Michael Elliot King

Mechanical Engineering Portfolio

Department of Mechanical Engineering
McGill University
817 Sherbrooke Street West
Montreal, Quebec H3A 0C3 Canada

(617) 633-0828
michael.king2@mail.mcgill.ca
www.michaelelliotking.com

Variable-Friction Shoe Surface Mechanism

Project: Research project for Professor Jeremy Cooperstock of The Shared Reality Lab - McGill Centre for Intelligent Machines

Goal: Design, manufacture, assemble, and demonstrate a mechanism to fit in a shoe that can control the coefficient of friction between the shoe and the floor surface.

Description: Based on research done by Guillaume Millet, Martin Otis, and Jeremy Cooperstock into various methods of varying friction during natural walking and the applications for this type of simulated environment, a fully functional prototype was created from scratch in seven months. Creating the concept involved choosing a method of deployment, researching all components and materials, calculating needed geometry and movements, designing the layout, and analyzing the stresses. The manufacturing, assembling and testing of the apparatus were completed in the next three months. This involved ordering materials and parts, machining and assembling components, developing the power and control system, and testing the mechanism prototype.

The full report can be found at michaelelliotking.com/report.

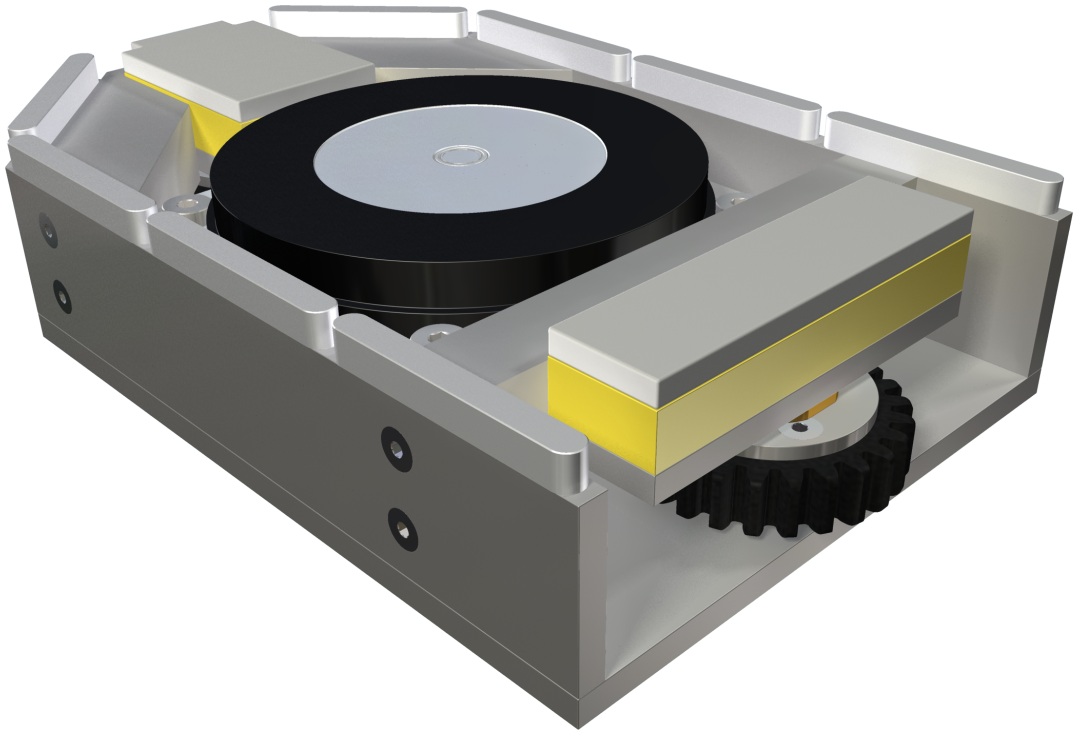

Figure 1: Assembly of the variable-friction shoe mechanism

To vary the coefficient of friction, a range of surfaces—from ice to concrete—is simulated using the combination of an adjustable, deformable high-friction material and a rigid, static low-friction material. The height of the deformable brake is adjusted to transfer more weight onto it, and because the friction force is proportional to normal force on the brake, the coefficient of friction changes with its height.

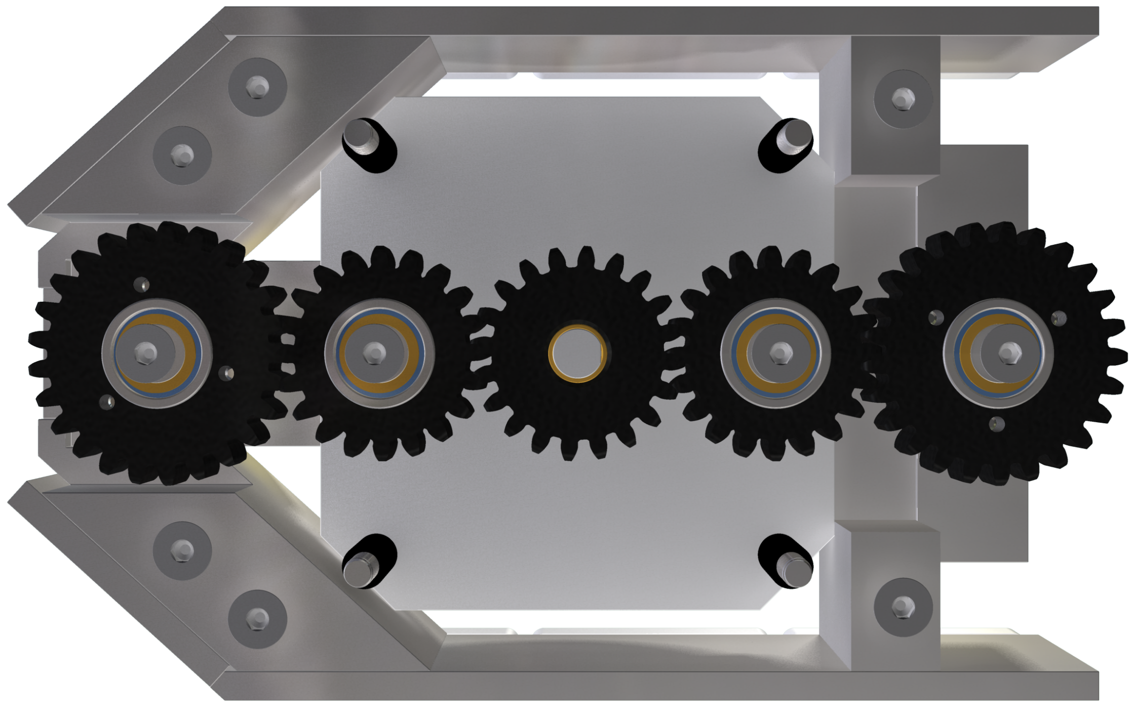

Figure 2: Bottom view of gear train and bearings

The mechanism uses a central stepper motor to drive a series of gears and a lead screw embedded in each brake to change the height of the braking surface. The drive system was designed from scratch and everything but the gears and bearings were machined in-house from aluminum and stainless.

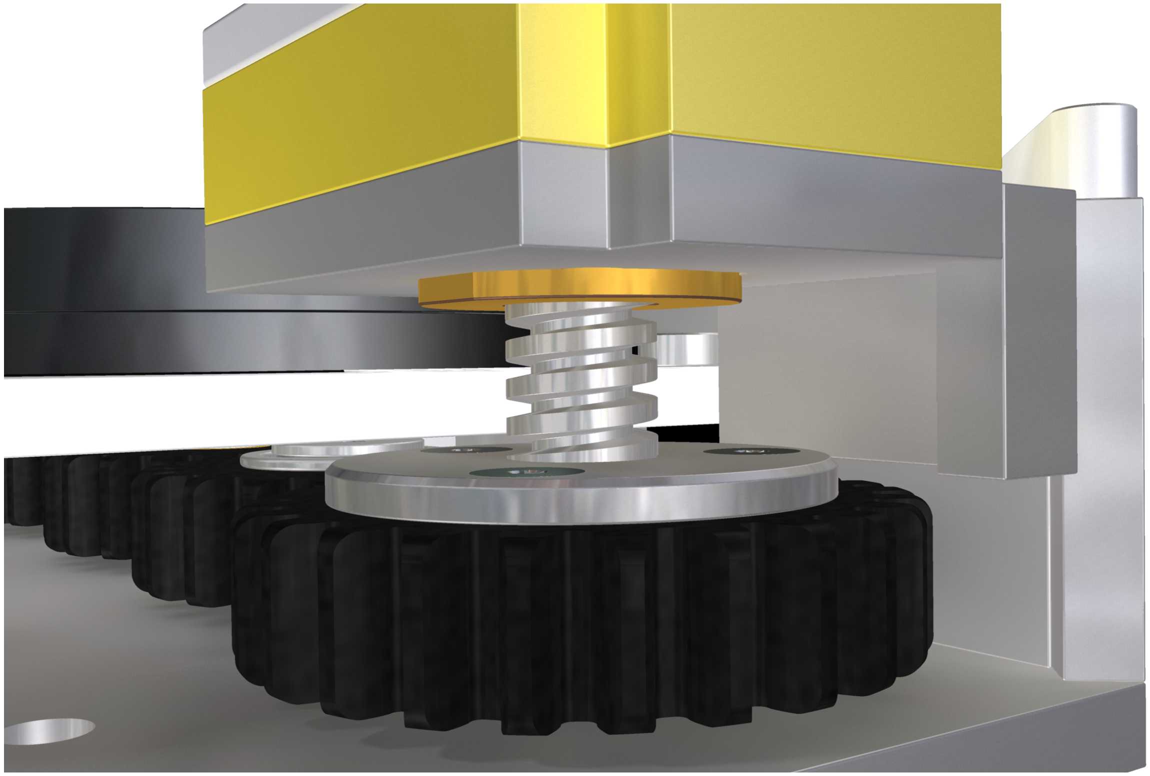

Figure 3: Cut-away view of gear, lead screw and brake

The lead screw is silver-brazed to the gear, which is threaded into the aluminum plate of the brake and sandwiched between two bearings. The brake consists of a metal plate, a piece of EVA foam for elasticity, and a strip of rubber for high-friction. The brake system allows for precise translations as small as a tenth of a millimeter, which is needed to achieve specific coefficients of friction.

Autonomous Underwater Vehicle

Project: Autonomous Underwater Vehicle for the McGill Robotics Design Team

Goal: Design, analyze, manufacture, implement and test an A.U.V. to compete in the AUVSI Robosub Competition in San Diego, CA in July 2014.

Description: Two months are used to research existing teams and industry designs, develop concepts, and evaluate them based on cost, simplicity, and manufacturability. Another two months are spent designing, CADing, and running FEA, to prepare for purchasing. Machine drawings are made and materials are ordered over the next month. Following this, one month is spent on machining, printing, and manufacturing, and less than a month assembling the components. The next four months are left for unit testing, dry testing, and finally wet testing. This period is also left open for any necessary redesign and manufacturing that will inevitably take place. The vehicle must be ready for competition in June to allow for shipping and travel to San Diego. In the next few pages, some of the major components that were CADed are shown in more detail.

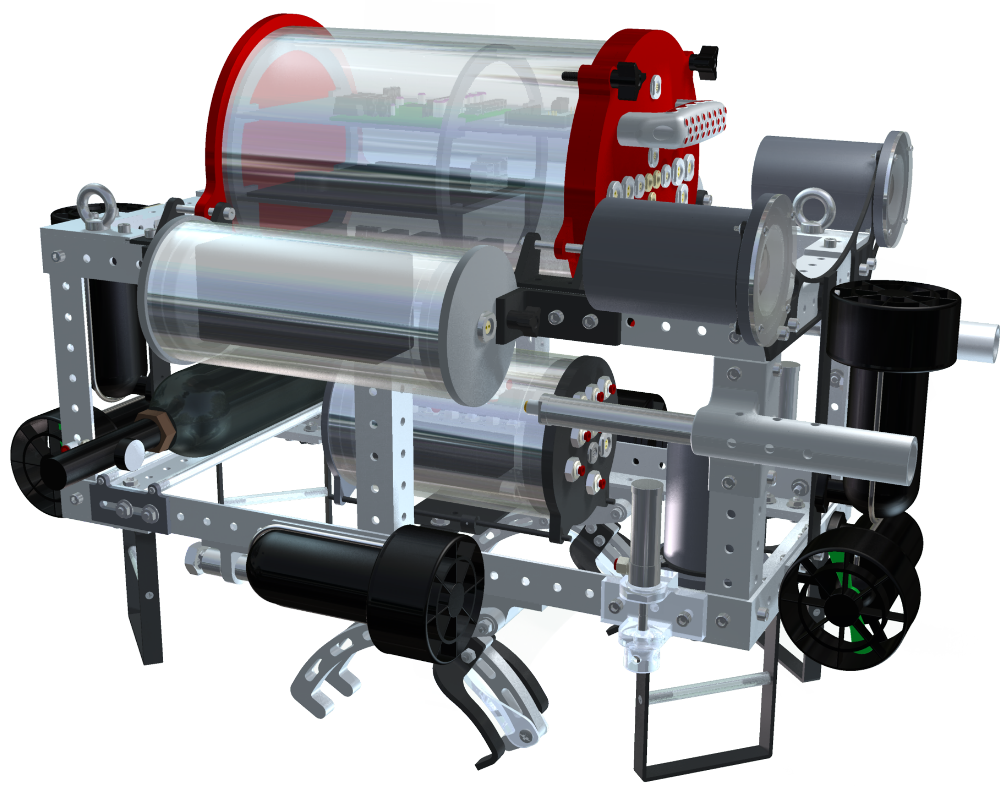

Figure 4: AUV assembly

Figure 4 shows the current CAD model of the entire AUV. It consists of a frame, a main hull pressure vessel, two battery pressure vessels, three camera pressure vessels, a pneumatic valve housing, an IMU pressure vessel, two claw mechanisms, two marker dropping devices, two pneumatic torpedoes, a CO_2 tank, and six thrusters. The majority of the materials are HDPE plastic, 3D-printed resin, and aluminum. All designs are from scratch, except for fasteners and electrical components.

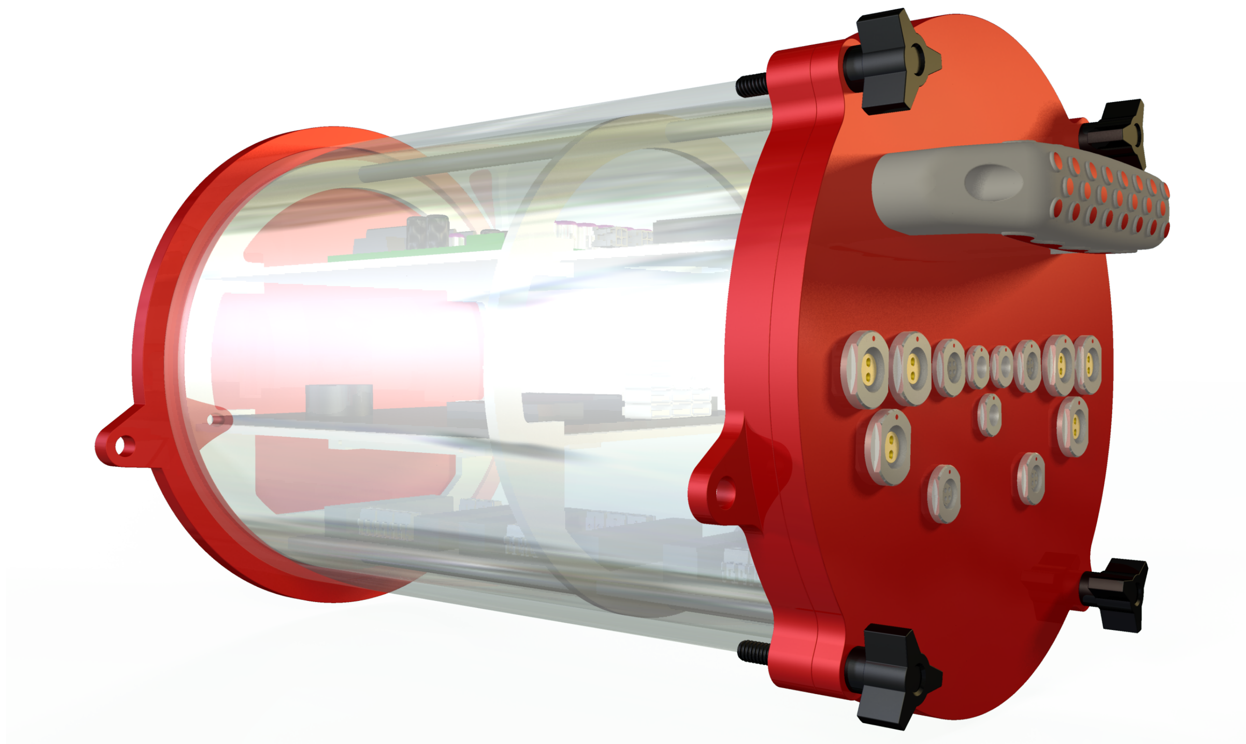

Figure 5: Main hull pressure vessel

The main hull houses most of the electronics and provides the majority of the buoyant force needed to keep the vehicle neutral and balanced. Inside, a rail system holds the electronics in place, and is removable from the front for easy access. It attaches to the top of the frame, and connects all the electronic components using a set of waterproof connectors.

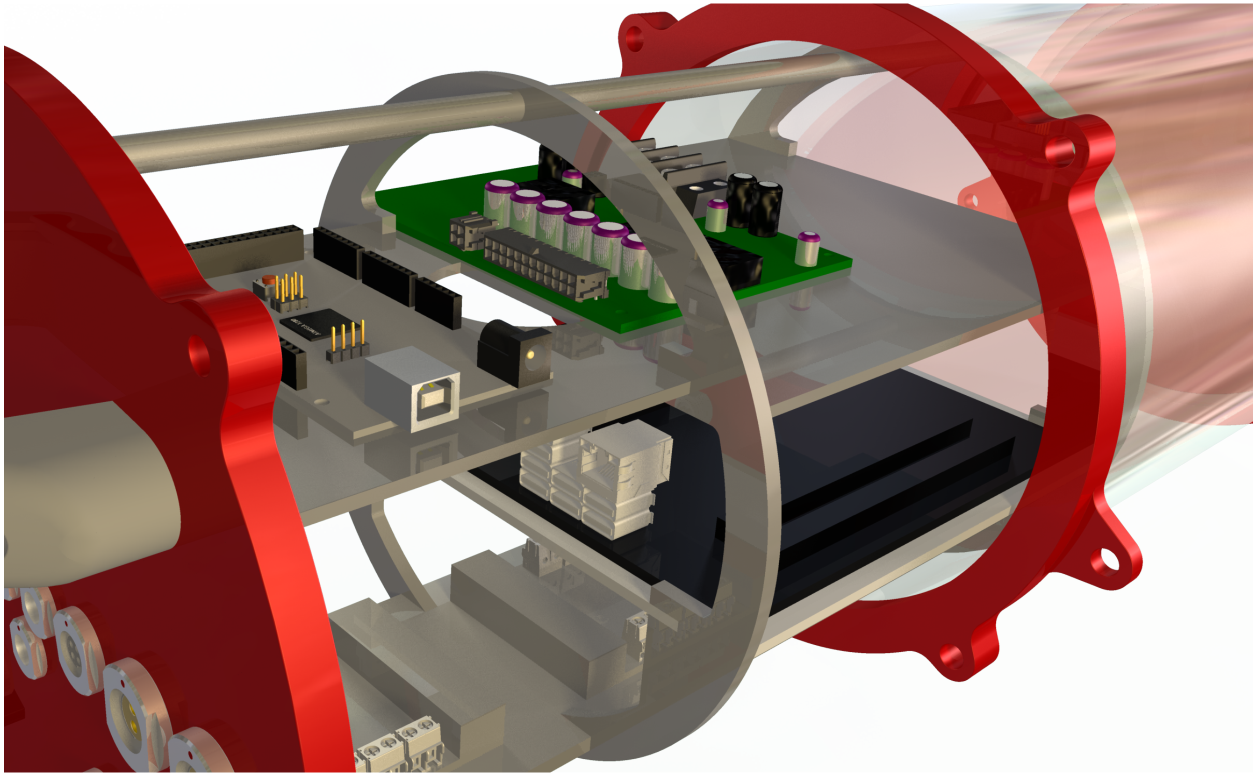

Figure 6: Internal electronics rack

Inside is the custom-built, on-board computer, as well as three motor controllers, an Arduino Mega, and a custom-built power distribution PCB board. These electronics are needed to manage the six thrusters, the sensor array, and the computer vision system. The frame is made of aluminum rails, with plastic racks, and uses a face O-ring with four nuts and vacuum seal to keep it water-tight.

Figure 7: Pneumatic claw device for picking up objects underwater

The pneumatic claw uses a double-acting piston to open and close two “fingers” of the claw, which are printed in an Stratasys Objet260 3D printer. A lever on one of the fingers senses when an object has successfully been picked up using a custom, waterproof limit switch.

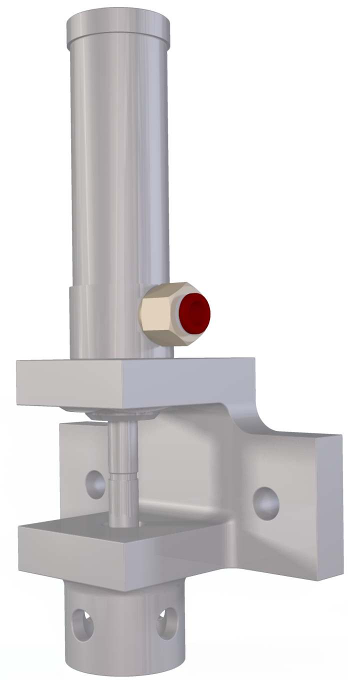

Figure 8: Pneumatic marker dropper device

The pneumatic marker dropper uses a reverse-acting piston with a magnet to release a ball bearing marker when over a target. It is printed in a FormLabs Form 1 3D printer and coated with a protective sealant.

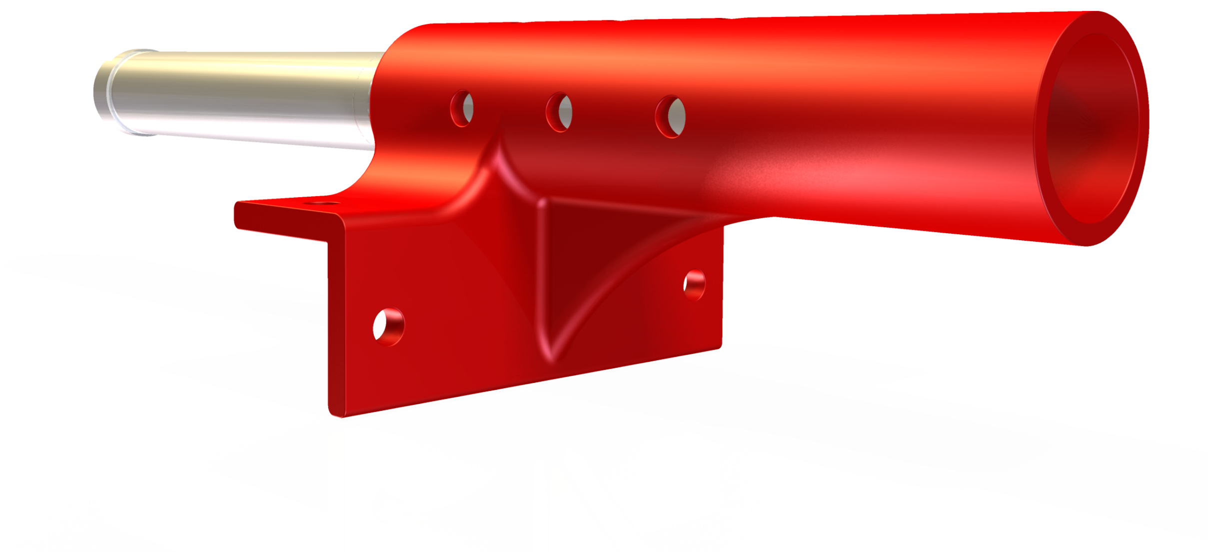

Figure 9: Pneumatic torpedo launcher

The torpedo launcher uses a pneumatic piston to fire a custom, 3D-printed projectile at a target at a distance of up to 5 meters. It is printed in a FormLabs Form 1 3D printer and coated with a protective sealant.

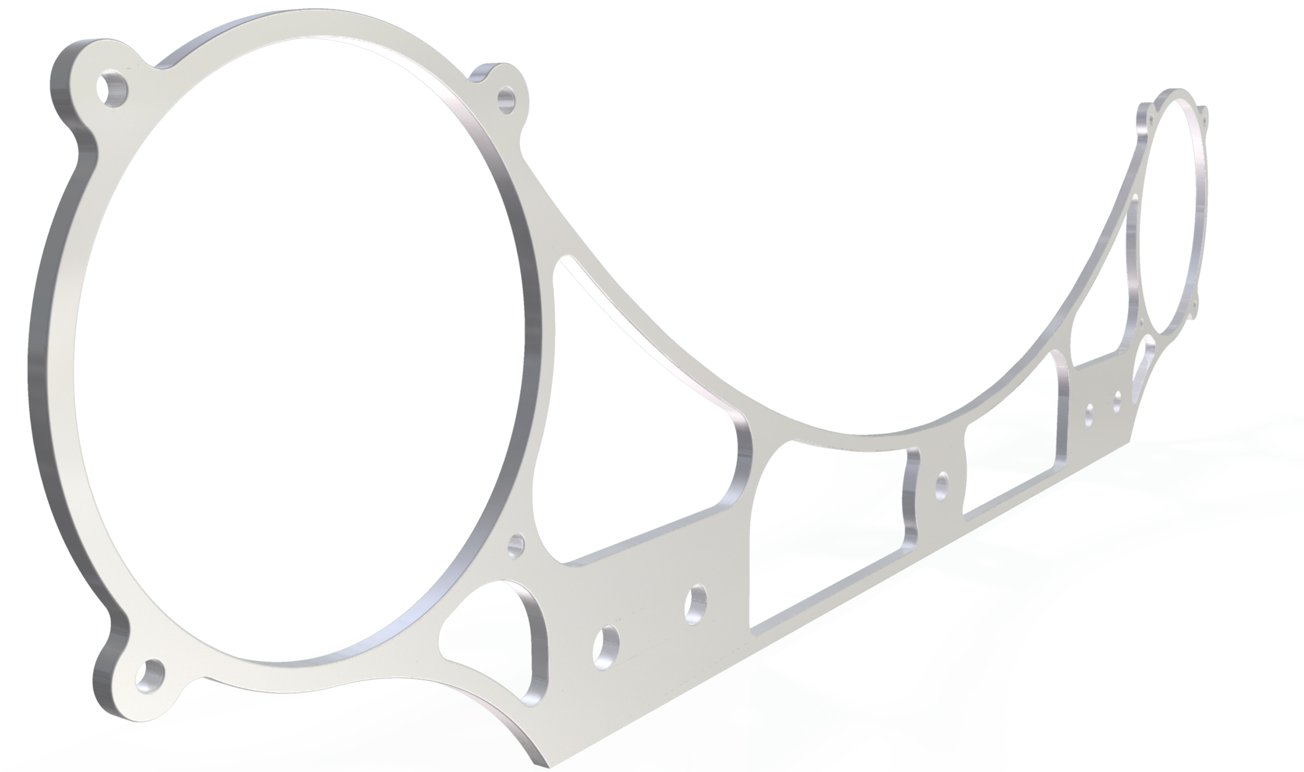

Figure 10: Front-facing CNCed camera bracket

The front-facing camera bracket connects two cameras to the bow to allow for stereo vision. The bracket is CNCed from a sheet of aluminum for rigidity and shaped to maximize the distance between the cameras and reduce weight. Like all the machined aluminum parts, it will be anodized following machining to prevent corrosion.

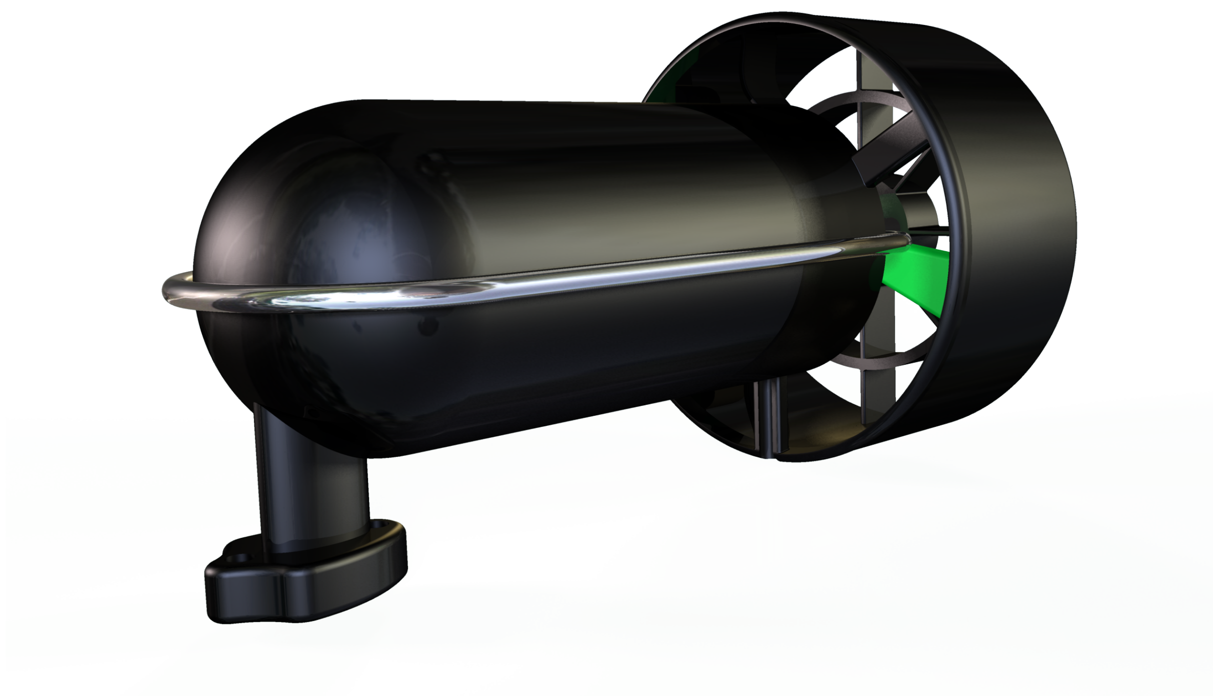

Figure 11: CAD model of the Seabotix BTD150 thruster

Six Seabotix BTD150 thrusters drive the vehicle and are arranged for five degrees of freedom - active surge, sway, heave, yaw, and pitch.

For the sake of time, I have only included my most recent work. I will continue to update this portfolio with my work - both old and new - and it will continue to be available at www.michaelelliotking.com/portfolio.

To be posted:

- Material collection system for an autonomous lunar mining robot
- Flying yacht conceptual design
- Commercial aircraft wing design