder air pressure
- Ride cycle counts
- Moisture / water ingress

Each attraction may have multiple ride vehicles operating simultaneously. Each vehicle system shall interface with the ride control system while located in the loading and unloading portion of the ride and notify the operator of any abnormal results from the previous ride cycle (loss of bladder pressure, high acceleration event, etc.)

The system should also interface with external Computerized Maintenance Management Systems (CMMS) or Park Operations software to collect and store the data in a centralized repository.

The system should be configurable for use on the entire Water Rides attraction portfolio, with each ride potentially requiring different parameters be tracked.

Deliverables

While a physical prototype of the system would be ideal, simulation software such as LabVIEW or MATLAB can also be used to validate and demonstrate the system. Other deliverables include:

- Bill of Materials of major components

- Electrical System Schematics (wiring and block diagram)
- Estimated cost for implementation on a representative attraction
- Report summarizing the theory of operation and design validation

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

WhiteWater employs roughly 100 engineers, designers and drafters at our head office in Richmond, BC. This is a great opportunity for those interested in the amusement industry to meet professionals in the field. The liaison for this project, Mark Hewett, is a former UBC capstone student and mechanical engineering alumni.

Typical Ride Control Systems used are Siemens SIMATIC or Allen Bradley PLCs. WWI can provide access to a virtual machine containing Siemens PLC programming software (TIA Portal), though it is not required or expected that students carry out any program modifications to the ride control system.

WWI owns a Park Operations software package, Vantage (<https://vantage.co/>), which would be desirable for the proposed system to integrate with.

Wireless transmission of data is a requirement.

Water Rides portfolio: <https://www.whitewaterwest.com/en/products/water-rides/>

Proposed system diagram:

https://whitewaterwest-my.sharepoint.com/:i:/p/mark_hewett/EcH1h6t8uvpBnr9PIpMZUUGB3EyxfdsuiWAOJEfQF-0_dA?e=tlyTzM

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Amusement, Systems Integration, Safety. Amusement, Systems Integration, Safety.

94: Anomaly Detection in Product Quality Control

Category

technology exploration

Primary Area

Organization

FLIR Systems - <http://www.flir.com/mv>

Background

The manufacturing sectors are constantly facing stress over the issue of quality control, as it adversely affects their business outcomes. Machine vision technology provides imaging-based automatic inspection and analysis for quality inspection. Depending on the yield in manufacturing, defective items are usually hard to find. As a result, machine vision applications usually have very few defective samples to work with. An anomaly detection approach, where the system is trained with good samples and then looks for deviations of any kind, is highly desirable. In anomaly detection, there is no direct definition of a defect. Good samples are provided, and sometime, a small amount of defective samples may be provided to help set boundaries between good and anomalies.

The proposed project seeks to develop a system that automatically inspects the quality of product by identifying samples that look different from the normal ones. The system needs to have high accuracy, high throughput, and low latency. An example of anomaly detection is to inspect plastic injection moulding. This is a complex process with many possible production problems. Plastic objects may also include some bending or other shape deviations that are acceptable for the customer. The anomaly detection solution should learn all acceptable deviations from the provided samples and then detect anomalies of any type when running on the production line. Another example is package inspection. When a sushi box is delivered to a market, each of the elements must be correctly placed at a specific position. Defects are difficult to define when correct objects may also vary. The deep learning solution should detect any significant variations from what the system has seen and learned in the training phase.

It is worth noting that the global automated industrial quality control market is forecast to rise to US\$688.6 million by 2021. Industrial manufacturers are seeking numerous opportunities for enhancing their manufacturing standards and practices without affecting the cost of production. Automated industrial quality control systems have gained popularity over manual quality control during the recent times. The proposed automatic anomaly detection system is just an initial effort of a large-scale supercluster project for FLIR in the area of industrial quality control.

Objectives

The goal of this project is to develop a computer vision solution that identifies anomalies based on the previously seen good samples. This is particularly challenging when the good forms also vary. For example, the same type of produce looks different from one item to another. The same

cable can be folded in different ways and hence look differently. Developing a robust automated anomaly detection system is important.

While traditional computer vision approaches have been well suited to reading standard barcode or measuring a manufactured part against specifications, deep learning solutions enable assessment that may need subjective judgment, such as produce inspection.

The automated solution should perform more accurately and reliably than human inspectors on anomaly detection tasks. The solution should be deployable and make real-time predictions on a PC or an embedded system, such as Jetson Nano or TX2. The solution should be transferable from one application to other applications without a complete re-design of the system. Limited amount of training images should be assumed, especially anomalies. Identifying the anomalous area(s) within the image is highly preferable.

FLIR will provide a PC with GPU for the solution development. If needed, machine vision cameras together with software tools will be provided for data acquisition purpose.

Deliverables

A complete end-to-end solution for automatic anomaly detection system should be developed. The system should be able to:

1. inspect the items and signal if there is anomalous areas that deviate from the good samples.
2. train with good samples only, or with very few anomalous samples.
3. be deployable on a CPU or an embedded system, and run real time inspection at a reasonable frame rate.
4. generalize easily to variety of applications.

Working with minimal amount of training data is preferable. Identifying and displaying the anomalous areas is a nice-to-have feature for this project. Another nice-to-have feature is continual lifelong learning, where the model is adaptive to the incrementally available anomaly samples over time.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Students are preferred to have some machine Learning and computer vision knowledge

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Deep Learning, Machine Learning, Computer Vision, Machine Vision, Image Processing, Quality Inspection. Deep Learning, Machine Learning, Computer Vision, Machine Vision, Image Processing, Quality Inspection.

96: Browser-based preventative technology extensions

Category

new product development

Primary Area

Software

Organization

aDolus Inc. - <https://www.adolus.com/>

Background

aDolus provides a cloud-based ecosystem called FACT™ (Framework for Analysis and Coordinated Trust) that acts as a trusted advisor in the software/firmware supply chain between manufacturers/suppliers and customers in mission-critical industries. FACT is unique in its ability to aggregate information from analysis engines and databases, and then use this information to provide a trustworthiness score for software in industrial control systems.

Asset owners (e.g., BC Hydro) subscribe to FACT to get scores on software being installed in their critical systems. Using the score, technicians and management can make informed decisions on whether to approve or reject software for use in their operations. Vendor partners (e.g., OSIsoft, Rockwell) access the tool to analyze existing and to-be-released product software for security issues.

Currently, we require a user to either submit a file or a file hash to the FACT database. File hashes, such as MD5, SHA-1, SHA-256, and SHA-512, are short fixed-length keys representing the blocks of data in the file. It is easy to generate file hashes using widely available tools. Software manufacturers list the file hashes for users to validate against. However, due to it being a manual process, very few computer users actually perform this step.

The purpose of this project is to expand the functionality of the FACT product and move security towards the end user—a user who is neither likely to check for hashes nor be overly careful when obtaining files to install or use in critical or industrial environments. Humans respond better to an automatic process that evaluates security behind the scenes and then generates a prompt, such as “this is unsafe because of X” or “this is safe because of Y.” Additionally, malicious entities are often leveraging Trojan horse-style tactics by piggybacking on OEM content or even managing to poison Google’s search results. An unsuspecting user will often click the first links/files they see. This project aims to disrupt that flow and provide a potentially measurable risk reduction to an organization while simultaneously growing FACT’s collection of files.

The feasibility of this approach was demonstrated by a 2018 undergraduate research project where a command-line executable was created to capture file hashes as the files are transmitted over a network, and then sent to the FACT platform. This code will be made available to the students for use as a prototype.

Objectives

The main objectives of this project are to:

- Detect files being downloaded from a website (or capable of being downloaded) and detect/calculate hashes for these files
- Detect any listed file hashes by scraping the visited webpage

After detection, submit the file hashes to the FACT platform via the FACT API. If the FACT database reports that the hash is unknown, upload the file to FACT for deep analysis. If the hash is known or a deep analysis is returned, present the results to the user and, if the file verdict indicates that the file presents a high security risk, highlight those warnings.

Deliverables

The main deliverable of this project would be a set of plugins/extensions for browsers such as Firefox, Chrome, and Internet Explorer/Edge that accomplish the previously stated objectives.

Make sure to:

- Provide an intuitive user experience for dialogue boxes
- Provide professional, documented, and modular code that has been reviewed for - potential cybersecurity issues
- Integrate build processes into an automated build and test framework
- Create automated test cases to test for regressions
- Gracefully handle lack of Internet connectivity in cases where it may be unavailable (temporary or permanent)

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

File analysis, software development, cyber security, supply chain security, preventative cyber security, risk reduction, endpoint protection. Security, web scraping.

97: Multi-source Security and Product Information Aggregator

Category

new product development

Primary Area

Software

Organization

aDolus Inc. - <https://www.adolus.com/>

Background

aDolus provides a cloud-based ecosystem called FACT™ (Framework for Analysis and Coordinated Trust) that acts as a trusted advisor in the software/firmware supply chain between manufacturers/suppliers and customers in mission-critical industries. FACT is unique in its ability to aggregate information from analysis engines and databases, and then use this information to provide a trustworthiness score for software in industrial control systems.

Asset owners (e.g., BC Hydro) subscribe to FACT to get scores on software being installed in their critical systems. Using the score, technicians and management can make informed decisions on whether to approve or reject software for use in their operations. Vendor partners (e.g., OSIsoft, Rockwell) access the tool to analyze existing and to-be-released product software for security issues.

Vulnerabilities in software are one of the parameters that FACT analyzes. Software today comprises innumerable externally-supplied packages and subcomponents. Industrial Control System (ICS) software is no different. Unfortunately, these 3rd-party subcomponents can contain vulnerabilities that remain effectively hidden from the end customer. In a traditional IT environment, vulnerabilities documented in the Common Vulnerabilities and Exposures (CVE) stored in the National Vulnerability Database (NVD) and other cyber security feeds are often well described, modeled, and standardized. However, in ICS, they are often hidden behind credential logins specific to that vendor and may not be in sync with other databases, such as the NVD or Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) databases. One of the hardest things to do as a security professional or company trying to ensure an adequate database of acknowledged and potential security issues/releases is tracking those in a sane, human manner.

Also, security information is not the “whole” picture when dealing with ICS devices. It’s difficult for security professionals, asset owners, etc. to track when new software is released and the corresponding documentation can point to changes that include software component updates: potential flaws that are not identified as security issues.

Objectives

The main objective of this project is to enhance and augment a human resource by making the collection and aggregation of multiple data feeds sane while also making analysis easier by improving human attention by pointing him/her to items that require human decision.

The objectives are to:

- Scrape webpages from multiple sources (vendor websites, security documents, articles, etc.) to create a standardized, queryable database
- Make scraping patterns modular for currently identified sources while also being easily adaptable to future sources
- Make an interface to easily access, retrieve, and update information
- Store the scraped data in a data format that allows extension, tracking, etc.
- Provide a notification interface that allows frequent updates and change tracking on a particular data feed
- Implement text analysis and natural language processing techniques to analyze and classify acquired documents (There will be assistance/guidance available from aDolus data scientists if/when needed.)
- Generate security insights that allow a piece of software to be tagged with additional vulnerabilities that may be unknown to the vendor or undisclosed to the public (e.g., a vulnerable component is found within the software and either no update exists for that component or the component is previously believed to not be present in the software; the results would be present in the FACT platform)

Deliverables

A configurable software application to efficiently scrape files from vendor sites and store that in a database.

Make sure to:

- Provide an intuitive user experience for dialogs
- Provide professional, documented, and modular code that has been reviewed for - potential cyber security issues
- Integrate build processes into an automated build and test framework
- Create automated test cases to test for regressions

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Web scraping, software development, vulnerability analysis, research, data science. Security, web scraping.

98: ED2Foundry Application

Category

new product development

Primary Area

Mobile app

Secondary Area

Software

Organization

St Paul's Hospital and UBC Emergency Medicine - <http://sphemerg.ca/>

Background

There is an urgent need to improve the ability of emergency physicians in British Columbia to connect youth to integrated youth services clinics across the province. We are hoping to develop a unique smartphone application to allow referrals from the emergency department to integrated youth services clinics. We're hoping for secure, two way communication capacity, and data sharing.

Objectives

- 1) Use and build off existing open source messaging and application platforms to develop a smartphone application to allow referrals and secure, two way communication.
- 2) Pilot-test the application with key stakeholders, and make improvements based on stakeholder feedback.

Deliverables

Smartphone application which allows secure two, way communication.
This application would require ease of use, data encryption, and compliance with relevant BC privacy laws and regulations.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Application must be secure for health data

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Emergency medicine, youth, smartphone application. Foundry' (specific to BC medical'government) .

99: Autonomous Navigation and Mapping of Deep-Space Objects Through Low-Gravity Swarm Technology

Category

technology exploration

Primary Area

Software

Secondary Area

Computer

Tertiary Area

Machine learning

Organization

3D-SR TECH - (No Website)

Background

A new space-race is underway in the global space community, due to the significant developments from private enterprise over the past 20 years. This has enabled the rapid advancement of many novel space technologies, such as the CubeSat. Within the next decade, humanity will venture out beyond Low-Earth Orbit and CubeSats will offer tremendous utility in this next phase of manned and unmanned exploration of deep-space objects—due to their ability to incorporate an extensive sensor suite in a compact low-cost space exploration vehicle. While one CubeSat can provide significant economic advantages compared to traditional space-probes, their utility compounds when multiple CubeSats are used to perform a task. Therefore, 3D-SR TECH is investigating the development of low-gravity swarm technology that utilizes multiple CubeSats to carry out a specific task (e.g., navigating and mapping deep-space objects such as asteroids, as described below).

As incoming young professionals, you will be integral in this next phase of space exploration. At 3D-SR TECH, we are a young team and are excited to work with individuals who are eager to participate in the next global space race! Ongoing research in the past two decades has proven swarm technology is possible with unmanned aerial, terrestrial, and submersible vehicles. We believe that the developing space launch market is creating opportunities to deploy this technology for space exploration, and we are excited to have you join us in this endeavour!

Objectives

1) Use swarm technology algorithm(s) to optimize the trajectories of a pre-defined number of

CubeSats for the most efficient mapping and navigation of a deep-space object of interest (e.g., an asteroid).

2) Implement and showcase the developed algorithm in a proof-of-concept demonstration / prototype in a simulated low-gravity environment.

Deliverables

1) Research various forms of state-of-the-art swarm algorithms. Perform a feasibility analysis on the top 3 algorithms best suited for the main objective of this project and summarize the findings in a report.

2) Identify a set of performance metrics relevant to the main objective of this project and customize one of the above three algorithms to meet these performance metrics given varying initial conditions. Implement this algorithm and characterize its performance.

3) Time-permitting, implement and showcase the customized algorithm in a proof-of-concept demonstration in a simulated low-gravity environment and compare the simulated performance metrics with the expected performance metrics.

Contributions Organization is Able to Provide

The first and third options above (financial support and support for engineering processes)

Additional Considerations

As young professionals, we understand the difficulty of the current situation with COVID-19 and are committed to supporting you through all aspects of the project. If the number of cases rapidly increases again, a campus-wide closure is likely, even with the currently planned online coursework. Fortunately, this project can be completed remotely in its entirety, as the research and software development can be done on personal computers and shared via free cloud sharing platforms. If hardware or in-person testing is required for the proof-of-concept demonstration and you do not feel comfortable / are not permitted to perform such testing in person, we will ensure that such testing can be performed by 3D-SR TECH and take place through a live “virtual” format, so all students can be involved. Ultimately, we are looking to create an environment where students can collaborate to solve a real-world problem, and we are willing to provide project guidance, industry experience, and financial support for this project.

Key skills that we think students might have who would enjoy this project and have a high probability of success with it are:

- Programming experience (e.g., C/C++, Python, MATLAB, Arduino, etc.)
- Exposure to topics related to machine learning, real-time autonomous decision-making algorithms, and swarm technology—this would be an asset, but is not required
- An interest in aerospace, space exploration, CubeSats, or similar topics
- Interest in creatively solving novel problems that will help shape humanity's future in space!

We encourage all interested students to apply!

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Real-Time Autonomous Decision-Making Algorithms, Machine Learning, Swarm Technology, CubeSat Mapping and Navigation, Deep-Space Exploration, Software Engineering. Real-Time Autonomous Decision-Making Algorithms, Machine Learning, Swarm Technology, CubeSat Mapping and Navigation, Deep-Space Exploration.

100: Atmospheric Thermal Sensing for Autonomous Unmanned Aerial Vehicle Navigation

Category

technology exploration

Primary Area

Software

Secondary Area

Computer

Organization

JHN Aerospace LLP - (No Website)

Background

The emergence of unmanned aerial vehicles (UAVs), combined with advances in machine vision and intelligent control has enabled a brand-new category of aerospace vehicles. These advanced aircraft are proving themselves extremely capable in a variety of applications including agricultural monitoring, infrastructure inspection, and search-and-rescue efforts during natural disasters. One of the major challenges (which we consider an opportunity) still facing UAV development, is the limited range of these vehicles in the sub-25 kg category. This project will focus on the design, development, and implementation of a novel method of extending the flight time of a fixed-wing UAV based on the concept of soaring. Soaring is a popular flight technique used by large gliders down to some large birds. JHN Aerospace is currently developing a soaring UAV and is providing an opportunity for students to have their input on the development of this aircraft from the ground up.

Canada has been a leader in the global aerospace industry for many decades. As a country we are at a turning point and are in need of diversification. Therefore, this is an opportunity for you to work on the development of a meaningful technology and an opportunity to contribute to the future of the Canadian aerospace industry. Ultimately by the end of this project, we want you, the students, to gain a strong sense of achievement and skill, and we want to foster your passion for aerospace technology. Given that we will be conducting this Capstone remotely, we want to assure you that this Capstone is feasible and achievable (please see the Special Considerations section below). We hope you will consider this exciting project.

Objectives

1. Determine the most suitable method of sensing the lower atmosphere for thermals (a mass of rising air that results from atmospheric convection) within a 10-25 km radius of a UAV.

2. Develop a real-time navigation system that autonomously senses the locations of these thermals and then plans the most energy-efficient path for a UAV to navigate to its destination, via the thermals.

Deliverables

1. The students would determine the most suitable method of sensing the lower atmosphere (troposphere) for thermals (masses of rising air resulting from atmospheric convection) within a 10-25 km radius. This could be delivered in the form of a feasibility study and would contain details of relevant literature, selected sensor(s), platform(s), and software architecture(s) to be used. When it comes to these selections, a trade-off analysis based on mass, power, cost, range, etc., would be required to support the teams' selections. We anticipate this to take about 1.5 months.
2. In addition to the first deliverable, the next deliverable would be to design a sensing platform based on deliverable 1, using off-the-shelf components. The students would be responsible to select the components within the project's budgetary constraints (see financial section). A suitable alternative may be required for demonstration purposes. We expect this to take about 2-3 months.
3. In parallel to deliverable 2, the third deliverable would be to design a path planning algorithm using input from the sensing platform. It is desirable if this can be implemented with an existing UAV autopilot system. Simulations in MATLAB, or another software, could be used to validate this approach. We expect this to take about 2-3 months.
4. The final deliverable is to provide validation for the sensing platform and path planning algorithm combined. This could be accomplished using simulations at a minimum, but if possible, a field test is highly desirable if it can be conducted safely (see Special Considerations section). There is potential that the sensing platform could be implemented onto a UAV, provided by the company. An onboard flight test would be an amazing opportunity for students to see their hard work in action.

While we have proposed some examples of how to achieve these deliverables, students are encouraged to investigate and pursue other ways of meeting them.

Contributions Organization is Able to Provide

We are willing to provide additional funds towards the project, to supplement the UBC ECE contribution, to support access to technology, information, or prototype production. The amounts will be approved on a case by case basis. We encourage the students to be creative throughout the project to keep the project cost within reason.

Additional Considerations

Due to the COVID-19 pandemic requiring this course to be taken remotely, we realize there may be inherent challenges. We see the worst-case scenario as a full university-wide closure if the number of cases begins increasing rapidly again. If this were to happen, this Capstone has the advantage of being completed almost entirely remotely through existing technology and resources. Programming/coding can be performed on one's personal computer and shared via

cloud sharing software (free). UBC provides MATLAB software to students at no charge. If the hardware testing phase is reached, and it is unsafe to meet in person, or students do not feel comfortable to do so, then we will ensure that the hardware can be tested in a live “virtual” format so all students can be involved. Furthermore, we will be available for regular communications through an appropriate software such as Skype, Zoom, Discord, etc.

Students that we think would enjoy this project and have a high probability for success would have:

- Developed or are developing strong programming skills in Python as well as MATLAB
- Any experience with UAVs (beginner to advanced)
- Not only technical knowledge but also creativity and an interest to solve problems
- The ability to visualize an idea in “real life”
- Desire to work with an early, flexible, start-up environment
- Interest in the aerospace technology sector

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Unmanned aerial vehicles, atmospheric sensing, path planning, decision-making, autonomous soaring, machine vision, machine learning. Remote Atmospheric Sensing, Unmanned Aerial Vehicles, Autonomous Navigation, Real-Time Autonomous Decision-Making Algorithms.

104: Reusable Mug Tracking and Exchange Solution for a Circular Sharing Program

Category

operational application

Primary Area

Mobile app

Secondary Area

Electrical (low voltage)

Organization

mugshare - <https://www.mugshare.ca>

Background

mugshare is a UBC student-founded social enterprise that tackles single-use coffee cup waste by providing a convenient reusable alternative through a deposit-return model. Under our current model, we prioritize accessibility and ease of use that does not require mugshare users to sign up in advance or download an app. Anyone can participate by simply borrowing a mug from a participating cafe by paying a refundable deposit, and then returning it whenever they like to any participating cafe that is most convenient. However, numerous aspects of the program could benefit greatly from better mug tracking data (e.g., to better manage inventory flow between cafes, to strategize cafe expansion, etc), as well as from technical software that enables easy, quick, contactless mug returns. We are very interested in collaborating with aspiring electrical and computer engineers that can think critically, creatively, and innovatively about the challenges and opportunities that this issue presents.

Objectives

To design, develop, and market test a contactless remote-drop off bin that enables customers to return mugshare mugs in a participating cafe without requiring baristas to handle used mugs and without the customer needing to wait in line. A key component would include conducting a feasibility analysis of different technological solutions that vary in sophistication vs. ease/accessibility of customer use (e.g., customer requires smartphone + personal app, RFID/QR-code tracked mugs that interact with drop-off bin but are not directly tied to individual users, built-in app that processes credit/debit transactions, photographic-recognition-activated bin). Additional necessary constraints to consider include: vandalism security, efficiency and cleanliness of mug/lid storage, likelihood and frequency of maintenance/repair.

Deliverables

A successful project would culminate in the delivery of an MVP solution and report that the

mugshare team could use to seek investment in order to implement a fully operational version across our full network. Core deliverables would most likely include four elements: 1) a feasibility assessment of which technical tools/infrastructure/software (e.g., RFID, QR codes, scanners, apps) can be implemented most seamlessly for cafe employees; 2) based on this assessment, a validated small-scale implementation of the chosen tracking solution tested with the mugshare team and select cafe partners (i.e., tech-enabled sample mugs produced, test tracking data provided in an accessible database, etc); 3) a user experience improvement tool (e.g., 'where nearest' app) that facilitates and encourages mug returns; and 4) a prototype of contactless return software that can successfully identify mugs and process refunds in a test-scale (e.g., 3D printed) drop-off bin.

In addition to these project components, we would like to further emphasize that we strongly encourage students to come to us with other ideas we may not have considered that could enhance the implementation and/or scalability of the mugshare program. As an early-stage local start-up, the outcomes of this project have the potential to significantly accelerate mugshare's growth within and beyond Vancouver, as well as meaningfully inform our long term strategy, and we welcome the contributions of interested and passionate ECE students.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

n/a

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

circular sharing model, sustainability, user experience enhancement, data tracking and analytics, engineered logistical solution. 3D printing.

105: LiDAR-assisted 3D modeling for AR-based installation guideline

Category

technology exploration

Primary Area

Digital Media

Secondary Area

Mobile app

Tertiary Area

Machine learning

Organization

TELUS - <https://www.telus.com/en/>

Background

Recently, the trend in industry is to replace all user's manuals, documentation, training and maintenance with Augmented Reality (AR) applications.

Other than the fact that manuals are far from an interesting read, attractive AR applications can easily and efficiently guide and train the user with the help of visually immersive experience, offering a much better understanding of what needs to be done.

In simple terms, AR provides direct access to information by overlaying virtual graphics and instructions on the real world, showing how to complete a task by identifying, for instance, how to use a specific knob on a device or connect a wire to a specific port. Such AR applications require 3D models of the overlaying objects, which are not always available. To address this issue, LiDAR scanning technology can be utilized. LiDAR scanners/sensors allow collecting depth data that can be used to create 3D models. Such 3D models are then integrated to AR-based installation guideline scenarios. A more advanced solution may involve a deep learning model that will identify a device using the camera feed and bring up automatically the 3D model of the device to be used by the application.

Objectives

There are two main objectives in this project:

1. Develop an algorithm that will use LiDAR information captured via a mobile device to generate an accurate 3D model of specific objects.
2. Train a deep learning model that can identify specific objects using the camera feed on a mobile device.

In the first phase of the project, the LiDAR information is collected via LiDAR sensor on a mobile device such as new iPadPro. The 3D models generated from LiDAR information are integrated to an existing AR application that in turn guides the users through an installation scenario. This is possible only if 3D CAD models are available. LiDAR based generated models will be used when 3D CAD models are not available.

In the second phase of the project, when the user points the camera of a mobile device (can be phone or tablet) to an object, the DL model should automatically identify the object and call the AR application to interactively guide the user through an installation scenario.

Deliverables

Phase 1: An algorithm that generates accurate 3D models of equipment in the format that is compatible with the existing AR applications.

Phase 2: A complete platform where a camera feed of a mobile device is used as input to a trained deep learning model in real time to identify specific equipment and then an AR-based installation scenario is "activated" based on the identified object.

IPad Pro with a LiDAR sensor and objects/devices will be provided.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

AR, AI, Deep Learning, LiDAR. .

106: LiDAR-assisted Wi-Fi heat map generation

Category

technology exploration

Primary Area

Mobile app

Secondary Area

Software

Tertiary Area

Digital Media

Organization

TELUS - <https://www.telus.com>

Background

The strength of Wi-Fi signal varies in an indoor environment. Given the present “work from home” situation, identifying remotely the strength of the signal around home is becoming important for occupants and a major concern for internet providers. There are existing applications that allow measuring the Wi-Fi signal by running an app in specific locations of the house. However, such information cannot be mapped easily to a 3D space. To facilitate this Virtual Reality (VR) can be used to overlay this information on a 3D model of the space. The latter may be generated via LiDAR data. LiDAR sensors are becoming widely available on mobile devices. LiDARs allow us to collect depth data that can be used to create 3D models of objects and our surroundings. Such a 3D space map that shows the strength of Wi-Fi coverage around each house will help internet providers improve the overall internet coverage.

Objectives

The objective of the project is to develop a complete platform that first allows the user to scan an indoor environment using a LiDAR sensor (of a mobile device such as iPadPro), generating a 3D model of the space and then a Wi-Fi signal measuring API will be employed to measure the signal strength around the house. The collected signal information will be automatically overlaid (e.g., as numbers and also in the form of heat map) on the 3D model

Deliverables

The team should develop a complete prototype that includes a LiDAR based 3D space generator which will be coupled with an algorithm that measures the strength of Wi-Fi in space and overlays that information in form of numbers and heat maps on the 3D space model. The application should be able to guide the end user in efficiently placing devices around the house.

LiDAR device will be available to the team.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

VR, AR, LiDAR. .

108: Automatic Road Deterioration Detection for Smart City Applications

Category

technology exploration

Primary Area

Digital Media

Secondary Area

Machine learning

Tertiary Area

Software

Organization

TELUS - <https://www.telus.com>

Background

Recently cameras are widely used by municipalities for different purposes such as road and weather conditions and identifying needs for road maintenance. Poor road conditions can result in major repair costs for public transportation and other drivers and even be the cause of accidents. Video camera and LiDAR sensor information may be used to detect puddles on the road at an early stage and that way avoid major costs and incidents. LiDAR sensors help to collect depth data of objects or surroundings, which combined with video data can give an accurate visual representation of the scene.

The proposed Road Detection project is part of a large-scale project in the area of smart-cities.

Objectives

Develop an automatic Deep Learning model to identify puddles on street using LiDAR and camera information. Data will be provided.

Deliverables

A complete software package which includes a trained Deep Learning model which uses live camera and LiDAR feed to identify puddles on the street.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Smart City, LiDAR, Deep Learning, Object Recognition. .

110: Monitoring and Optimizing Game Development With Ubiquitous Telemetry

Category

operational application

Primary Area

Software

Secondary Area

Computer

Organization

Blackbird Interactive - <https://blackbirdinteractive.com>

Background

Game development is a complex process involving the collaboration of many people from different disciplines to build sophisticated software and rich content that come together in compelling interactive experiences for players. Long project timelines and large teams make this an expensive process, and the more we can do to improve team effectiveness and efficiency the better.

As with CPU performance optimization, it is vital to measure the process, make incremental changes, and track progress over time. This project will explore the measurement and analysis of a variety of characteristic metrics of the game development process. By measuring and reporting on the process, we expect that trends will emerge and opportunities for improvement will become clear.

Objectives

This project aims to provide technical, creative and business leaders with insights into the development process that will enable targeted changes to achieve measurable improvements in team effectiveness and efficiency. The project will create an extensible framework for gathering telemetry from a variety of disparate data sources, including automated build processes, individual developer workflows, project management tools, revision control systems, and company directories.

The Capstone team will work with Blackbird developers to identify specific sources of measurement data and select metrics of interest, such as build time, load time, frame rate, iterations per day, changes per week, etc. The team will research alternative methods of data extraction and storage, as well as reporting frameworks that provide complex queries and rich visualization of the data. Working with data provided by Blackbird, the Capstone team will create a proof of concept framework that gives meaningful insights into development efficiency and can

be extended and improved in the future with additional metrics and new reports.

Deliverables

The successful project will deliver a functional and extensible framework for extracting, storing, and reporting on a wide variety of game development metrics. The framework will include specific data extractors for data sources agreed to by Blackbird and the team during requirements gathering, and be extensible so that additional data sources can be added in the future. The framework will create and update a data store that is compatible with an existing reporting framework such as Tableau or the Elastic Stack. Specific useful reports will be identified during requirements gathering and implemented as part of the project, but the reporting process should also be open and extensible. Reports must be able to show not just data from a moment in time, but also to report on trends over time.

The framework should be cloud-hosted on Azure in Linux. Blackbird will provide access to required Azure resources. Some data extractors can also run in the cloud, provided the data is accessible; others will need to run inside the Blackbird corporate network or on the Windows workstations of game developers.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Telemetry, game development, process optimization. Telemetry, game development, process optimization.

111: Volleyball Velocity and Ball Flight Path Tracking

Category

technology exploration

Primary Area

Software

Secondary Area

Digital Media

Organization

UBC Thunderbirds Men's Volleyball - <https://gothunderbirds.ca/sports/mens-volleyball>

Background

This is a follow-up from a current capstone project where we are looking to automate the process of collecting velocity and ball flight path data for the UBC Men's Volleyball team. This is done using a fixed-camera system to collect the velocities and flight path (objective data) and we have aspirations that through the collection of a significant amount of data over time, we can begin to automate the tracking of subjective information such as serve and serve reception quality.

Objectives

The objective for this project is to continue the work of our current Capstone group to automate data collection through the use of fixed-camera video and computer learning. Additionally, we want to continue building out the app that has been successfully designed by our Capstone group that enables our coaching staff and student-athletes to have immediate analysis of serve velocities and pass outcomes, leading to our predictive measures of success. This platform is currently being registered and will be in use immediately upon the start of our season at the beginning of September

Deliverables

Main deliverables will be computer learning to automate our data collection through our fixed-camera system and the further development of our app. The app will also house all of our custom data from the objective (and hopefully subjective) information we are able to collect.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Computer Learning, AI, Sports Analytics, App Development, Software Development, Ball Tracking.
Sport advantage analysis.

113: Automated Camera Switching in Hockey Broadcasting using Deep Learning

Category

technology exploration

Primary Area

Digital Media

Secondary Area

Machine learning

Tertiary Area

Software

Organization

TELUS Communications - <https://www.telus.com>

Background

Sports broadcasting utilizes multiple cameras which are installed in various positions, capturing different viewpoints. Choosing which view to be shown is done at the switchboard/editing station and it depends on several parameters, usually decided by importance to human viewers. Although this is the norm for professional games, in the case of regional, amateur community games the cost is prohibitive to allow the use of a switchboard and a team of experts. Although such games are broadcast around the country by communication providers, there is a need for improved coverage which will attract more viewers and in turn increase the support of young athletes and local communities. A solution may be based on a deep learning model which is trained to identify importance of a scene and through some logic/algorithm determine which view is important given some criteria, thus switching between cameras without the intervention of humans.

Objectives

The main objective is to first develop a system that uses a deep learning model to recognize players, goal net and puck for the case of hockey and then utilize an algorithm that depends on some criteria that lead to which camera view is more important and switches cameras accordingly.

Data for training and validation will be provided. More data will be needed to be collected from online public sources.

Deliverables

The team should train a deep learning model which will accurately recognize players, puck and

goal net. An algorithm should be developed that will determine which view is visually more important to viewers and decide to switch cameras for a specified duration. The entire system should be integrated and demoed on unknown data.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

AI, Deep Learning, Object Recognition, Multiview. .

114: Automated AI Photogrammetry Apparatus

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Digital Media

Tertiary Area

Computer

Organization

UBC Studios - <https://ubcstudios.ubc.ca>

Background

Photogrammetry is the process of combining dozens or hundreds of photos taken with cameras to form precise 3d models for education and training. Currently as part of a pilot project, we have built a high end photogrammetry rig featuring multiple DSLR cameras, hubs to power the system with custom hardware and software included to control the setup. However there are still quite a few manual adjustments that have to be made with many improvements to the current rendition that can be done. As our next phase, we are planning to move on to a more automated system that can adjust and handle different types of captures more easily and effectively.

Objectives

The goal of this project is to build an automated apparatus that will be able to precisely capture the object using machine learning or sensory data. This will be further enhanced by also building robotic solutions for moving the cameras, positioning of the rig and adjustments of a few physical features of the camera itself like zooming and adjusting focus. The end goal would be that users that need a 3d capture of a project only need to press a few buttons to start the process with the rest of the capturing and transferring of data to be automated and streamlined.

Deliverables

The main deliverables of this project are mostly hardware. We will need to build/procure camera control solutions such as robotic arms for moving the cameras in closer, a focus apparatus to adjust focus, a remote controlled pan and tilt system and a stable wheeled vehicle for the rig to move around the object. The project doesn't have to encompass all the above if there are too many components, this can be further discussed with the team at the start of the project. Lastly

a software to control and monitor the different parts of the system will be needed.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

PCB Manufacturing and knowledge of how software and camera parts work together a plus. Experience in robotics, mechatronics or software programming would also be helpful in this project.

Due to the current COVID - 19 pandemic, work will be primarily done from home. Gear and equipment can be picked up from UBC Studios, or if needed shipped/delivered to a project team members home/area. Final assembly if possible can be done at UBC Studios with social distancing adhered by project team members- however if not possible, UBC Studios personnel can pick up the final gear and software, and put it together through guidance over online communication.

A robust contingency and project fund will be provided to cover additional costs of equipment needed that goes over the amount set by Capstone ECE. UBC Studios also has equipment available from the current project including - a professional grade 3d printer, a variety of camera equipment and software as well as access to technical experts in both camera systems and prototyping and building.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

innovation, media, digital, AI, Robotics, Digital Media. .

116: IoT Enabled Smart Inventory for small and medium sized retailers

Category

technology exploration

Primary Area

Electrical (low voltage)

Secondary Area

Software

Tertiary Area

Web app

Organization

TechPOS International Corp - <http://techpos.ca/>

Background

Small and medium sized (SM) retailers need a mixture of personnel and technology to be able to compete with online stores and big box retailer. The technology needs to automate common processes, integrate popular systems. With these in place the technology can partially monitor and manage the store. All these are possible with the help of cloud and IoT. Currently at TechPOS we are achieving this with the use of cloud technologies. To further help SM retailers IoT is key. One of the areas is to know exactly how much inventory is available using IoT and connect that to rest of TechPOS ecosystem.

Objectives

Container with embedded pressure/weight sensor that reads the total weight of the products at any given time. The container publishes their weight/pressure changes to internet.

A system where multiple containers are handled. Containers can join or leave the system. The system needs to know when a container's sensor is faulty and not responding.

The system must attach the containers to different products.

Based on the product configured for a specific container, the system should be able to estimate number of products currently stored in the container and detect if a product is added/removed. TechPOS products should be able to configure containers through system's api (attach containers to products). TechPOS products interact with the system to read current number of products in a specific container.

Any addition or deduction of products should be logged.

For all of the above cost has to be considered for the final product. A SM retailer doesn't have the budget to spend on costly technologies.

Deliverables

Identifying ideal design and implementation of a system/app that handles and configures the containers (With cost in consideration)

Identifying ideal mechanisms for TechPOS ecosystem to talk to the sensors. Cost for the final product is a factor (With cost in consideration)

A fully functional prototype (container with embedded sensor and transmission) (With cost in consideration)

Documentation sufficient to allow our company to evolve the design and refine the device.

Contributions Organization is Able to Provide

Support for engineering processes. (PCB manufacturing, software licences, fabrication tools)

Additional Considerations

This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

iot, retail, cloud. IoT, sensors, webapp, inventory management.

117: Capturing and Synthesizing UBC's Tree Inventory for Biodiversity Enhancement

Category

Combination of technology exploration and new product development

Primary Area

Computer

Secondary Area

Software

Organization

SEEDS Sustainability Program/UBC Campus and Community Planning -
<https://sustain.ubc.ca/teaching-applied-learning/seeds-sustainability-program>

Background

UBC Vancouver has begun to build an updated campus tree inventory that accurately represents the campus urban forest and related natural assets, such as shrubs. An updated natural asset inventory is critical in order to consider the broader campus urban forest and associated suite of socio-ecological benefits to inform future land use decision-making and development. There is an immediate need to update and build an accurate campus tree inventory. Given the size of the campus, various areas have been prioritized for updating the tree inventory. Leveraging emerging technologies will help to expedite the inventory process, and integrating existing data will aid in contributing to the accuracy and completeness of the tree inventory.

This inventory is especially important because it will be used to inform upcoming policy and plan updates on the Vancouver campus. Plans slotted for updates include: Climate Action Plan 2030, Public Realm Plan and Vancouver Campus Plan.

Objectives

- To conduct background research on emerging technologies that can enable fast tree and vegetation biodiversity inventorying and monitoring (ex. existing LiDAR data, orthophoto imagery, or new methods such as using drones to collect aerial images)
- To pilot the data capture process by actually using new technologies and datasets to build a 2020 tree inventory
- To produce a platform where data can be aggregated and accessed

Deliverables

Natural Asset Inventory for UBC Campus (either partial or complete, depending on how the project goes)

Protocol or Methodology for producing the inventory
Online Platform for accessing and communicating the Inventory
Executive Summary + Report (to be uploaded on the SEEDS Library)
Presentation for clients, faculty, and other campus stakeholders

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

N/A

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

urban forest, biodiversity, drones, lidar, campus, inventory. .

119: Precision electron microscopic imaging to accelerate COVID-19 drug discovery

Category

improve an existing product

Primary Area

Machine learning

Secondary Area

Software

Tertiary Area

Biomedical

Organization

UBC - <http://electron.med.ubc.ca>

Background

Cryo-electron microscopy (cryo-EM) is a revolutionary new technology that has enabled us to image protein structures at atomic resolution. The dramatic advances in the field were recognized with the award of the Nobel prize in 2017 to three scientists who laid the foundation for the field over two decades ago. The high-level workflow includes obtaining images of fields of randomly dispersed proteins and viruses in an electron microscope, followed by extracting relevant molecular images and constructing 3D models of the proteins. The capstone project focuses on the use of deep learning models to steer the automated selection of the most relevant regions of the molecular images to achieve the highest quality of protein structures in the shortest possible time. Once developed, these methods will be relevant not just for COVID-19 therapeutics but will be broadly applicable to design better drugs for diseases such as cancer.

Electron microscopic images are collected from frozen protein molecules that are arrayed on a patterned copper grid with an array of grid squares. In turn, each grid square contains an array of "holes". The raw images that emerge from the microscope are from proteins distributed in these holes. Present day methods for data collection involve a series of manual steps by a trained operator who makes decisions such as selection of the optimal dimensions of the grid squares, optimal dimensions of the holes, the specific features associated with the distribution of proteins in the holes and many other such parameters that ultimately influence the quality of the recorded images. Because we have a rich data base of protein structures that span a range of qualities that can be mapped back to decisions made during data collection, we expect to establish predictive models that can automate and optimize selection of the most useful regions on the copper grid for data collection. We envision that these tools will be immediately applicable to our goals of accelerating determination of S-protein structures in complex with

various drugs that can be used for treatment of COVID-19, and more generally for cancer drug discovery applications.

Objectives

The main objective of this project is to apply deep learning techniques and design robust methods to classify, score, and optimize how data is collected in electron microscopes in order to obtain the highest resolution structures in the shortest possible time.

Each protein grid has thousands of regions from which images can be obtained. Instead of an expert user selecting regions manually, we seek to work with an energetic team of students that can help us to develop automated tools using deep learning that can achieve similar or better outcomes.

- Develop image classification model or leverage state-of-the-art architectures (Resnet, VGG, Inception) to determine whether or not particular sets of images will result in high quality data
- Develop training procedure for models using deep learning frameworks such as Tensorflow or Pytorch
- Evaluate and report the performance of the deep learning model on a representative test set

Deliverables

- Assess performance of different image classification models
- Train chosen model on dataset and report various performance metrics
- Develop scripts that enable users to use the trained model to classify new data

Contributions Organization is Able to Provide

access to our in-house GPU network will be provided

Additional Considerations

novel extension of successful Capstone project from last year .
This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

AI, precision electron microscopy, COVID-19. AI, precision electron microscopy, COVID-19
Deep learning.

120: An Apple Watch app for clinical trial follow-up in congenital heart disease patients

Category

new product development

Primary Area

software

Secondary Area

Mobile app

Organization

Vancouver Stroke Program - <https://www.vancouverstrokeprogram.com/>

Background

Clinical trials change patient care. Usually studies involve patients coming in-person for visits but this is resource intensive and now, with physical distancing measures, even more challenging. Monitoring of study patients with wearables may make research easier and more efficient.

Objectives

We want to make an Apple Watch app that monitors patients every three months using a quick yes/no questionnaire and the ability to send free-text feedback for NLP processing for sentiment analysis and human study coordinator oversight. There are opportunities to expand monitoring capabilities of the app through signal processing of heart rhythm and physical activity. In addition to regular batch response input there will also be rapid alerts sent to the study coordinator.

There will need to be a special emphasis on usability embedded in the design and validation of the watch app.

Deliverables

Apple watch app

Contributions Organization is Able to Provide

Education - can see the clinical environment to gain context - plus funds if needed

Additional Considerations

patient confidentiality - Canadian server needed

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

App, healthcare. apple watch, client server.

121: Control hub for modern food production

Category

new product development

Primary Area

Electrical (low voltage)

Secondary Area

Computer

Tertiary Area

Software

Organization

SEEDS Sustainability Program/UBC Campus and Community Planning -
<https://sustain.ubc.ca/teaching-applied-learning/seeds-sustainability-program>

Background

Make a difference in food security and sustainability through your Capstone project. The rate of food insecurity among undergraduate students at UBC is similar to that observed on other campuses across the country at approximately 40.5%. The recently formed UBC Food Security Initiative's goal is to build capacity for community food security, including developing a physical food hub. Aquaponic and hydroponic systems are unique means to address food insecurity by increasing production in urban settings: hydroponic systems allow for growing plants with limited resources as they require added nutrients but do not rely on soil. Aquaponic systems utilize the waste produced by fish to provide nutrients, which in turn can feed into hydroponic systems. A remote control and monitoring system is an integral management component of Aquaponics and Hydroponic grow systems. Such a system can make a clear impact on the quality and amount of food that can be grown in small spaces. These grow systems can be distributed around our campus in many indoor and outdoor spaces, utilizing already existing infrastructure. Food can be grown right on campus, reducing the carbon footprint and food insecurities when distributed to members of our community who are in need of support.

The proposed control hub project is an important part of these grow systems and will greatly increase the maintainability and manageability. This project would directly tie in with two Co-op summer projects where student teams studied and designed aquaponics grow systems. All the design work from these teams will be available to you. Furthermore, a Capstone project was approved at UBCO which will provide a physical installation on which your control system can be tested over a distance. An industry partner, JustAquaponics, will also be joining the project team in an advisory role.

Objectives

- Research the availability of secure IoT hubs to monitor a potentially high number of food growing installations on campus.
- Scope for technical requirements, scalability, cost, availability, reliability and maintenance among available choices.
- Scope network requirements and security issues for implementation at UBC.
- Create a demonstration unit that is hooked up to physical hydroponics units as proof of concept.
- Add a low-cost unit-specific monitoring system for critical alerts.
- Additional objectives can be outlined based on the team's capabilities – extra challenges may be added if there is interest from the team.

Deliverables

Critical Milestones
Executive Summary
Report
Presentation
Working demonstration of IoT hub
Data flow diagrams
Logic diagrams
Component lists

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

None

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Food production, monitoring, aquaponics, hydroponics. .

122: Game Narrative Database and Workflow Tool

Category

new product development

Primary Area

Software

Secondary Area

Computer

Organization

Blackbird Interactive - <http://www.blackbirdinteractive.com/>

Background

Narrative and dialog development for video games is a long, complex, and costly process with complicated interactions between several departments and external facilities like recording studios, and the work involved can very easily be derailed by an insufficient toolset and pipeline.

Each development phase, from mission and systems design, to writing and iteration, to recording and localization, has unique requirements for viewing and working with the same overall dataset. Our current toolset does not allow for developers in each phase to use the tools in a way that is optimal for their work, which in turn slows development and stifles creativity.

Objectives

The goal of this project is to provide BBI with a database and interaction tool that will serve as the foundation for the narrative development of all Blackbird games going forward.

As each game has its own design and set of requirements for dialog, we would like to start by building a solid, project-agnostic toolset which covers the basic set of functionality that all teams need. The toolset should also be developed in an expandable way that allows for teams to customize the tracked data types, view and export types, etc.

What we are looking for is a solid technological base which allows us to Import a standardized set of data in a variety of formats, with the ability to add and update entries. We will need to:

- * Store the data securely in a version controlled and centralized repository.
- * View, filter, and edit the data in a performant front end tool.
- * Export filtered sets of data in a variety of formats, for a variety of use cases.

Deliverables

* An analysis of user requirements, by department - a good understanding of the data flow and different users' interactions with it will be critical to the success of the toolkit.

* A prototype version of the toolkit. It need not be fully feature complete as we expect the toolkit to evolve over time, but at least demonstrate the ability to view, import and export data in a variety of formats depending on the user role, as well as a relatively complete implementation of the framework for supporting various user roles, import and export formats, and communication between front-end and the back-end storage.

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

games, video games, narrative, frontend development, backend development. games, video games, narrative, frontend development, backend development.

124: Log Image Classification

Category

technology exploration

Primary Area

Machine learning

Secondary Area

Software

Organization

FPIInnovations - <https://web.fpinnovations.ca/>

Background

One of the first steps in manufacturing wood products is taking the bark off raw logs (a process called debarking). Logs have complex properties that depend on the species and growing conditions of the originating trees. During manufacturing, log geometry is scanned to allow automated process control. In the past operators used their knowledge of log properties and appearance of debarked logs to adjust processing equipment to optimize debarking. This is not possible for high speed operations. Without an automated feedback method to detect debarking defects, the debarking process can not be improved. Traditional image processing methods have not been successful in identifying these defects, but Convolutional Neural Networks (CNN) and open source platforms such as TensorFlow have been a game changer in developing image classification systems to mimic human skills and surpass human performance and speed. These methods have been successfully applied to lumber defect detection (grading). However, logs are considerably more complex. To assess the potential of using CNN for debarked log defect detection, defects with varying levels of identification difficulty are chosen for testing. Since training samples must be classified manually, only a limited number of images can be used for training the CNN algorithms, which means simple defects are more likely to be detectable.

Objectives

The main objective of this project is to determine if CNN, or another learning algorithm can be used to detect any of the common defects in debarked logs using an existing set of manually classified images of processed logs.

Another objective is to determine if cropping the images to isolate the log image from the conveyor background improves the success rate or reduces the number of training samples required.

Deliverables

- 1- Software source code (preferably in Python) implementing a CNN or another learning algorithm trained to detect a set of debarked log defects. List of defects and log images classified according to existing manual criteria for defect detection will be provided.
- 2- Image processing source code to crop log images or perform pre-processing to improve processing and defect detection, with the CNN algorithm.
- 3- Documentation to explain the results of the defect detection, function of the provided code, and allow maintenance and future extension to the code.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Understanding of software development, image processing, and statistical methods is needed for this project.

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

Image processing, deep learning, artificial intelligence. Neural Network.

125: Knowledge Translation Portal – KTP

Category

new product development

Primary Area

Web app / information system / data services

Secondary Area

visualization

Tertiary Area

digital media

Organization

Fisheries Economics Research Unit - <https://feru.oceans.ubc.ca>

Background

There is a rising interest from the increasingly informed general public about the research being done across the world's universities, particularly in areas crucial to the survival of our planet; namely climate change and food security. However, there is limited accessibility to this research; scientific information that might be publically accessible is often difficult to find and understand without proper background knowledge. To bridge this gap between the non-experts and academic information, we propose a public information access portal that leverages a set of information visualization and knowledge translation (KT) techniques. At present, we have a medium-fidelity prototype with the goal of facilitating citizen engagement with the Fisheries Economics Research Unit, although the model could be applied to any research project.

Utilizing datasets published to repositories such as Data Dryad, Dataverse, and others, data should be extrapolated by DOI and presented in a simplified way for the user, although still providing access to all data sets, metadata and so on for advanced users. Additional fields for layman's terms, media coverage (links to external articles), impact (social/citation) data, media entries (embedded videos or photo galleries) should be provided.

Objectives

KTP will be a research data Knowledge Translation & Mobilization tool, allowing the public an easy-to-use, direct access to all of a project's research data (unless the data is protected/restricted) by connecting to the data repositories used by the project, the paper itself if available, as well as simplified/condensed versions of the papers' findings – presented by the paper's author or by other individuals in the space.

The project will comprise of two parts. A back end will collate information on each research paper, organized by DOI. Additionally, it should support:

- Integration of multiple data sets;
- The metadata associated with each DOI will come from a range of sources, including:
 - Direct/manual metadata entered by the author or submitter.
 - Repositories such as Dataverse, Dryad, Github, etc
 - Journals
 - Metrics – Social, Citations, etc
- Information will undergo checks & validation
- Data will be extracted from these sources, cleaned, and cached.
- User login
- Database & project structure created in such a way as to allow for continued development and expansion of system capability.

The front-end will display:

- All data associated with each item in a simple to use interface.
- Topics arranged by key words.
- Search function
- Author detail
- Visualization/infoviz elements; graphs, charts, creative/interactive elements.
- Mapping functions
 - For individual items, the area(s) affected by the study, plus access to any simple geospatial data supplied by the project (geojson, kml, etc)
 - The primary interface will have a map displaying articles based on a range of filters (weight, date, etc), and the primary list of articles will show only items from within the bounds of the map.
 - The map can be broken down for ease of use, filtered by keywords, country, etc
- Data submission
 - All elements should be submissible by the user.
 - A simple login system with verification should be included.
- There should be some method of moderating a user's input (version based?)

This project supports the development of the team's critical software engineering skills needed for successful full stack development. The engineering challenge involves applying a user centred design approach with an agile development cycle to create a high fidelity user experience that matches the needs of all users of the application. The KTP project will be a framework for an application designed for processing metadata.

Likely solution: Progressive Web App via Vue/React, Nodejs, Websocket for real-time communication between app and server, Leaflet or MapBox as a base library for web mapping views and MongoDB to store data, and caching of external data sources. JavaScript visualization library (D3.js or similar) for infovis elements. Additionally, there will be a variety of low and medium fidelity prototyping tools for front end development.

Participation in this Capstone project offers a unique experience that will expand your software engineering skills while providing an outcome that will differentiate your engineering expertise from others preparing you for the job market. Your group will also be making a large contribution to improving the general public's understanding of complex research topics with far-reaching applications far beyond the initial scope of the project.

Deliverables

1. Web app with backend database integration; including automated unit test and system test.
2. Web interface to display content to the end user;
 - a. Web interface to insert, update, and manage items in database.
3. User evaluations:
 - a. Usability studies for app including low-fidelity and high-fidelity prototype evaluation on end user groups;
 - b. Usability study on content providers (researchers and citizens) using web interface design. Expected usability reports to be used for user-centered design iterations of front facing components.
4. As we are using user centered design process; we expect this project will have 3 cycles of design-prototype-evaluate deliverables. The final prototype will be used for production of the final product (i.e. deliverables 1 and 2).

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

None

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Web App, Database, Software App, Media. Information portal.

126: Design of an Ultrasound-Augmented Spinal Surgery Drill

Category

new product development

Primary Area

Biomedical

Secondary Area

Electrical (low voltage)

Tertiary Area

Computer

Organization

UBC - Centre for Hip Health and Mobility - Surgical Technologies Lab - <http://stl.mech.ubc.ca/>

Background

Placing of pedicle screws during spinal surgery is an important component of reconstruction of spinal stability after a wide variety of procedures. Nonetheless, this aspect of the procedure presents several risks. Lateral deviation can cause significant bleeding, medial deviation can cause paralysis, and poor fixation can result in destabilization of the spinal fusion. Nonetheless, there is an outstanding need for an accessible, effective and efficient navigation system for placing these screws.

Traditional approaches have focused on either anatomic landmarks or real-time fluoroscopy however both of these result in high error rates. More modern techniques include O-arm stereotactics (intraoperative low-res CT) and robotic solutions. However, these newer approaches are often cost-prohibitive for smaller centers, inappropriate for certain patient populations (such as young scoliosis patients), and still result in imperfect placement.

Our team is proposing augmenting the traditional freehand spinal drill with built-in ultrasound. This would leverage a technology at UBC called poly-CMUT (Polymer-based Capacitive Micromachined Ultrasonic Transducers) which allows for the form-factor and low manufacturing costs required to build the ultrasound array into a guidance cannula. Computer simulations have validated that distance estimations from these ultrasound arrays can be used to accurately estimate the 3D position and orientation of the drill relative to the spine. We believe that this tool would allow for accessible, accurate and affordable percutaneous pedicle screw insertion.

Objectives

A preliminary design of the tool has been proposed, but our team is looking for support in further developing the design so as to address certain technical limitations. The primary deliverable is to propose the guidance canula design so as to allow for the space of both the ultrasound transducers and their necessary wiring. Further, the design would need to keep the transducers insulated from the aqueous environment within which the surgery surgeries will take place. However, any protective insulation cannot overly inhibit the accuracy of the ultrasound distance estimation. The team would also need to work on hardwiring the transducers into a computer processor. Finally, the team would propose a basic signal processing framework of the ultrasound A-mode data acquisition. They will need to use the signal from their hardwiring and make an estimation of the distance measurement of the nearest bone surface.

Deliverables

- Spatial constraint design of the guidance canula for both the transducers and relevant wiring
- Insulation of the electrical system from the aqueous environment
- Hardwiring the transducers to a computer processing unit (Verasonics custom DAQ)
- Signal processing to both estimate the nearest bone surface distance measurement

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Primary Supervisor is Dr. Antony Hodgson (Distinct from the technical contact above)

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

Ultrasound, Surgical Navigation, Hardware Design. .

127: High-Efficiency Smart Lithium Charger using Gallium Nitride (GaN) technology

Category

integrating new technology, developing new product, research, design, and prototype

Primary Area

Electrical (low voltage)

Secondary Area

Computer

Organization

GluxKind Technologies - <https://gluxkind.com/>

Background

As more powerful electric devices and machines enter our world, the need for faster, smaller, and more efficient charging become increasingly significant (think phone charging, car charging, etc.). Gallium Nitride based switching technologies are emerging in power electronics applications. GaN has larger bandgap, higher electron mobility, along with other characteristics that allow for more compact and higher efficiency circuit design. This project will be to develop and prototype a fully functioning smart lithium battery charger using GaN technology, as well as, implementing an easy to use interface to operate and monitor the charger. The charger will be designed for use to charge a medium size battery pack, that powers a robotic vehicle system.

Objectives

- this project focuses on electrical circuit board design, power electronics modeling, simulation, as well as computer engineering design, firmware, UI, microcontrollers, embedded. this project's lab work/in-person testing is dependent on covid-19 updates and NOT required at all
- a charging circuit using GaN fets, that plugs into the wall socket outlet as input at 120VAC and outputs a user programmable current controlled/voltage controlled variable DC up to 60VDC
- full charger system efficiency is above 90% with a charging rate of greater than 500W+
- wireless connectivity to operate and use the charger, including the software program/app on either android, ios, webapp, windows, or mac os (to tell the charger what to do)
- a graphical user interface for monitoring the smart charger's state, displaying real time data such as voltage, current, and energy (to tell the user what the charger is doing)

Deliverables

- a fully functional hardware prototype demonstrating 3 safe and complete charging cycles consecutively
- a fully functional software/app demonstrated on a wireless enabled device (phone, laptop,

tablet, etc.)

- documentation of both hardware and software including design files and source code

Contributions Organization is Able to Provide

Financial support based on project needs and following organization's approval.

Additional Considerations

have background in power electronics design, circuit board design, app/software development, coding microcontrollers. we are a startup in Vancouver, BC and we move fast, please consider the time zone for mentorship and collaboration with our engineers

Project is Proprietary?

Yes, IP and NDA agreements are required for this project.

Key Words

computer engineering, electrical engineering, research, modeling, design, simulation. power electronics, GaN devices, PCB design.

128: Software for detection of cancer cells in pathology images using smart phones

Category

technology exploration

Primary Area

Machine learning

Secondary Area

Software

Tertiary Area

Biomedical

Organization

BC Ovarian Cancer Research Program (OVCARE)/Vancouver Coastal Health Research Institute - <https://www.aimlab.ca>

Background

Visual microscopic study of diseased tissue by pathologists has been an important tool in cancer diagnosis and prognostication for more than a century. With the recent advent of high-throughput automated slide scanners, the field of digital pathology has exploded; making it one of the areas in medicine that can be revolutionized by employing image processing and machine learning techniques. Remote and under-served communities do not have access to expensive slide scanners and this delays diagnosis of critical cancer patients. In this project, we develop a software that enables healthcare workers with little knowledge in pathology to scan a slide by mounting a smart phone on the microscope and guides them to the diagnostically relevant parts of the slide. The acquired images will be sent to a specialist pathologist in a remote site.

Objectives

Our goal is to build a software for smart phone mounted on an optical microscope that guides the user to the areas in a slide containing cancer cells. Below is the breakdown of the tasks:

- (1) The platform will take as input, the images of the tissue as well as the areas of the image that contain tumor cells. The images will be preprocessed (e.g., cleanup, de-noising)
- (2) The images will be sent to a server where another software stitches them together.
- (3) We provide a pre-trained machine learning model to the students. This model is used in the server to find areas in the slide with cancer cells.
- (4) Cancer areas in the slide will be beamed back to the smart phone and get highlighted.

- (5) User acquire images with higher magnification from the cancer areas.
- (6) For each cancer area images of low and high magnification, are stored with preserving the hierarchy and sent to the remote server.

Note 1: the platform will be prototyped/tested on ovarian cancer data (to be provided by the organization)

Note 2: the organization will provide a pre-trained deep learning model for finding the cancer cells.

Note 3: we recommend this project to groups that have excellent programming skills in Python. Familiarity with machine learning/deep learning is an asset. Experience with Docker/Singularity and source version control (e.g., Git) is recommended.

Note 4: Students who are interested in learning the deep learning model, provided they finish other tasks advance in time, are given opportunity to explore that area as well.

Deliverables

A fully functional prototype. The level of testing and functionality should be sufficient to allow beta testing with a group of users. Documentation sufficient to allow our organization to evolve the design and refine the platform.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

This project is a repeat or continuation of a past capstone project.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

software, smart phone, image processing, Python, machine learning. software, smart phone, image processing, Python, machine learning.

134: AURORA Intelligent Transportation Connectivity System

Category

operational application

Primary Area

Software

Secondary Area

Computer

Organization

UBC Radio Science Laab - <http://rsl.ece.ubc.ca/>

Background

The emergence of 5G wireless has finally provided the means required to move data across intelligent transportation systems in an effective and efficient manner. Microsoft and Ericsson have recently developed important software platforms required to gather and process such data, but demonstrations of the efficacy of systems based upon these platforms are still relatively rare.

UBC, Transport Canada, the BC Ministry of Transportation and Infrastructure, Ericsson, Microsoft and Rogers Communications, together with several startups, are supporting a campus wide effort to demonstrate the ways in which 5G Wireless can enhance urban mobility. This project will fill in an important gap by demonstrating how Microsoft's Azure and Connected Vehicle Platform (MCVP) can be used as the basis for the AURORA Intelligent Transportation Connectivity Platform.

MCVP 2.0 will be released in September 2020. Students pursuing this project will be among the first to use it. Access to MCVP is generally restricted to Microsoft partners. This project provides students with rare opportunity to work with such a cutting edge technology.

Objectives

The project will supporting a campus wide effort to demonstrate the ways in which 5G Wireless can enhance urban mobility by developing a data gathering and processing system based upon Microsoft Azure and the Microsoft Connected Vehicle Platform.

Deliverables

The main deliverable will be a software system based on Azure and MCVP that supports the gathering, processing, and display of transportation data across the UBC campus and several

research projects.

Contributions Organization is Able to Provide

Access to technology and / or information supporting the project. (special equipment, data, test facilities)

Additional Considerations

Ideally, students will have had previous exposure to cloud computing and MS Azure.

Project is Proprietary?

No, IP or NDA agreements are not required for this project

Key Words

IoT, cloud, Azure, MCVP, connected vehicle, intelligent transportation. IoT, cloud, Azure, MCVP, connected vehicle, intelligent transportation.