Eric Zhao

Mechatronics Portfolio

University of Waterloo

February 2021

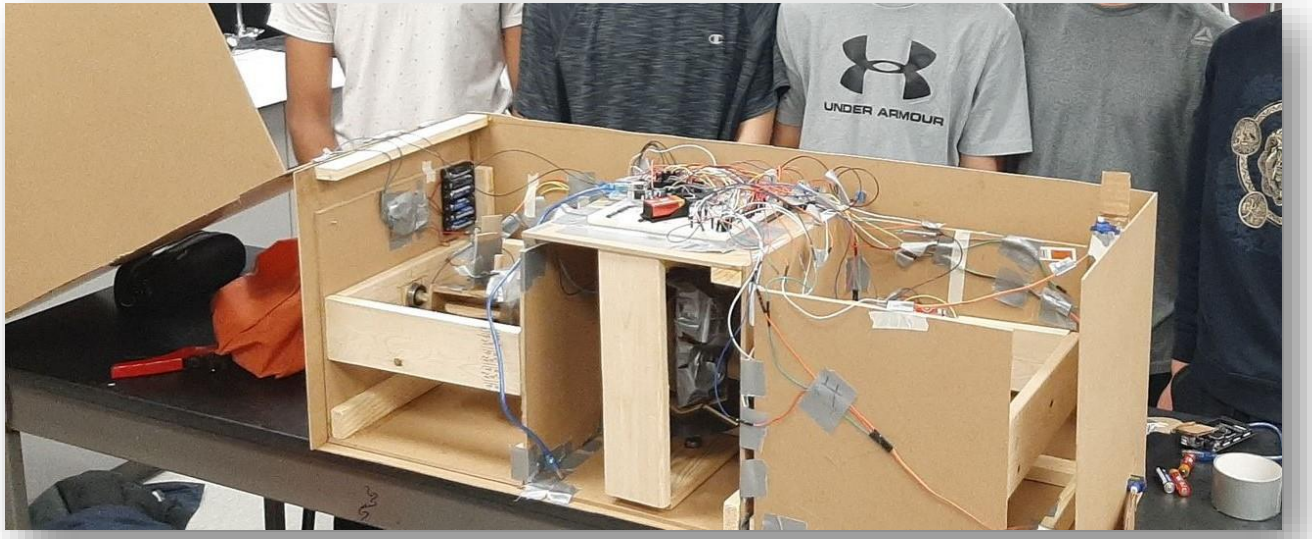
résumé

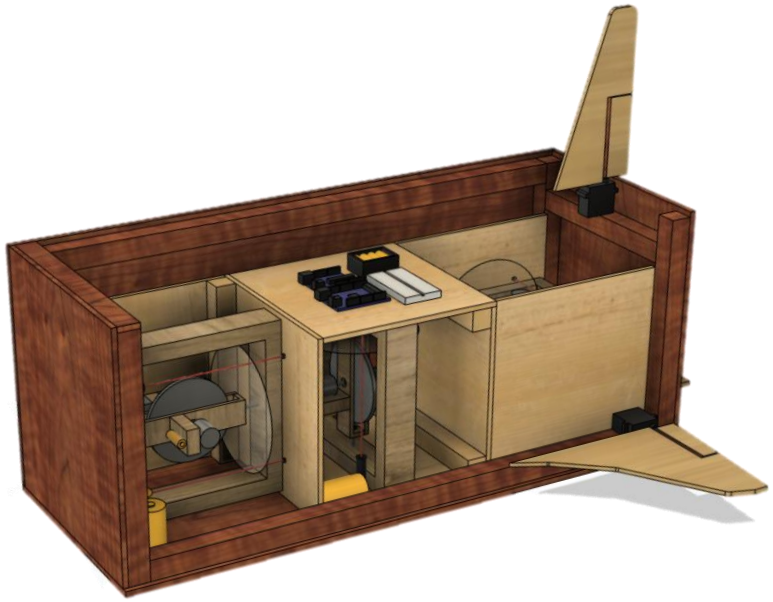
POLARIS

Rudimentary Spacecraft Guidance System

Skills used: Fusion360, Arduino, machining and hand tools, soldering and wiring

Summary: Three single-gimbal gyroscopes were built to find a model spacecraft's orientation in space. By shining lasers through circular gradients attached to the gimbals of each gyroscope, and analyzing the light intensity of each laser, the spacecraft's rotational position around the 3 axes was measured.

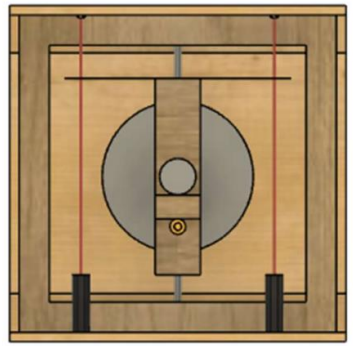


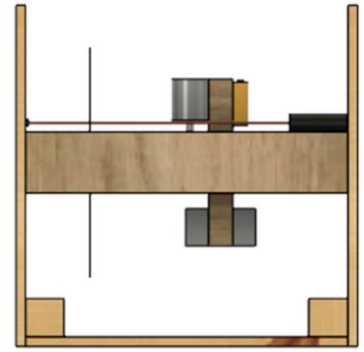


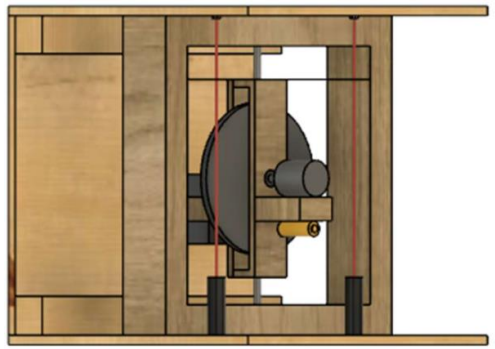
I was responsible for the mechanical design and assembly of the project, including the gyroscopes, fins, spacecraft housing, and circuit board, motor, and sensor placements.

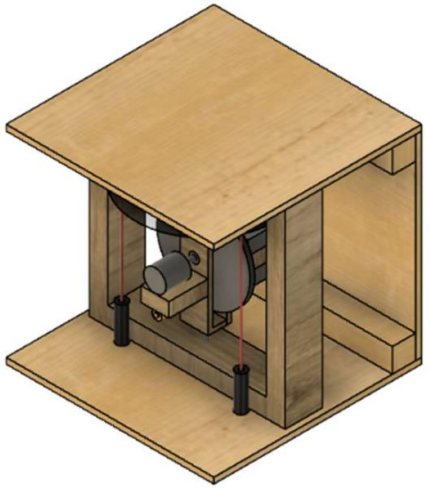
I designed the gyroscopes modularly, with each cubic module containing a motor-powered disc in the center, attached to a freely rotating gimbal. The resulting angular momentum of the spinning disc allows the disc to maintain its orientation in space.

Everything was modelled fully in Fusion360.









Flight

As humanity explores the frontier of space, SAJER continues to demostrate cutting edge innovation and design for spaceflight - the unifying force between the world.

Control

To go where no one has gone before requires more than just power—it is essential to fly with stability and precision. POLARIS detects rotation in all three spatial axes, to calculate and set appropriate fin positions to correct a craft's path.

Design

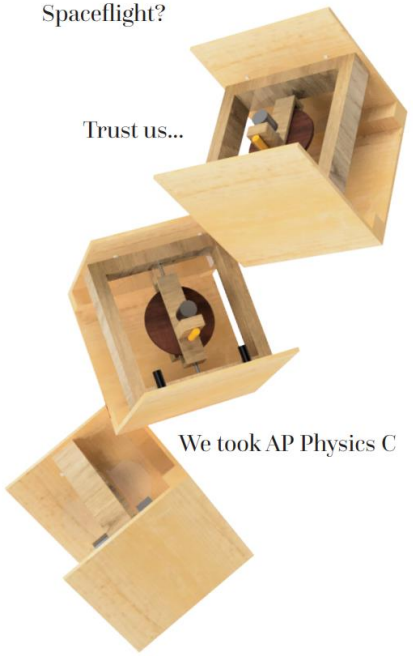
The driving principle behind POLARIS is the use of lasers. Shot through a conical gradient, the perceived intensity on the other side is proportional to the sheet's angle of rotation. By attaching this gradient to a free-rotating gimbal around the gyroscope and shooting a laser through towards a photoresistor, POLARIS accurately determines the system's angle of rotation.

Designed by SAJER in Toronto
sajer.com

POLARIS

Spaceflight?

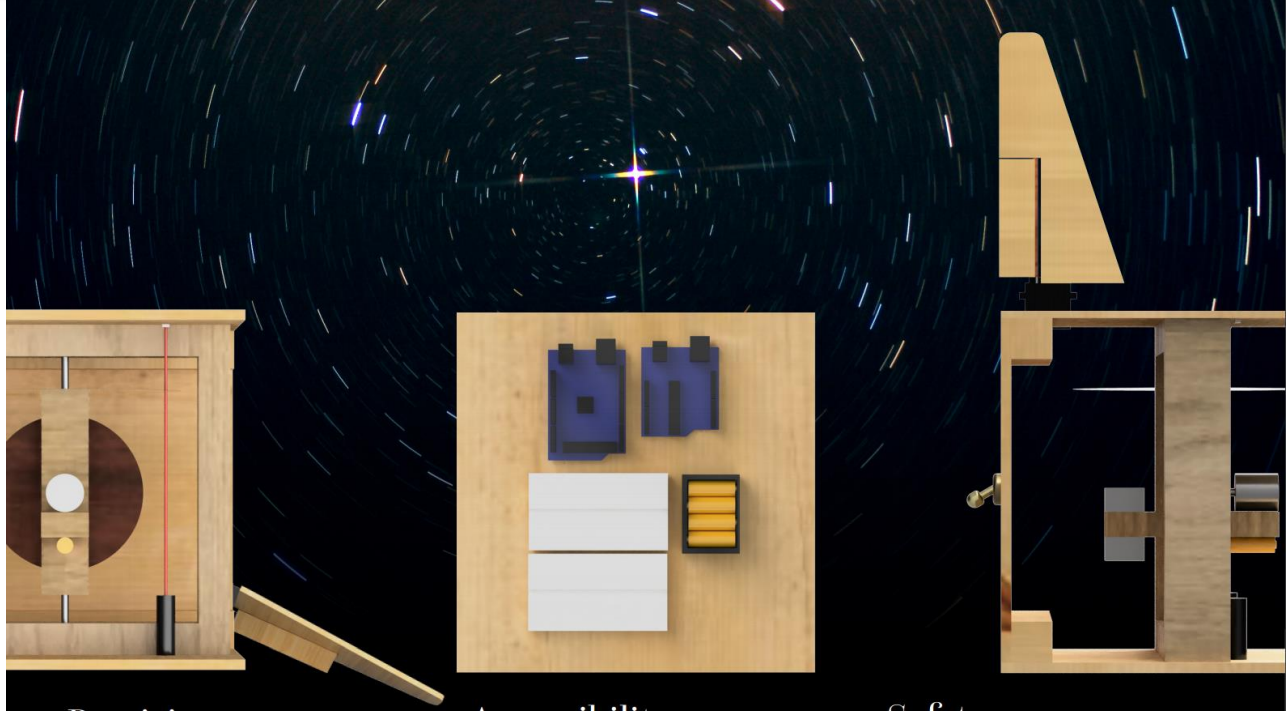
Trust us...



We took AP Physics C

POLARIS

Precision Optical
Laser-Based Aeronautical
Rotation Information System



Precision

POLARIS reads rotation up to a resolution of 5 degrees in all three axes of rotation. In complete, implemented, and calibrated systems, this value is expected to become even more precise. Four sets of servo controlled fins react to every read movement, ensuring your path stays true.

Accessibility

The POLARIS system relays rotational and technical data to an external display, allowing you to easily ensure the system is functioning at the proper level. This information can be conveniently displayed using the given software, providing graphs to visualize your every need.

Safety

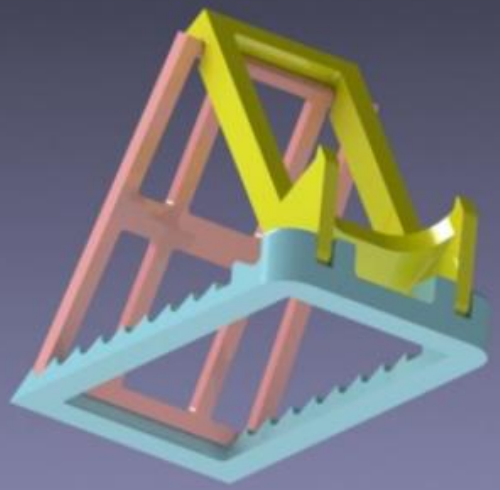
Designed with safety in mind, the entire POLARIS system may be turned on and off with ease, using externally accessible switches. The use of individual, modular circuits rather than a large combined circuit minimizes the risks of laser diode burnouts or dangerous high voltages.

I used woodworking tools to cut out and assemble the gyroscopes and housing out of wooden panels. I also soldered wires to sensors and motors, connecting everything to an Arduino UNO.

A marketing pamphlet that I created for POLARIS in Adobe InDesign is shown above.

uPhone Stand XX Plus

Stability. In every way.



Eric Zhao
November 24, 2020

Foldable Phone Stand

Skills used: Solidworks, GrabCAD Print

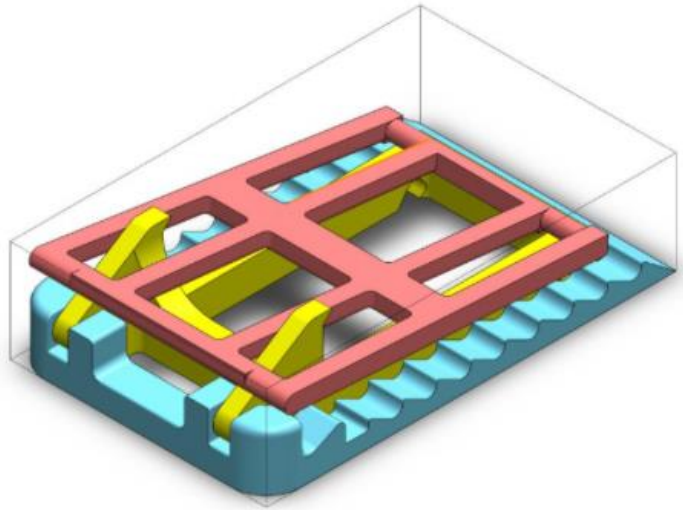
Summary: I designed a 3D printable phone stand that can hold my phone at 8 different angles with room for charging. I optimized the design for 3D printing in GrabCAD Print and was able to order a print from the University of Waterloo.

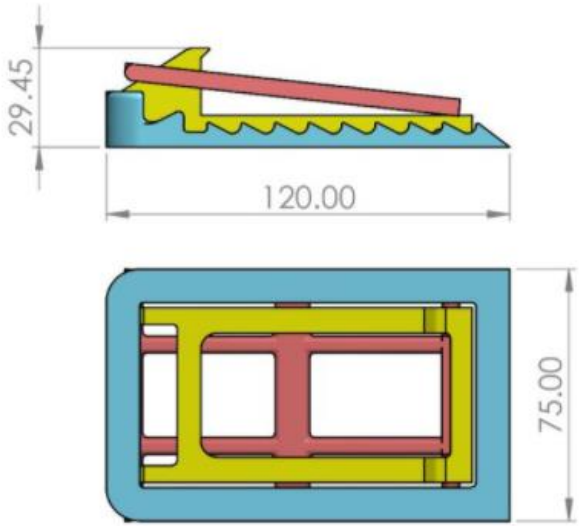
The assembly can be collapsed to fit into a 75x120x30 mm box for shipping or storage.

Easy to use.

Simple to disassemble.

Small to carry.

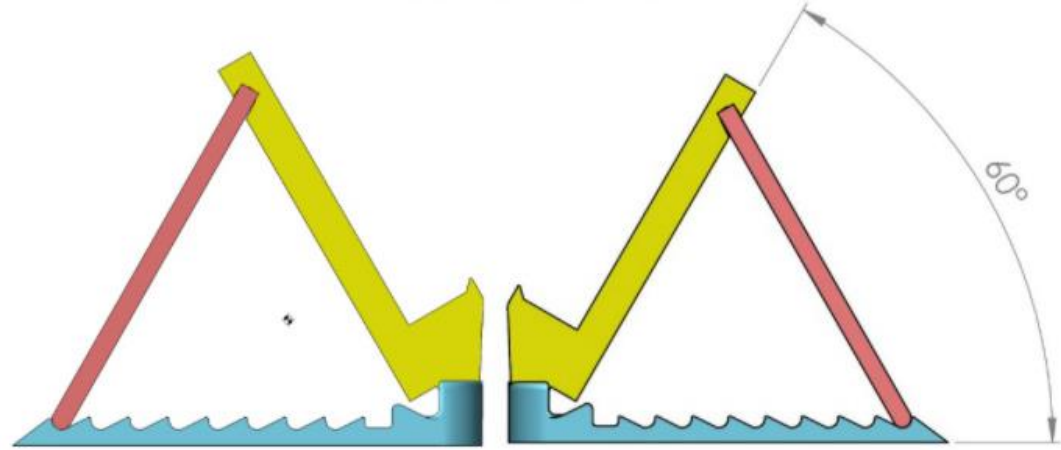


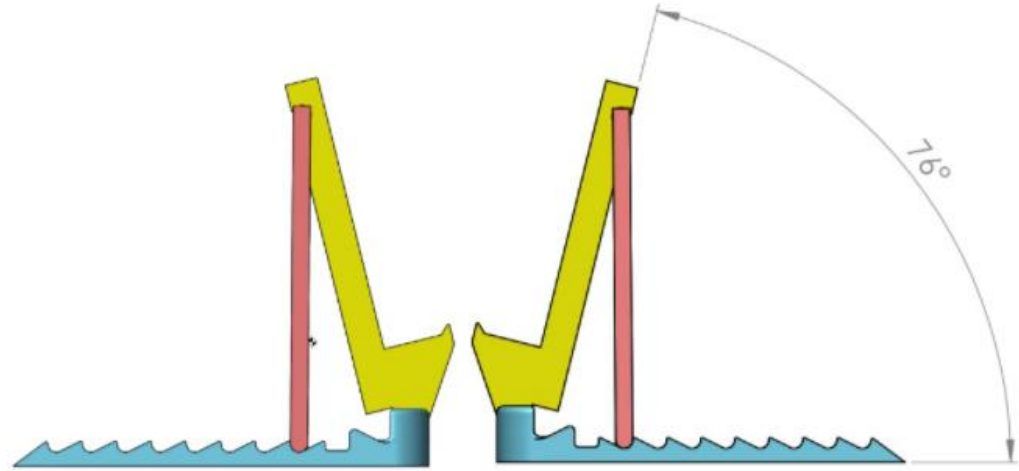


8 angles.

16 degrees.

1 Phone Stand.





Conveyor Design Project

Skills used: SolidWorks, Microsoft Word, Adafruit MakeCode

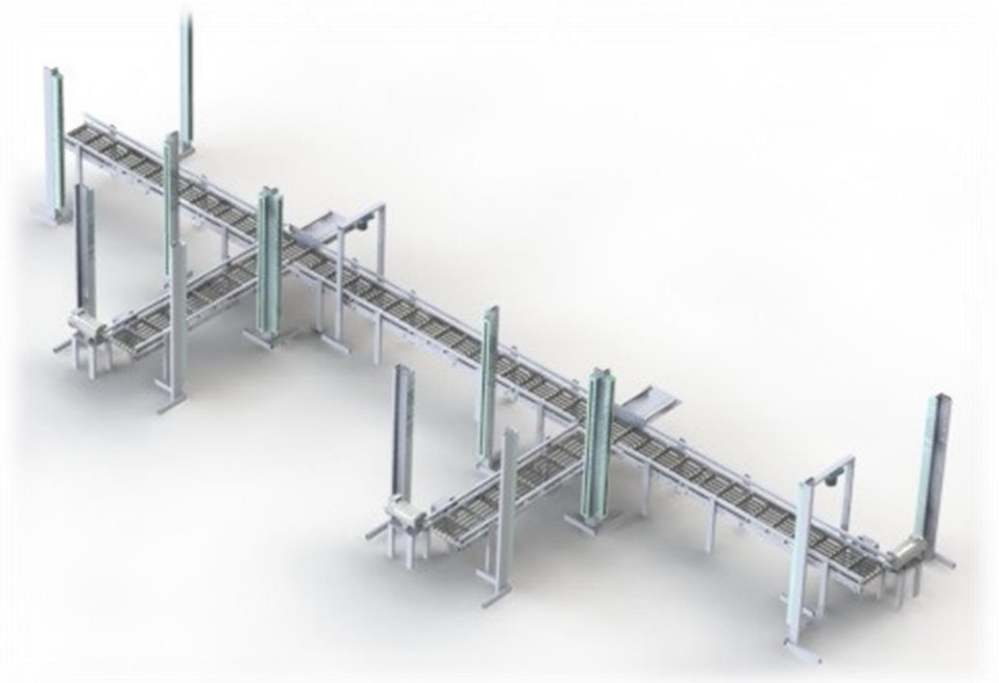
Summary: I led a team of 4 to design and produce a professional report, bill of materials, and CAD model for a fully functional conveyor system which autonomously identifies and sorts packages. Solidworks was used to design the frame and assemble the system, and Adafruit MakeCode was used to run simulations of the sorting software.

Appendix B: Cost Estimate Bills

Section 1:

Table 4: Bill of Materials

Qty	Manufacturer	Part Number	Description	Unit Price	Cost
46	McMaster-Carr	6546K39	Aluminum Rectangular Tube, 1/8" Wall Thickness, 1" High x 2" Wide, 6 ft. Long [6]	$53.93	$2480.78
14	McMaster-Carr	6546K21	Aluminum Rectangular Tube, 1/8" Wall Thickness, 1" High x 1" Wide, 6 ft. Long [50]	$34.91	$488.74
28	McMaster-Carr	4416T65	Hex Bar, 1/2" Wide, 3 ft. Long [8]	$7.49	$209.72
42	McMaster-Carr	2277T13	1.9" Diameter Conveyor Roller, 7/16" Hex Axle, for 13" Between Frame Width [14]	$11.33	$475.86
4	McMaster-Carr	91257A546	Hex Head Screw, 1/4"-20 Thread, 1-1/2" Long [7]	$7.87 per pack of 50	$31.48
1	McMaster-Carr	97633A200	External Retaining Ring for 1/2" OD [13]	$10.54 per pack of 100	$10.54



Refocus

Skills used: JavaScript, HTML, CSS

Summary: I collaborated with a team of 4 to create a study app, Refocus.

A Tensorflow JavaScript face-recognition web API was utilized to measure facial expressions and check when the user is distracted.

A voice-recognition API was used to recognize key words in lectures and create a voice-activated assistant and note-taking section.

Connection Port

Skills used: Solidworks, Confluence, GrabCAD Workbench

Summary: The connection port of the Midnight Sun solar car required a redesign, as the original hinged lid did not work. I created an entirely new port housing and cover, converting the hinged design into a 3D printable sliding cover.

The port housing prints in 3 separate pieces: The port housing, the sliding cover, and a glue-on piece which secures the cover, ensuring it doesn't completely slide off the housing.

The design process for the lid included a back-and-forth feedback cycle between the Interiors team lead and me to optimize the design for 3D printing and assembly. I documented the entire design process onto a Confluence page for the Midnight Sun Solar Car Team.

Part of the design includes a "soft lock" mechanism which ensures the lid stays closed through the vibrations of the car. There is just enough clearance for the rail to slide over the hump, providing a soft click when the cover has been pushed to the end.

CC Connection Port

EZ

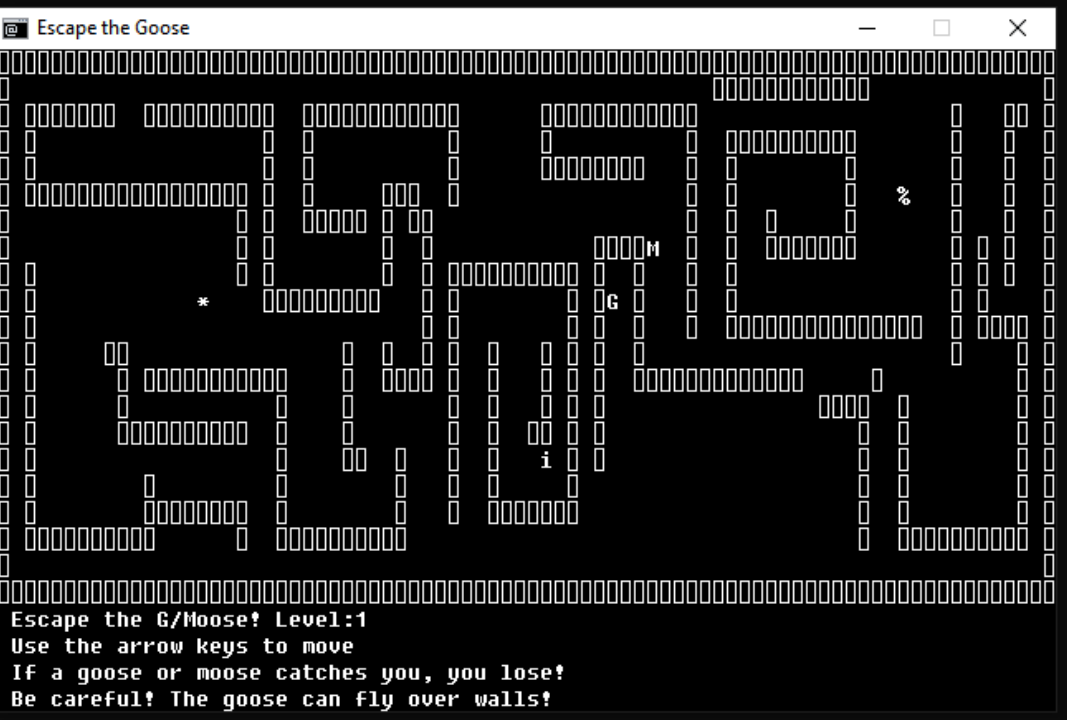
Created by Eric Zhao
Last updated less than a minute ago • 7 min read • 2 people viewed

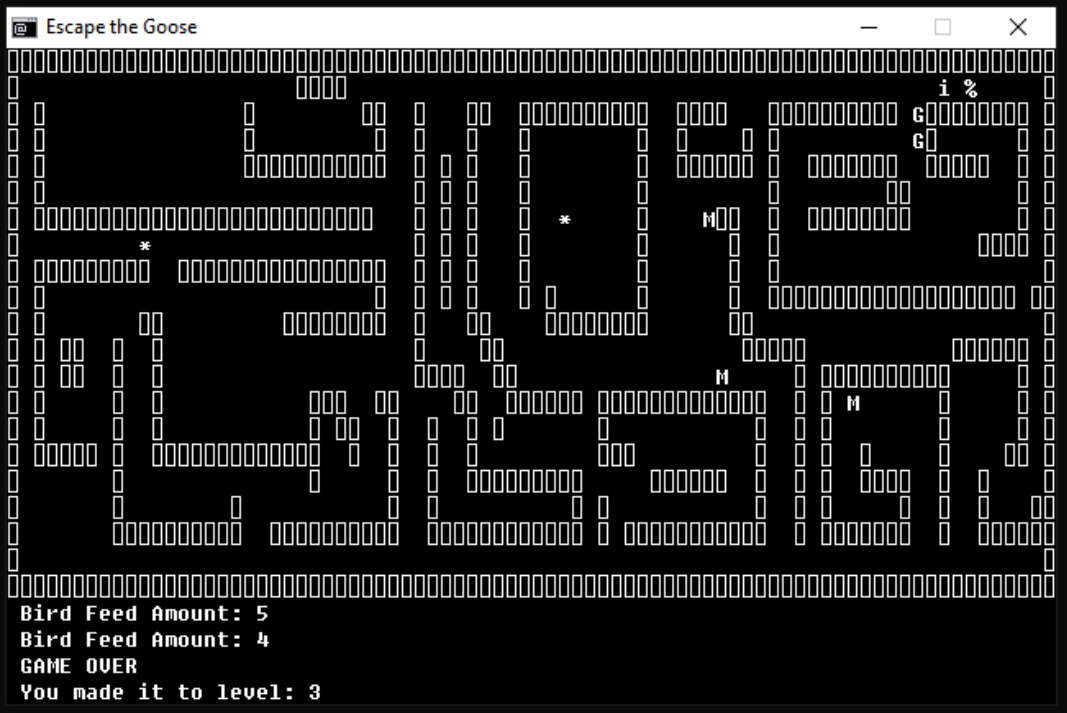
Intro

The side of the catamaran cover will have a port that houses the connectors we need such as USB-C fo
phone charging and CAN debug outputs. @Renzo Villanoy originally designed a port housing and c
be 3D printed but the design for the hinge had some issues that needed to be improved upon. The go
this mini project was to find a redesign for the port cover and housing that is able to meet all the
requirements and is easy to use.

Requirements:

- Outer dimensions do not ch
- Must be 3D printable, the simpler the





Goose Escape

Skills used: C++

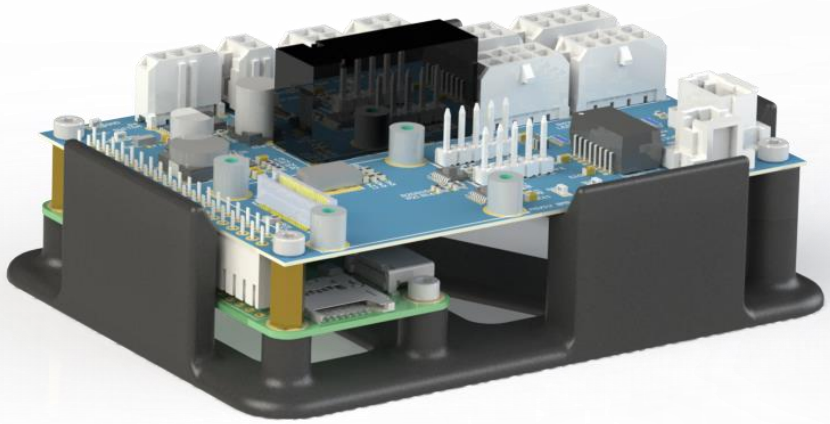
Summary: A 2D, endless dungeon, arcade game created in C++ using BearLibTerminal libraries.

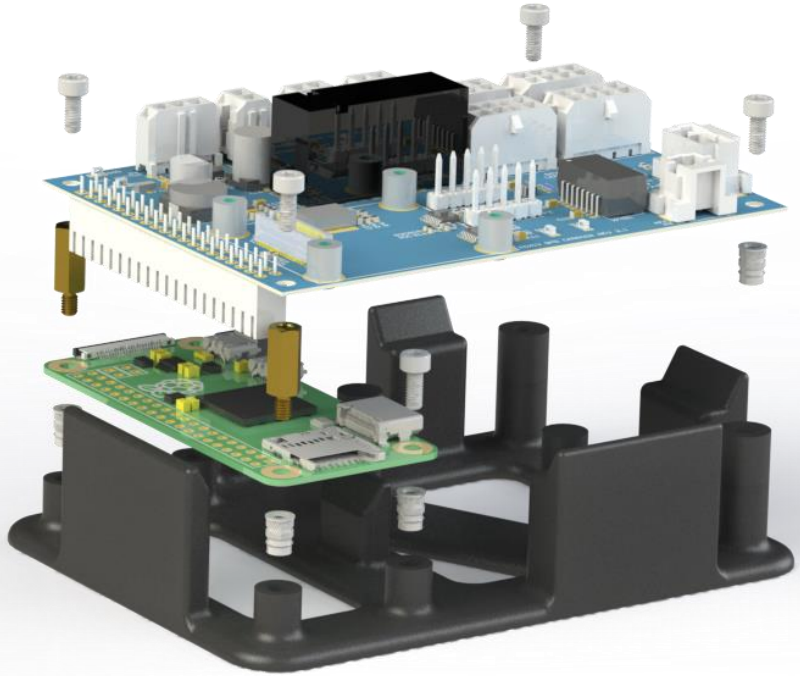
I developed algorithms to generate fully randomized mazes, special game mechanics such as powerups, and various types of monsters and chase movement.

PCB Mounts

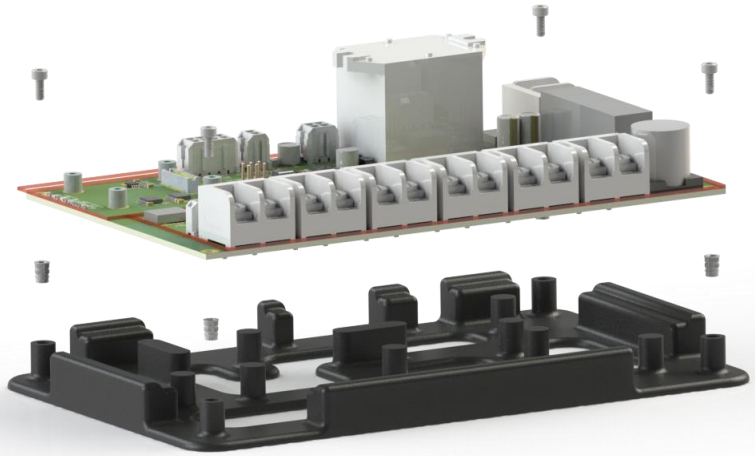
Skills used: Solidworks, Altium 365, GrabCAD Workbench

Summary: In order to secure the newly designed printed circuit boards for the Midnight Sun Solar Car Team safely, I was responsible for designing mounts for 9 different boards. Altium 365 was used to pull the most recent board versions into Solidworks, where personalized board mounts were created for each of the new boards.





I also performed research into heat inserts, designing the mount standoffs so that heat inserts can be used to provide threads for fasteners.



GrabCAD Workbench was used to sync up my designs with the rest of the project, allowing for easy collaboration of work on the Midnight Sun solar car.