Raymond Yu

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PROJECT PORTFOLIO

Unmanned Aircraft Systems Student Design Team

- Automatic Antenna Tracking Station
- Drone Canopy
- Augmented Reality CAD Viewer
- Vortex Generators

Other Projects

Travel Planning Map

Induction Charging System

Virtual Reality Submarine Game

Remote Controlled Fireboat

Solid-fuel Hobby Rocket

CAD Helicopter Main Rotor System

Future Projects

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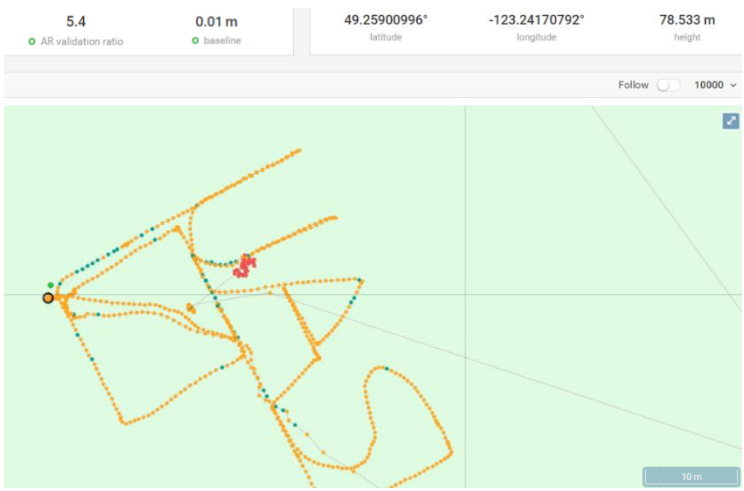
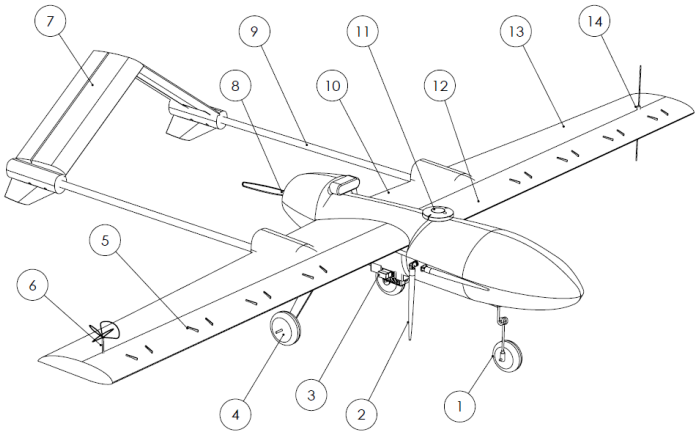
Unmanned Aircraft Systems Student Design Team





1 NOSE GEAR
2 TELEMETRY ANTENNA
3 GIMBAL AND CAMERA
4 MAIN LANDING GEAR
5 VORTEX GENERATOR
6 DATALINK ANTENNA
7 INVERTED V-TAIL
8 MOTOR AND PROPELLER
9 CARBON FIBER TAILBOOM
10 FLAPS
11 GPS UNIT
12 LEADING EDGE SLAT
13 AILERON
14 RADIO CONTROL ANTENNA

On UBC UAS, I developed innovative unmanned aircraft and their support systems, such as 2m wide heavy-lift quadcopters and antenna tracking stations, while incorporating new technologies like centimeter-accurate RTK GNSS and augmented reality prototyping tools. My passion for aerospace led me to become a project manager and then the captain of the entire group of 35 students; I led the team to a podium finish at a national competition for the first time in the team's history.

I also spearheaded development efforts of a multi-mission UAV technology demonstrator to explore VTOL technologies, by modifying the airframe and performing aerodynamics and load analyses in wind tunnels and simulations. This aircraft created a foundation for future UAS projects, inspiring growth and innovation.

The team website can be viewed here.

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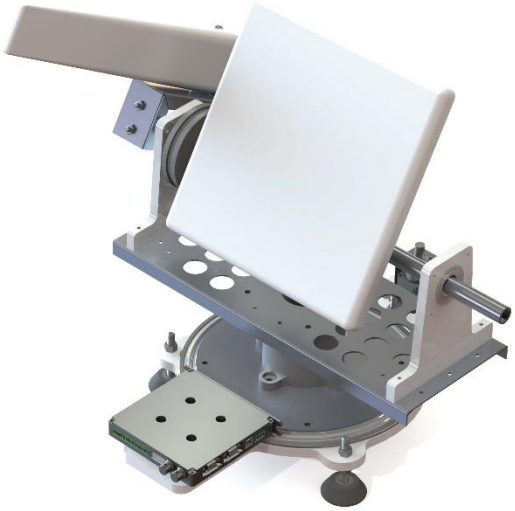
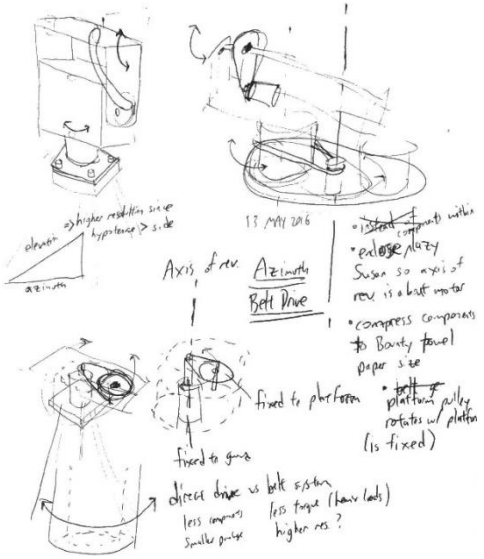
Automatic Antenna Tracking Station

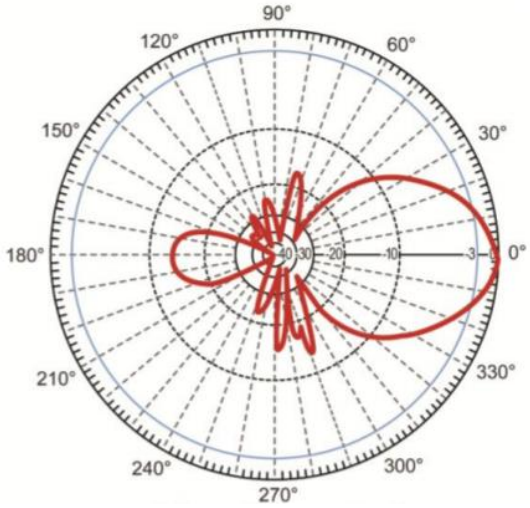
This unit can support a high-throughput datalink so images and videos can be processed live on the ground, instead of waiting for a drone to land and remove the camera SD card for post-processing. It was deployed at multiple UAV competitions, tracking drones and relaying mission data.

I designed, tested, and manufactured the tracking station, and calculated operating parameters dependent on drone and RF performance. Also developed a feedback error-correction loop and formulated experiment procedures to test the motor torque, GPS and IMU accuracy, and signal attenuation.

High-resolution rotation in yaw and pitch was achieved using stepper motors in belt-drive configurations. A software program parsed GPS coordinates from the MAVLink stream and vector subtraction is performed, in order to command the station to rotate and minimize the difference.







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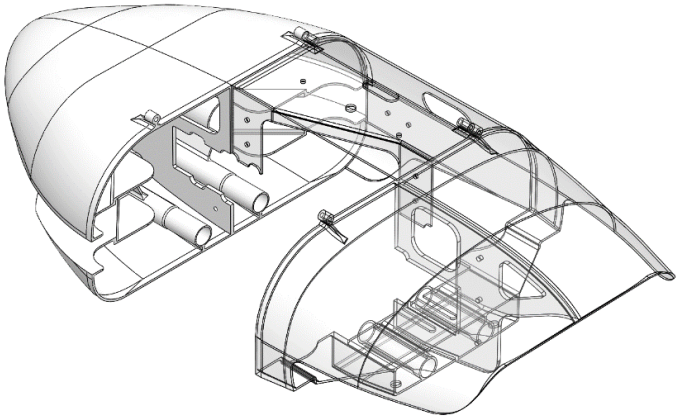
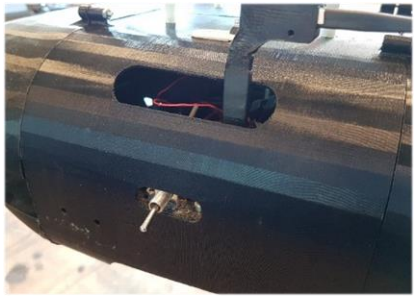
Drone Canopy

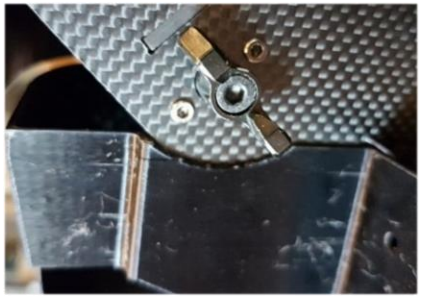


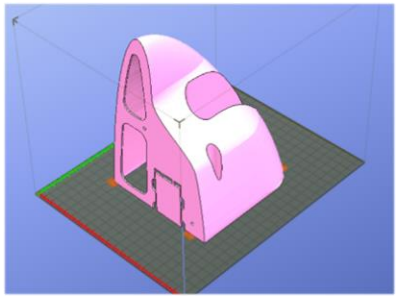
I designed a shell to be fitted over an existing drone frame to provide ingress protection in poor weather while maintaining aerodynamics and transportability.

It was purposely designed to accommodate for tolerances and meet clearances, so it had zero interference problems with existing antennas, transmitters, switches, and flight controller. The ability to cool the PDB and collapse the motor booms for transportation was also retained. I successfully 3D printed canopy and assembled the pieces on the first attempt after many digital mock-ups, including the use of an augmented reality CAD Viewer.

The canopy was praised at the USC 2018 competition by organizers and law enforcement for aesthetics and the ability to shield internals from the dusty environment.







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Augmented Reality CAD Viewer

Often in the design process of new components, difficulties arise when trying to visualize the scale of designs or predicting problems without a high-fidelity prototype.

Recognizing this issue and the lack of accessible solutions, I developed an interactive AR program, reducing iterations while refining workflow. I developed it with the Unity game engine and Vuforia SDK for target image or surface recognition, in addition to online documentation and YouTube tutorials.

Algorithms were coded for the user to reposition the model, scale objects, and reset the program. An future upgrade would be to change the SDK to Google's ARCore.

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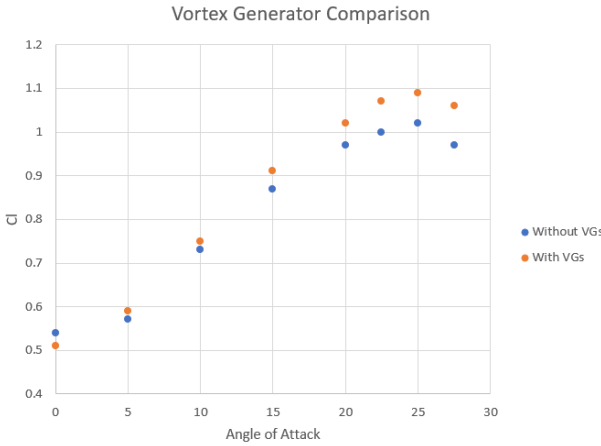
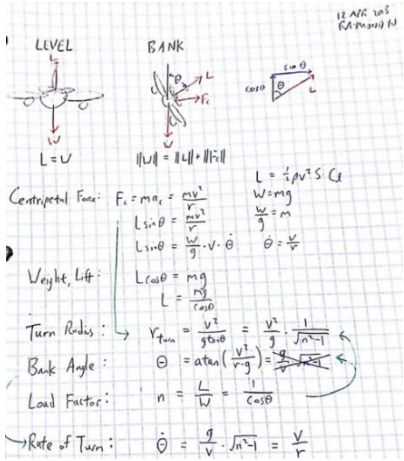
Vortex Generators

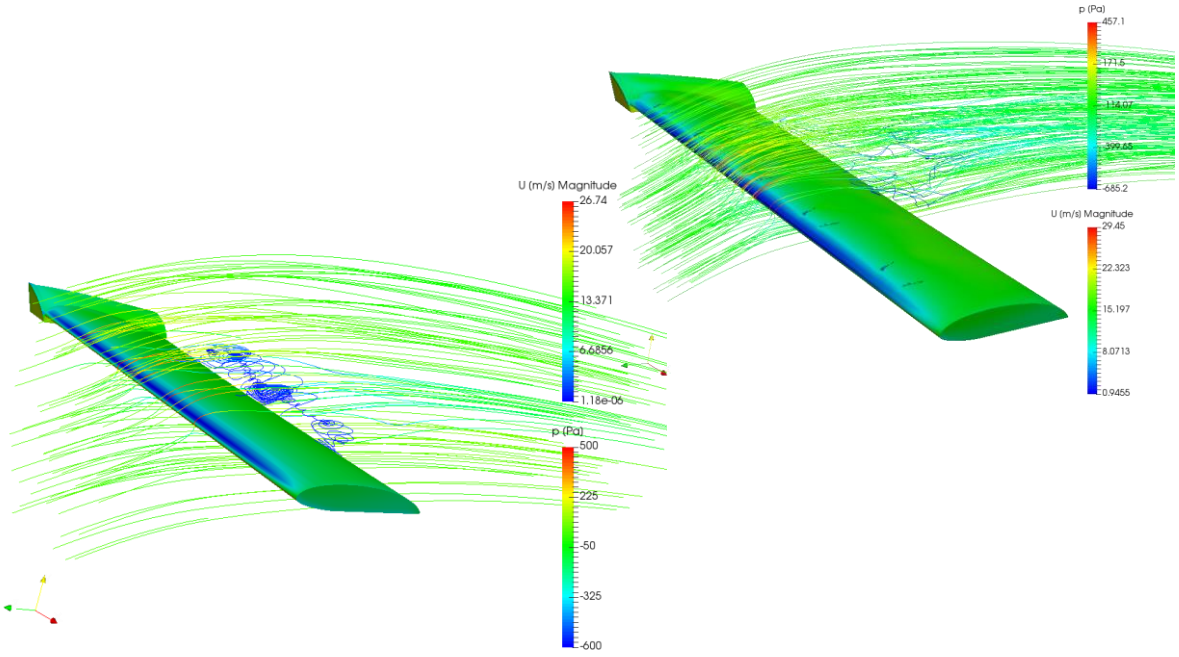




In order to overfly corner waypoints without breaching the geo-fence for the AUVSI 2018 competition, I designed vortex generators for a 2m wingspan drone.

Dimensions were calculated as proportions of chord length, vortex radius, and boundary layer height, while CFD simulations were performed using cloud-based FEA software, allowing for dozens of simulations to be performed in parallel, drastically expediting the analysis.

Stall speed and turn radius were theoretically reduced by 5% and 8% respectively by comparing Cl vs AoA plots with and without VGs. The pilot-in-command praised the stall recovery performance and increased maneuverability.



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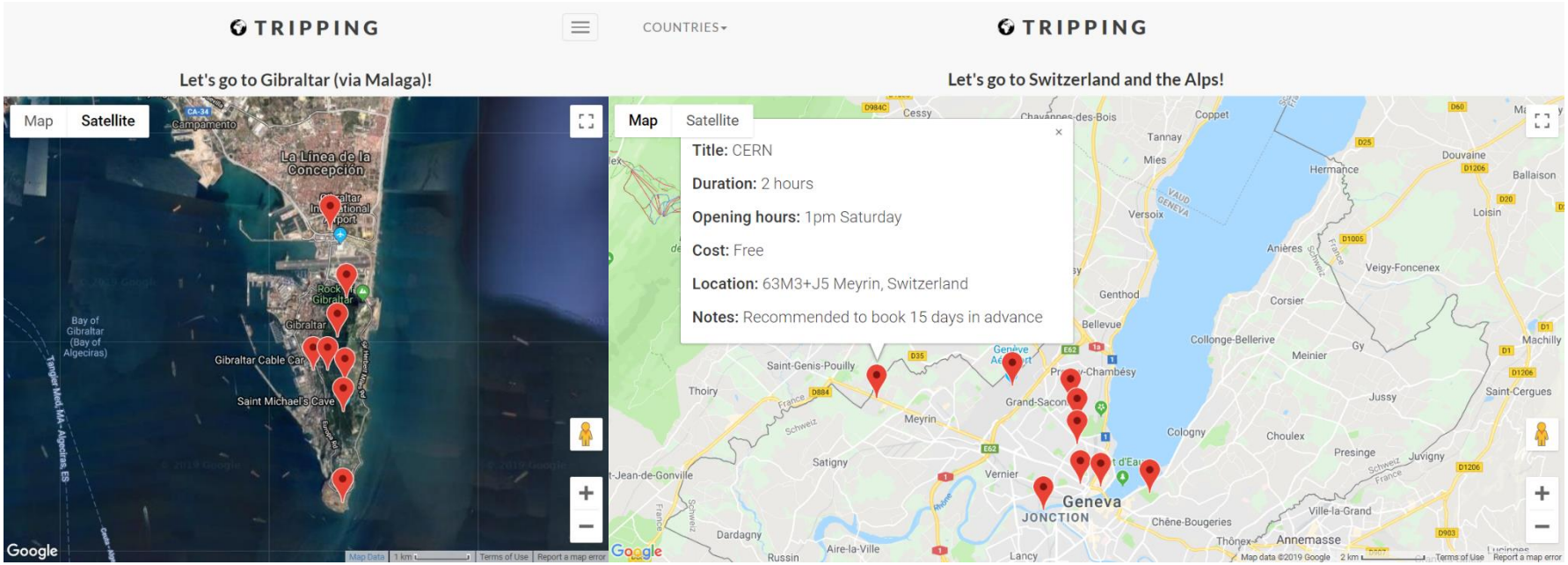
Travel Planning Map

To help plan and coordinate my travels in Europe with friends, I developed an interactive web-based map utility with Google Maps API, Google Scripts, JavaScript, and HTML. Travel information like opening hours, cost, and facts all updated live from Sheets. Scripts automatically search for the street address and latitude/longitude coordinates to reduce manual input, and the live user location is displayed too.

While I only realized that a customizable map was already released by Google *after* this was created, this project was nonetheless an engaging experience. Currently focused on expanding features to increase practicality, such as showing the user's device orientation and adding navigation directions with Directions API.



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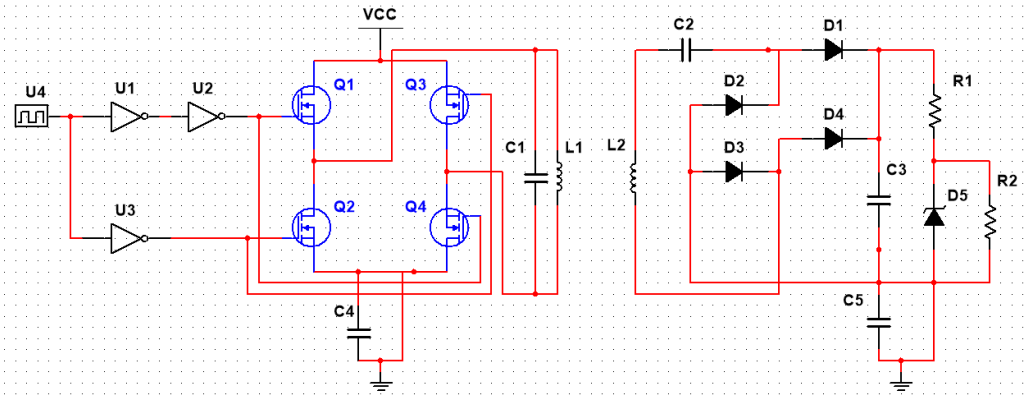
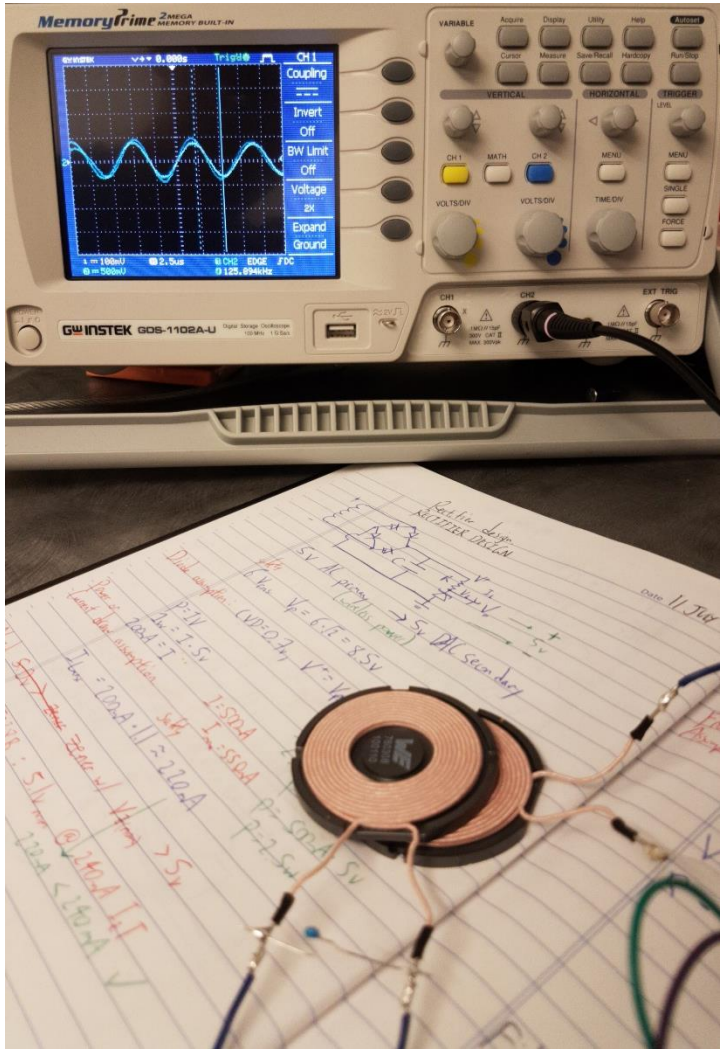
Induction Charging System





Wanting to avoid the nuisance of tangled wires during phone charging and to apply conceptual knowledge, I created a wireless charging station.

I designed the circuit using online tutorials, forums, and class notes, with components sourced from DigiKey. Raspberry Pi and logic gates used to provide PWM to H-bridge and to regulate voltage. Induction was optimized by maximizing the Q factor at ~150kHz according to the coil datasheet, and I calculated the capacitance required for magnetic resonance.

A future project would be to move the circuit onto PCB and design ergonomic housings for the transmitter and receiver for practical implementation.

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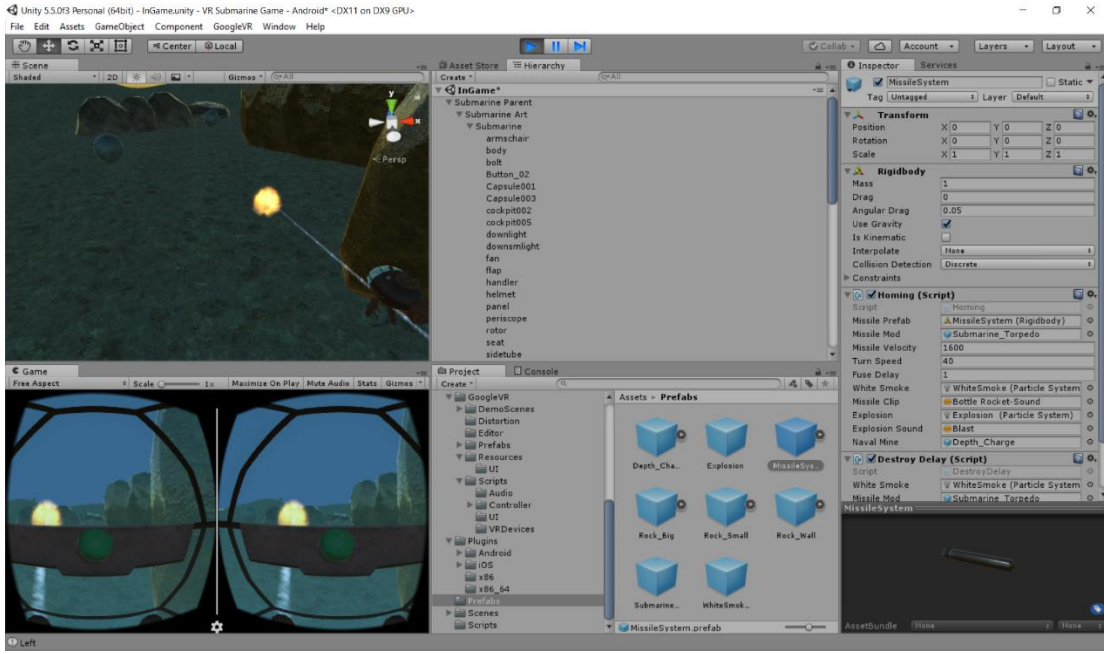
Virtual Reality Submarine Game

An interest for new technologies led to me attending a workshop on virtual reality applications, which brought experience using the Unity game engine and VR development. The game is designed for Google Cardboard with Android Studio.

I applied vector math operations for displacement and modified gameplay by scripting in C# and JS, following tutorials and documentation. Gameplay includes variable user-following movement, guided torpedoes, and explosion effects.

Sample code can be viewed at: github.com/raymondhcyu



```
void FixedUpdate () {

    float step = turnSpeed * Time.deltaTime; // time.deltatime makes speed indepednent of f

    if (missilePrefab == null || target == null) { // check to see if missile system or tar
        Debug.Log("Error: Cannot find missile prefab.");
        return;
    }

    missilePrefab.velocity = transform.forward * missileVelocity * Time.deltaTime; // prope
    aimDirection = Quaternion.LookRotation(target.position - transform.position); // define
    missilePrefab.MoveRotation(Quaternion.RotateTowards(transform.rotation, aimDirection, s

    // missilePrefab.transform.forward = (target.position - transform.position).normalized;
    // missilePrefab.AddForce(missilePrefab.transform.forward * missileVelocity * Time.delt
}
```

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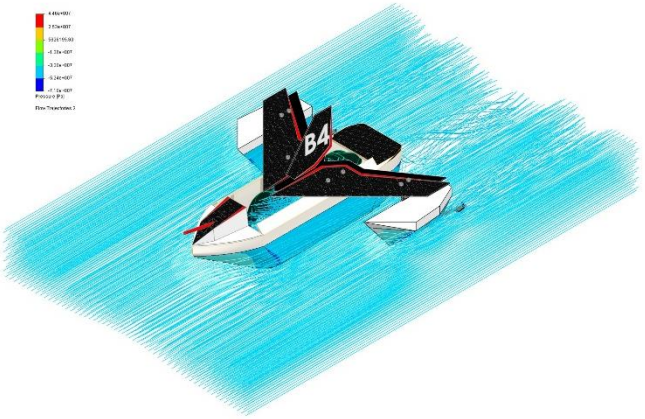
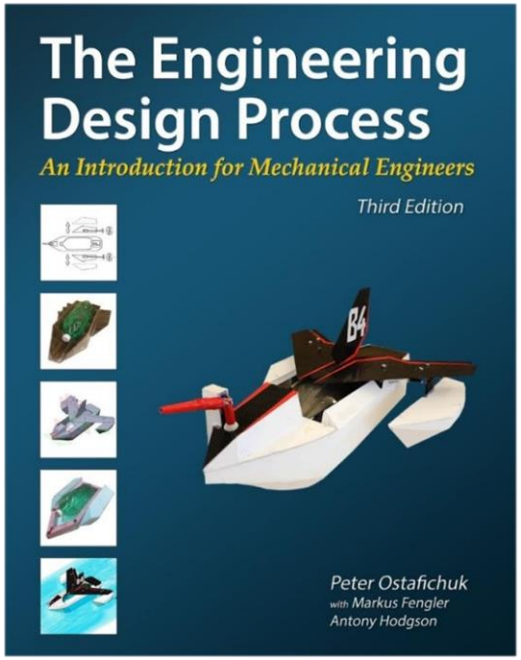
Remote Controlled Fireboat



A scale model maritime response and rescue boat was built as part of a project design course. My team proceeded with an unconventional design after consultations with a renown naval engineering professor. The design process was subsequently featured in an engineering design textbook at the request of the UBC Mech2 Program Director.

The vessel was modelled and rendered with SolidWorks and optimized with SolidWorks CFD. I designed the water cannon cupola, inspired by stealth technologies, while a servo motor system provided water cannon trajectory control through pressure and elevation changes. An RC receiver provided control of propulsion, steering, and water deployment. The high maneuverability was achieved through trimaran hull and dual BLDC motors using alternating thrust.



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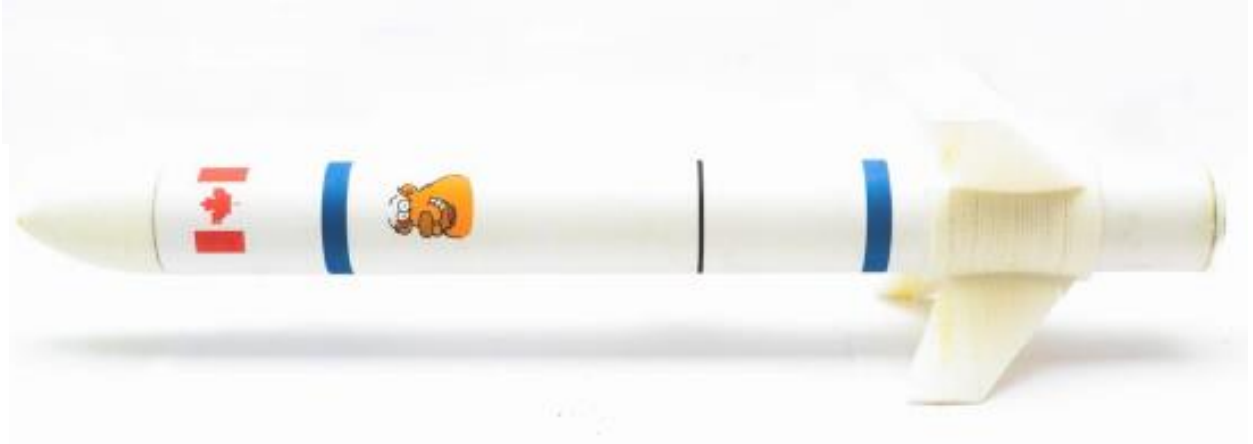
Solid-fuel Hobby Rocket



This model rocket was designed, manufactured, and test-launched as part of a self-led high school chemistry project.

The fuel cell comprised of potassium nitrate, sugar, and sulphur, while aerodynamic surfaces were 3-D printed. Flame-retardant paper lined the interior to protect the fuselage against the delayed parachute charge. I tested individual subsystems like the parachute and motor using estimated flight parameters.

See fuel cell/motor test here.

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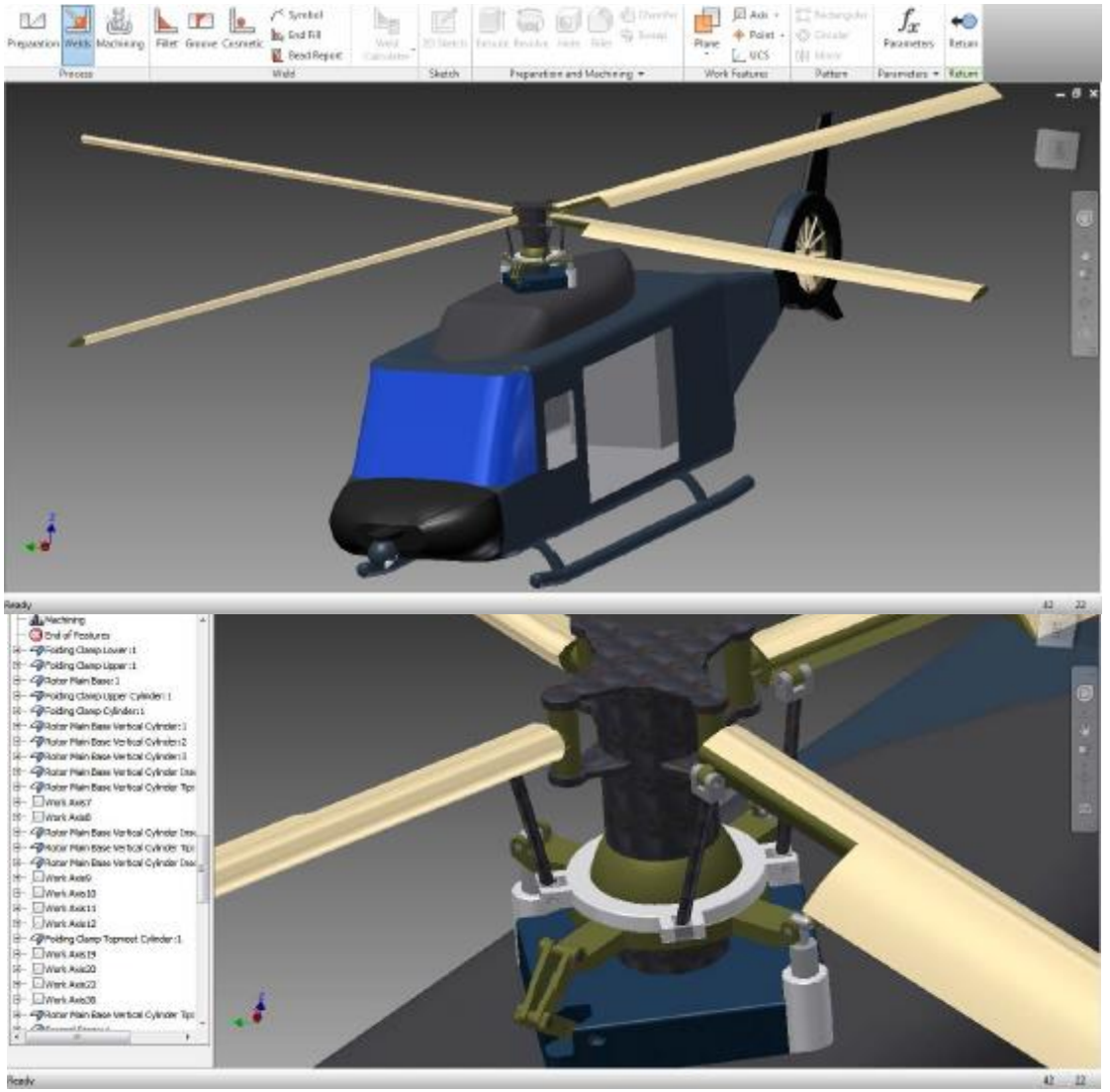
CAD Helicopter Main Rotor System

This is a simplified and functioning main rotor system of a Sikorsky S92 helicopter on a modified Bell 412 airframe that I designed with Inventor for a high school drafting project.

Dozens of complex individual components move with one another so that the final assembly is perfectly capable of coordinated movement. The angle of attack can be changed by the vertical translation of the swash plate.



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Future Projects

Currency Exchange Rate Scraper

Having unsuccessfully tried scraping online currency exchange rates with BeautifulSoup (against their terms of use**),** I want to try again using Selenium. The intent is that whenever a preferable rate is found, a notification would be sent so I can order foreign currency at the best rate.

Cellular IoT or LPWAN implementation

With a fascination towards wireless communication and the importance that the technology has on our day-to-day lives, I want to learn more and implement cellular or long-range communications on a DIY project. Currently unsure what application to test it with, but inclined towards BVLOS drone operation, and combining a technology like LoRaWAN with MAVLink.

Portfolio Pages on Website

I hope to transfer this project portfolio onto dedicated pages on my website (instead of a PDF attachment) for better presentation, navigation, and description.