Sink or Swim, an Underwater ROV

The design, and implementation of a low cost Underwater Remotely Operated Vehicle

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Objective

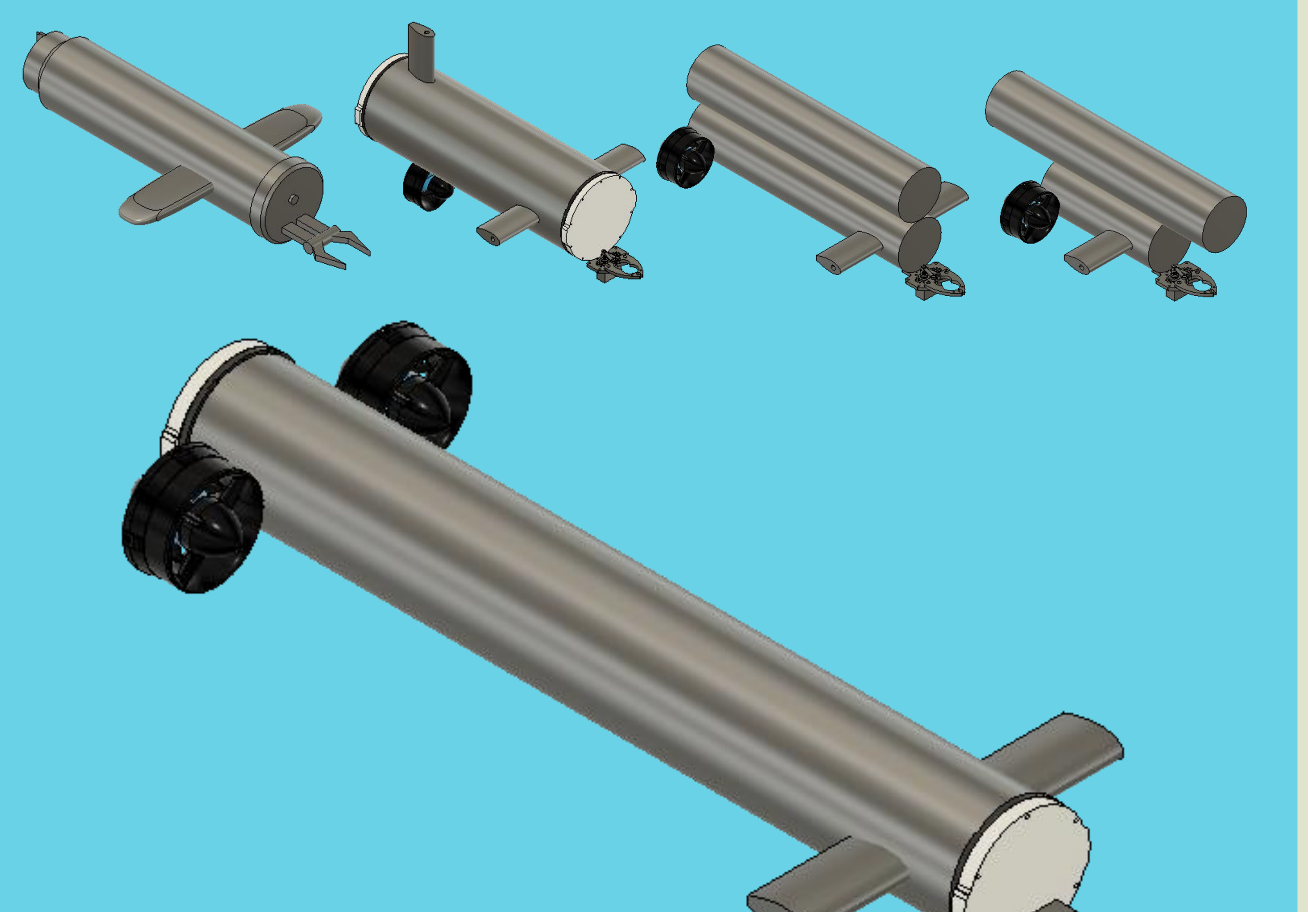
To design and construct a remotely operated submarine from easily accessible materials that would be able to use to explore the bottom of Cultus Lake and pick up objects, run scientific tests, or catch a fish.

Innovations

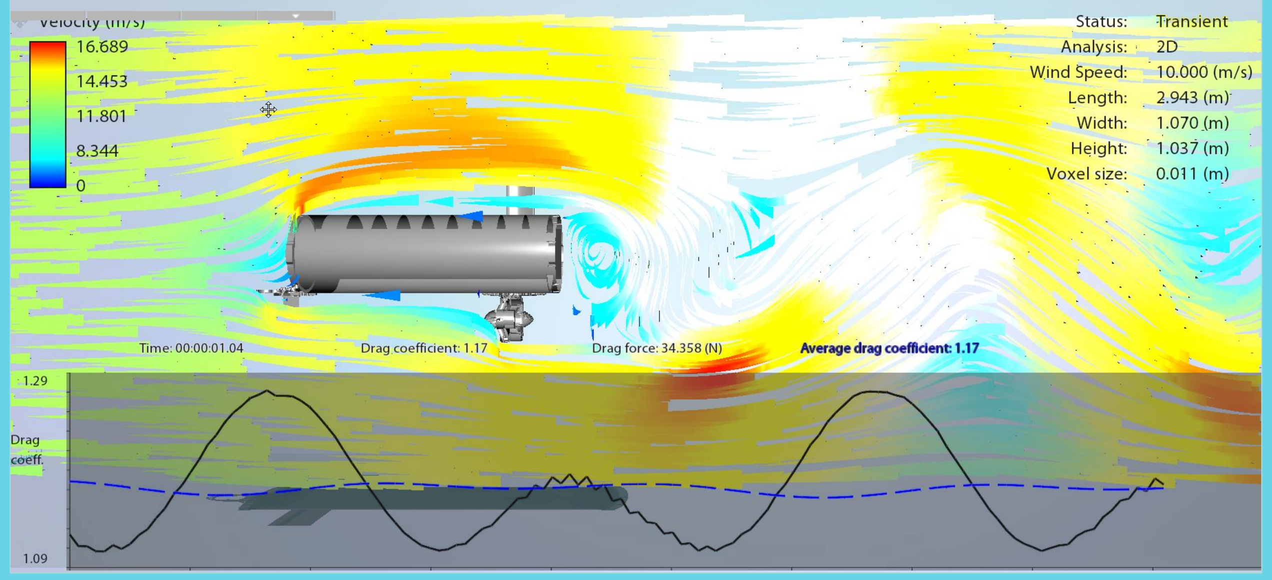
The changes that this project will bring to the world are nothing new, but an exercise in proving that with the skills, materials, and tools everyone in the 1st world has access to, we are able to build a ROV. We were able to find all our parts from amazon, digikey, and home depot. Any bespoke or custom parts that we found online in open source materials we were able to 3D print or laser cut.

Design

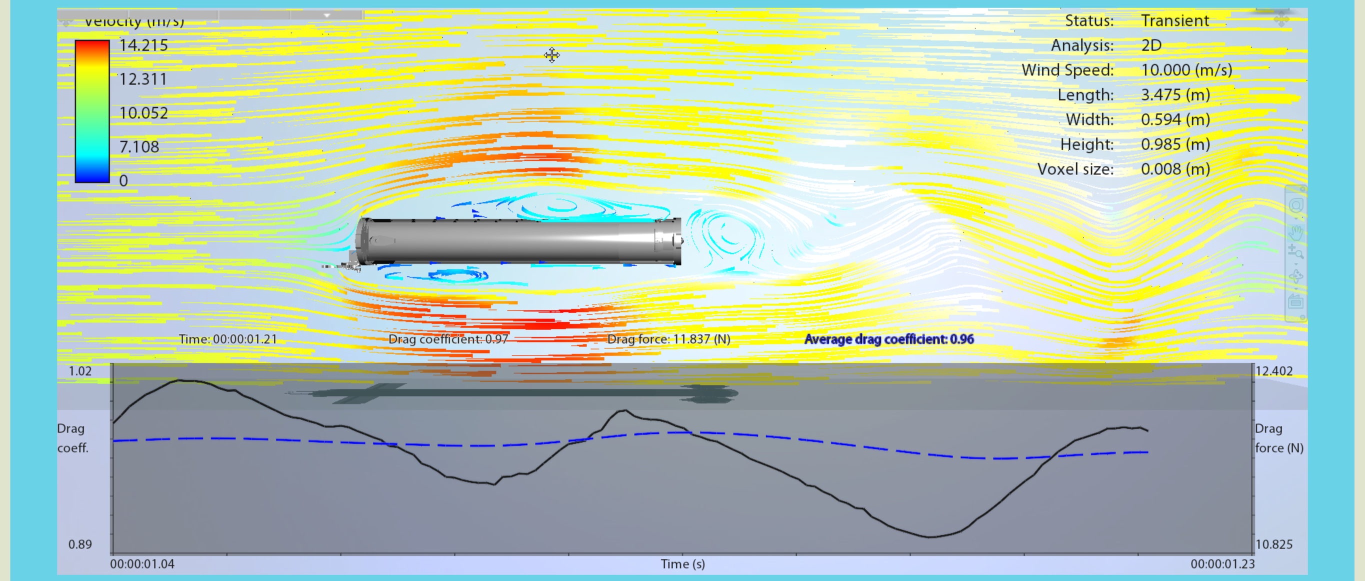
Most ROV's are constructed in a "box" style. The box style is traditional used for inspection, mine removal, or short range scientific research, but have much more drag. Our ROV is built with the idea of AUVs and submarines in mind. The "cigar" shape is better for constant motion since it is more aquadynamic. This longer shape also requires less thrust to achieve greater speeds, and is often used for long range or long haul missions. Having the body be a cigar shape, but the control being remote operated is a good challenge to have it operate in both worlds.



Design iterations 1-5.
Starting from December 17th to the Present



First Design: "Chonk"



Fifth Design: "Sticky"

Physics

Above are two images juxtaposed, this shows the difference in our first design compared to our sixth design. "Chonk" is a 152.4mm diameter hull, 500mm long, with three planes, and one thruster. "Sticky" is 101.6mm diameter hull, 750mm long, with two diving planes, and two thrusters.

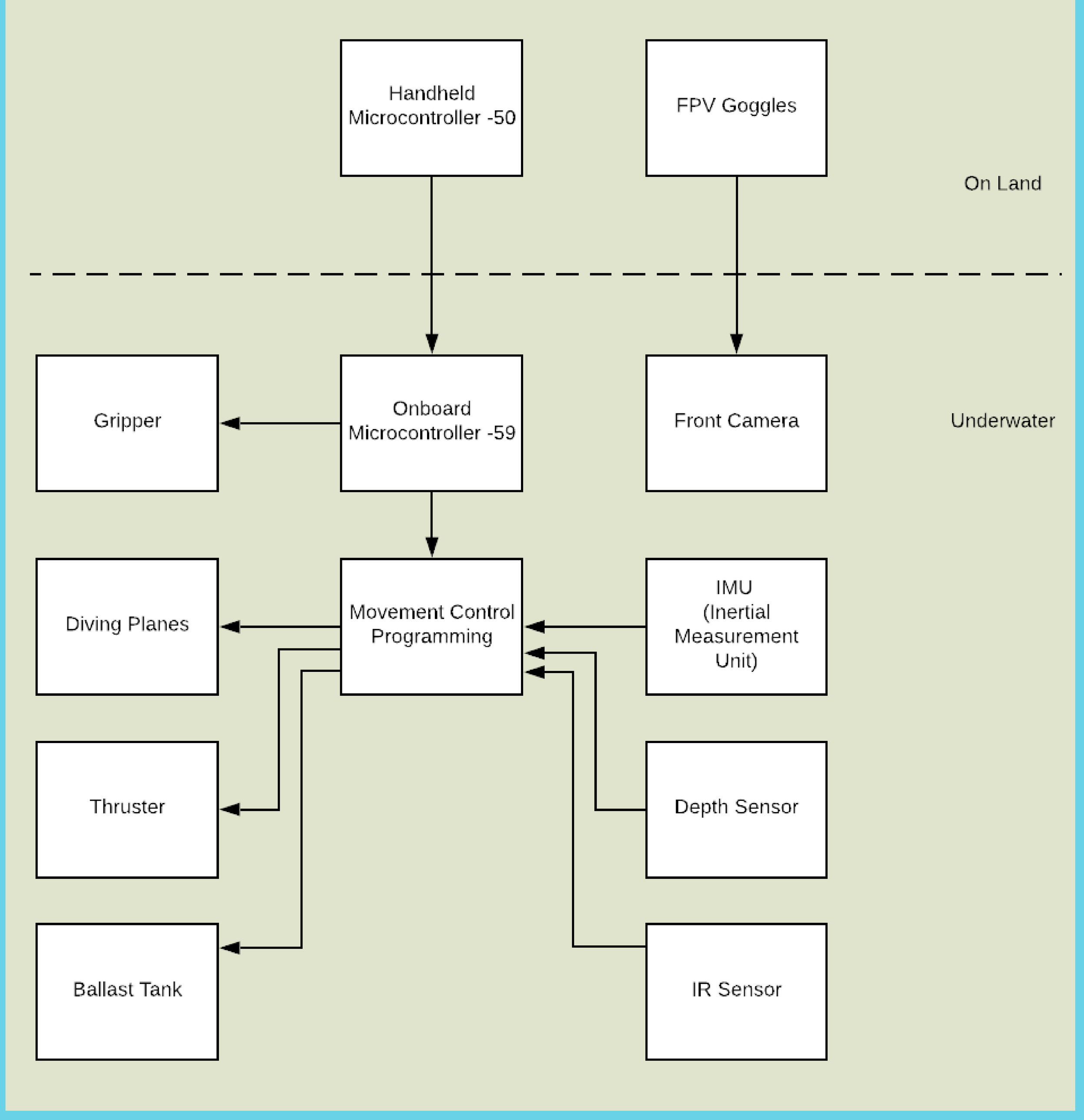
The biggest visual difference in these two images are the *vorticity* coming off the rear of the designs. Chonk is creating much more vorticity not because of its greater width, but because of its ratio of width to length. A short cylinder (one with its diameter similar to its length) will have a *drag coefficient* closer to 1.15. A long cylinder will have a drag coefficient closer to 0.96.

In the simulation both Chonk and Sticky are experiencing the same flow speeds but there is the 18% different in their drag coefficients, but this does not cause the *291% increase* drag seen in Chonk. The decrease in drag is coming from the change in diameter, the change in length, and the positioning of the planes and thrusters. Although having a well functioning model is a good start, there will always be real world problems that cannot be modelled. To deal with this we needed a well made controller to compensate for these errors.

Controller

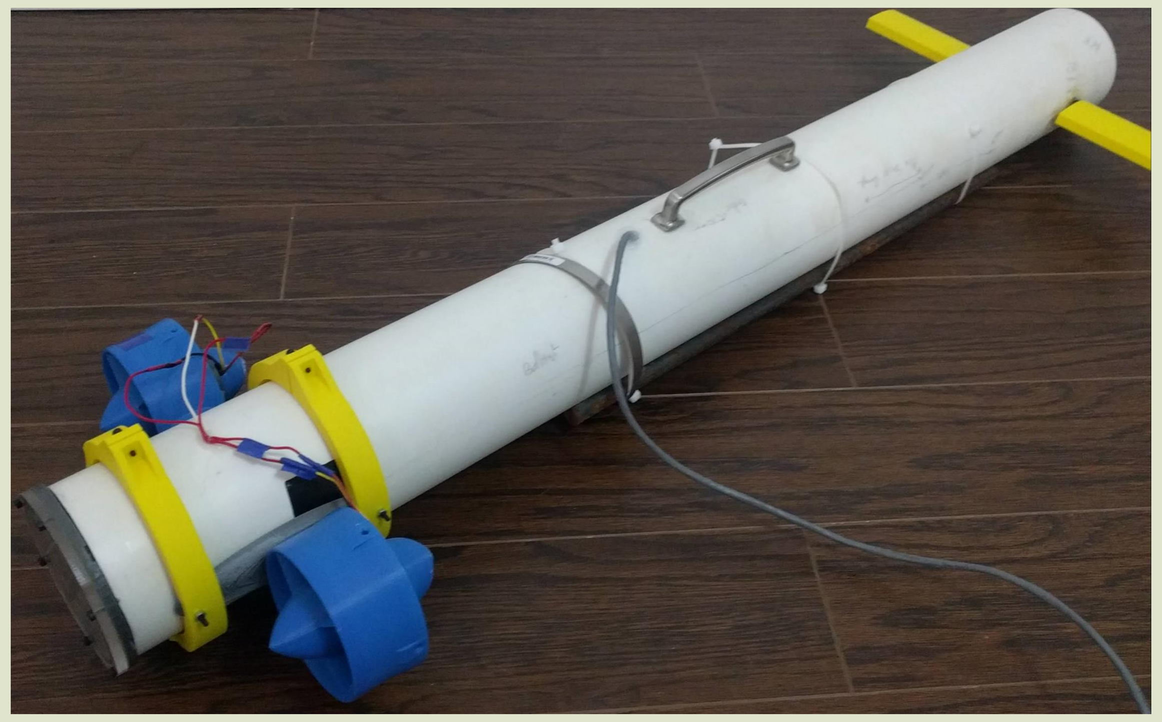
Our ROV works off of two separate micro-controllers. The first MC is hand-held controller which is operating on in *open-loop* system which takes in human inputs with no correctional feedback. It then processes the inputs and sends it down to the onboard MC along an ethernet cable.

The onboard MC takes in the data from the handheld microcontroller as well as the data from all the onboard sensors, processes and combines the information, and outputs signals to the various motors. The onboard microcontroller is working on a *closed-loop PID* system which is much more complex. A closed-loop system will take both the inputs from a human, as well as feedback from sensors. PID works off three correction terms: the proportional term, the integral term, and the derivative term. By calculating these three terms, we are able to apply them to a correction in the motion of the system. The onboard IMU and pressure sensor will send information to the onboard MC telling the ROV its orientation and depth. If the pilot is telling the submarine to move forwards in a straight line, but the IMU tells the onboard MC that the submarine is beginning to list to the left, the onboard MC will correct for this by slightly slowing the right thruster.



Conclusion

We have been able to successfully build our ROV, with thrusters and diving planes controlling movement. Upto this point we do not have everything implemented but we are well on track to having the entire ROV completed by the end of semester.



Acknowledgments

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