Michael Lu

EECS @ MIT ‘23

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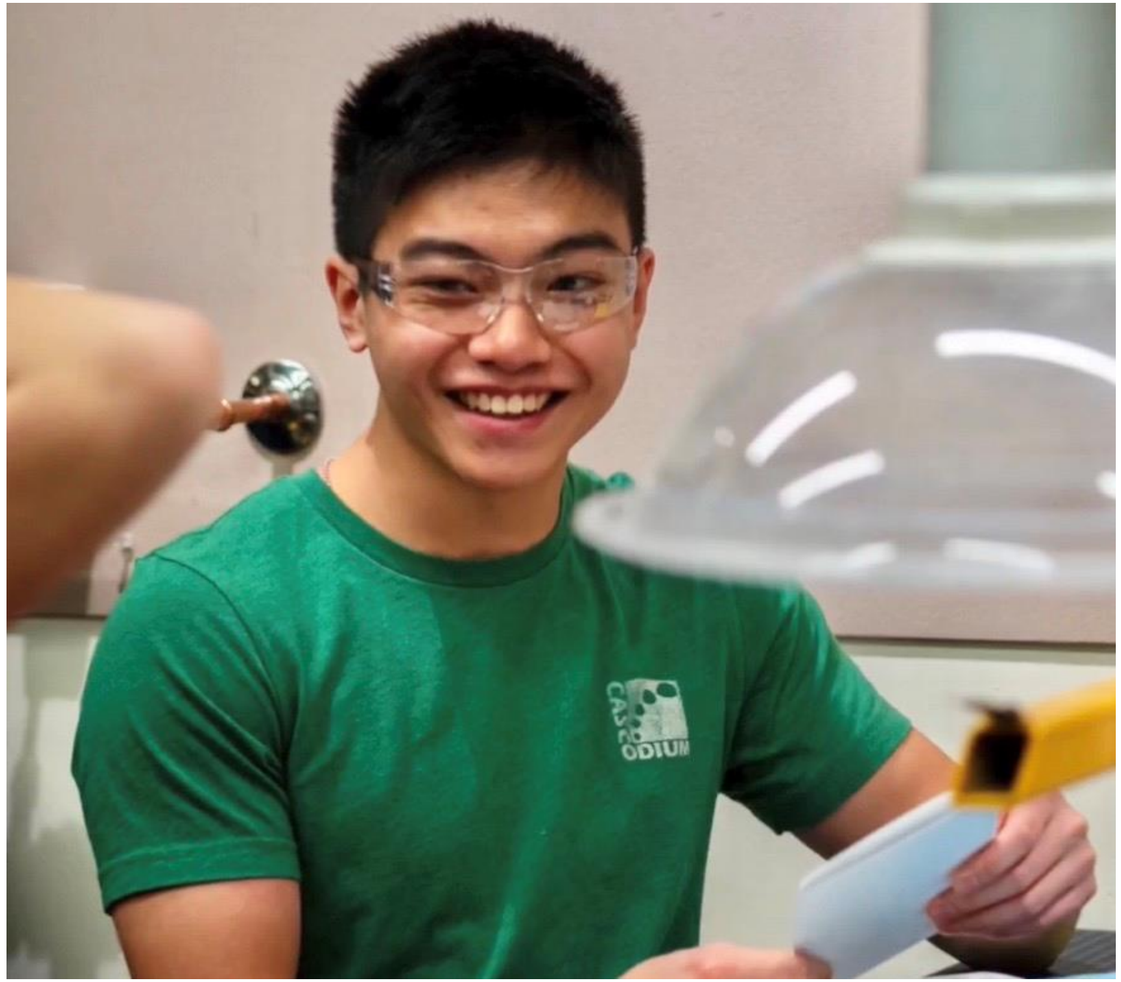


Hi, I’m Michael!

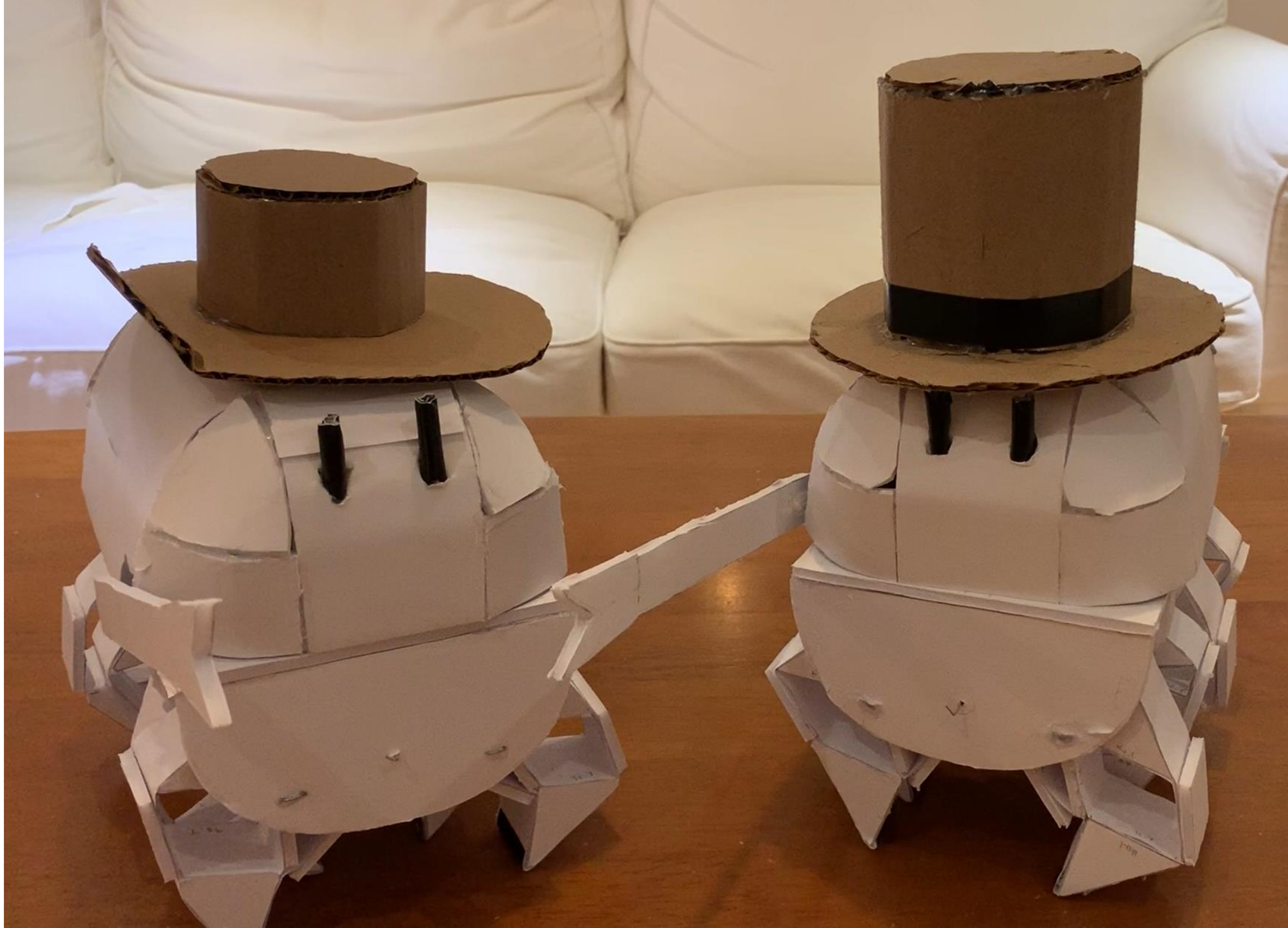
Just as painting is the creative outlet of an artist, engineering is my way to translate the imaginative ideas of my mind into the inventive work of my hand. This perspective is the foundation of my work as a sophomore at MIT studying Electrical Engineering and Computer Science.

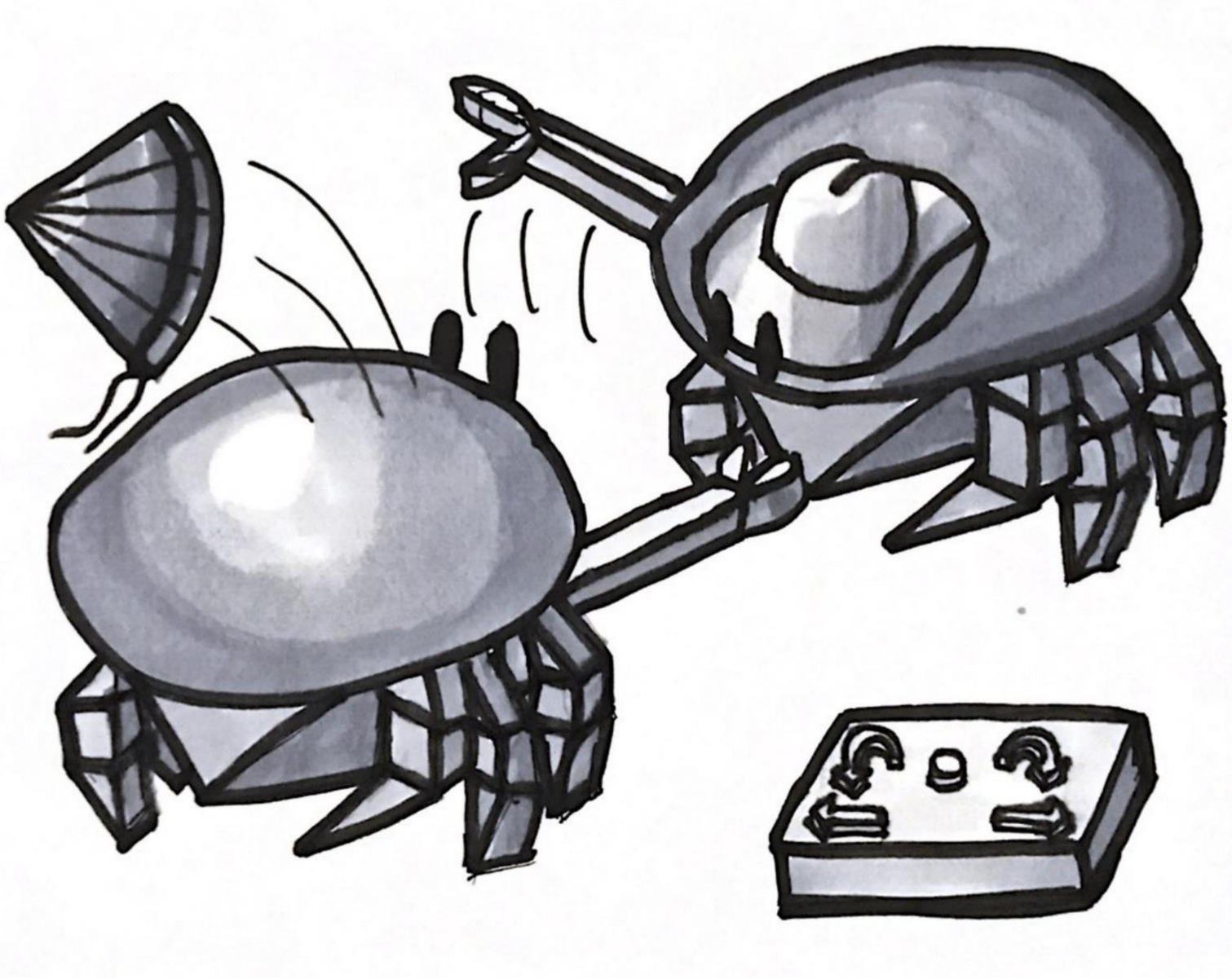
Kombat Krabs

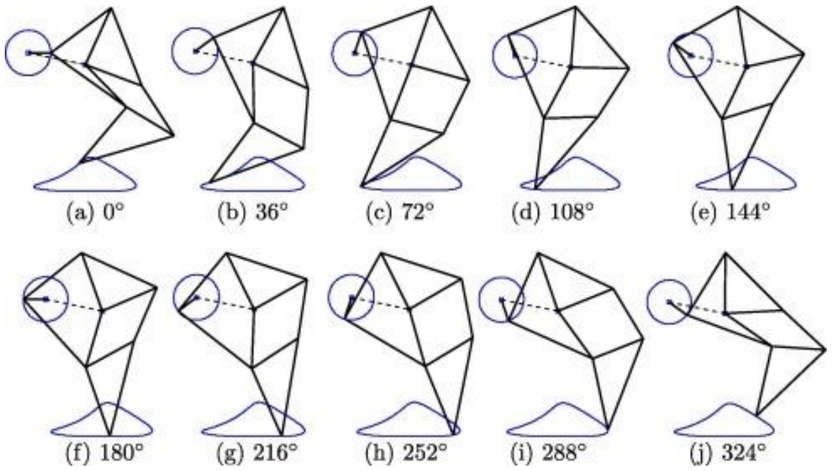
2.00B – Toy Product Design
April – May 2020

Remote-controlled toy robot crabs that walk using the famous leg linkage of kinetic sculptor Theo Jansen. These were built primarily out of foam core, paper, and cardboard.

Demo:
web.mit.edu/2.00b/www/portfolios/student_portfolio.html?s=mlu0708&a=playsentation
Code:
github.com/michaellu2019/kombat-krabs
CAD:
a360.co/3ePCxNx

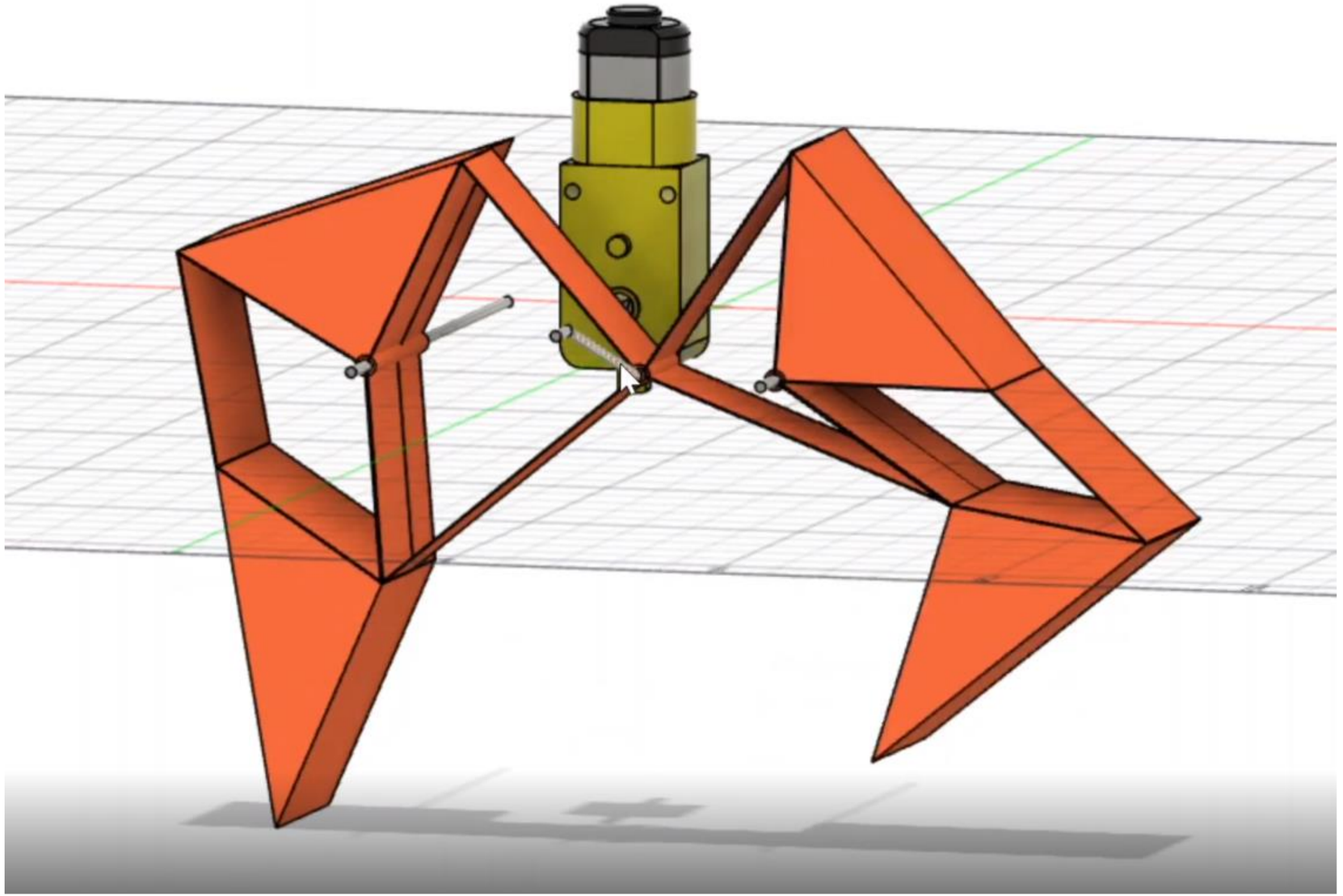






Ideation and Sketching

The biggest challenge of Kombat Krabs was designing a mechanism for the crabs to walk on eight legs. I decided to use Jansen's Linkage, a clever walking mechanism composed of several connected segments that would trace out a smooth walking curve when driven by a circular rotational shaft.

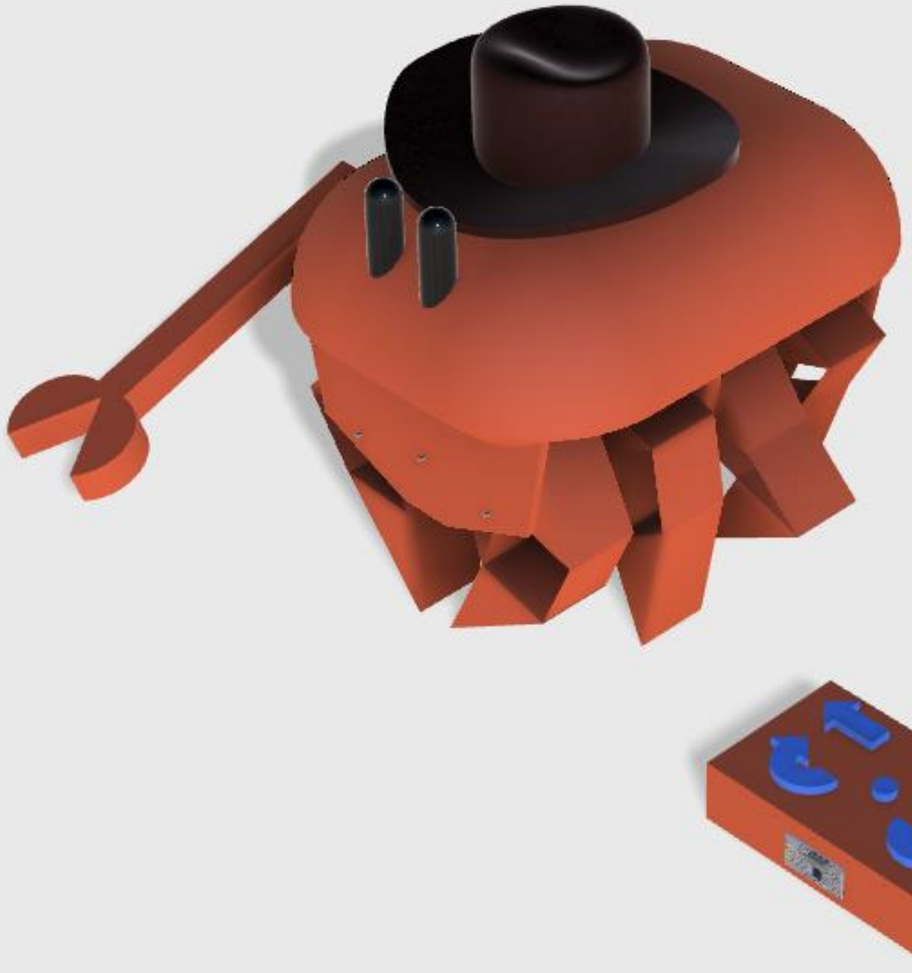


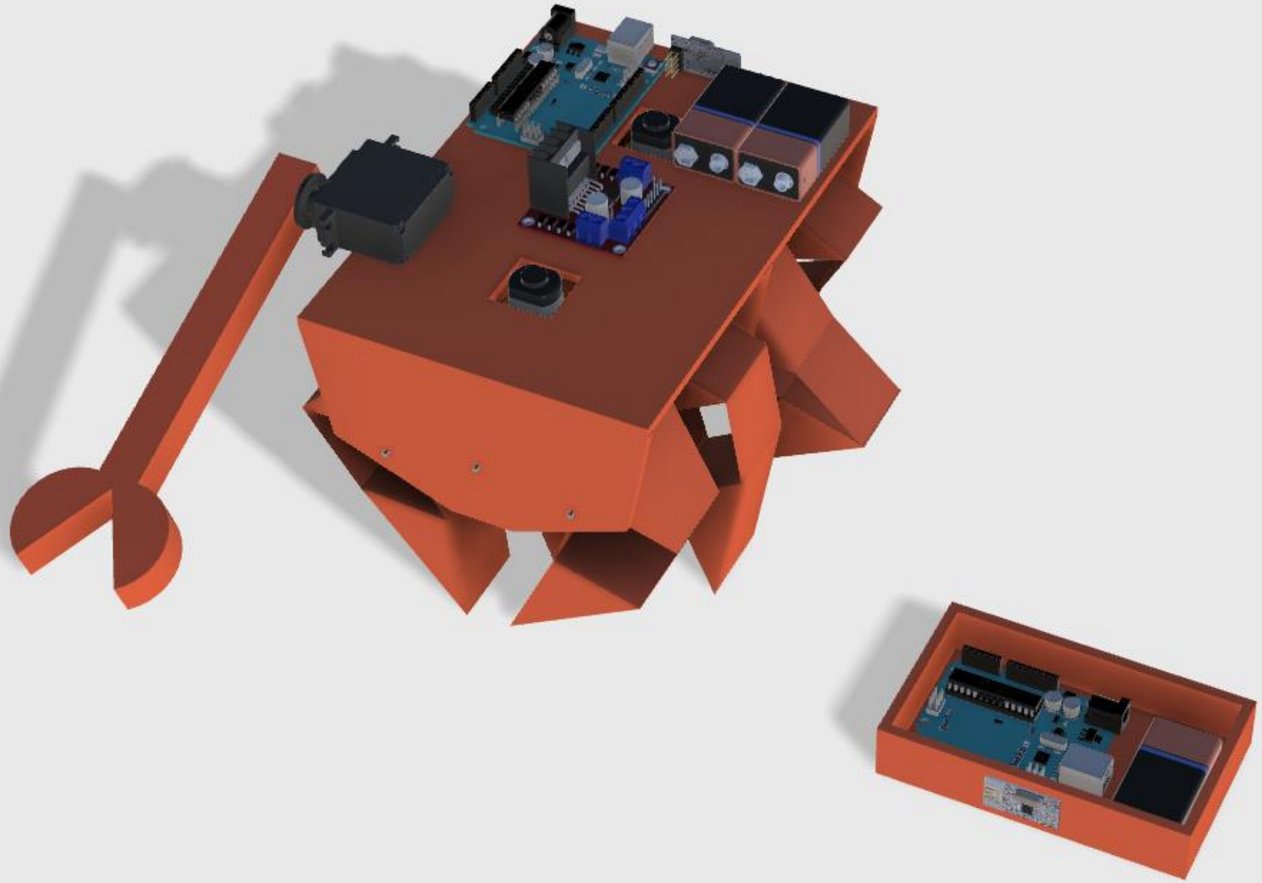
3D Modeling

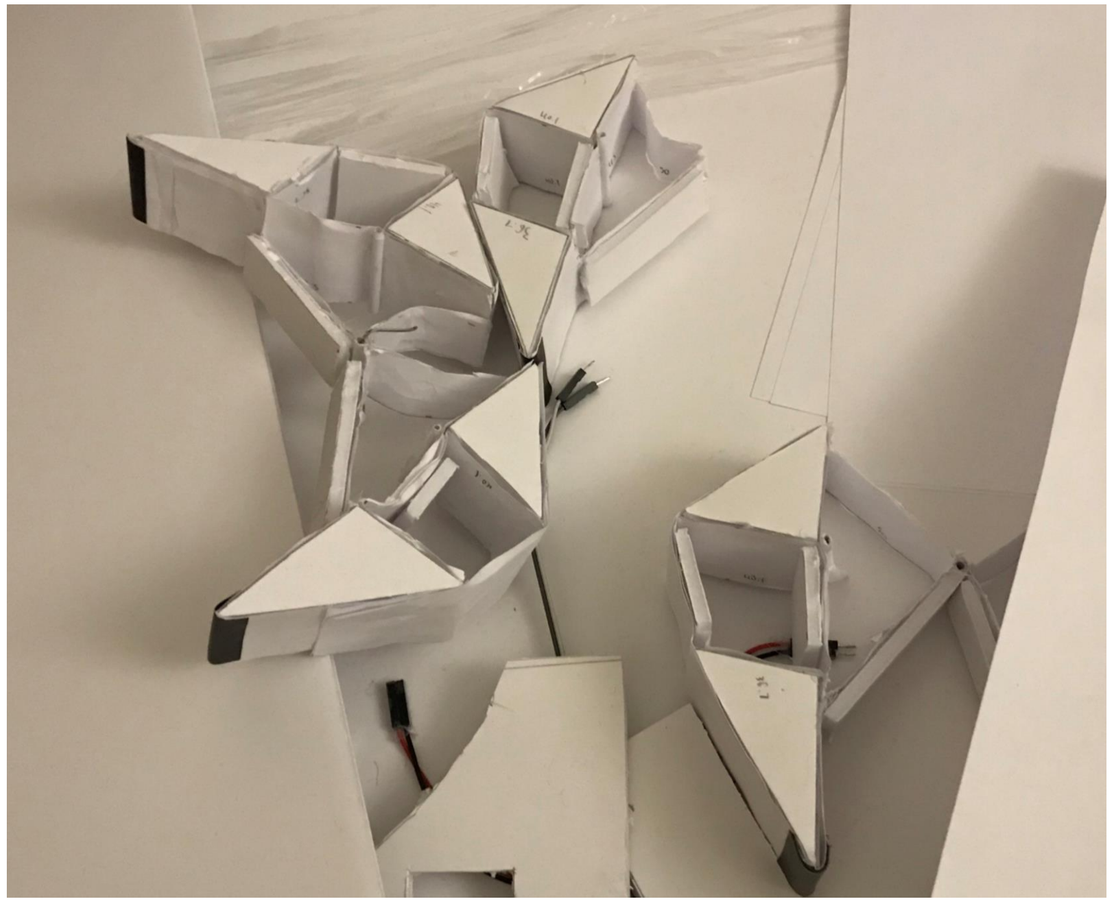
Using Jansen’s Linkage, multiple legs could be driven by one motor. Thus, a crab with eight legs would have two motors, each controlling four legs. This would allow crabs to move straight and turn.

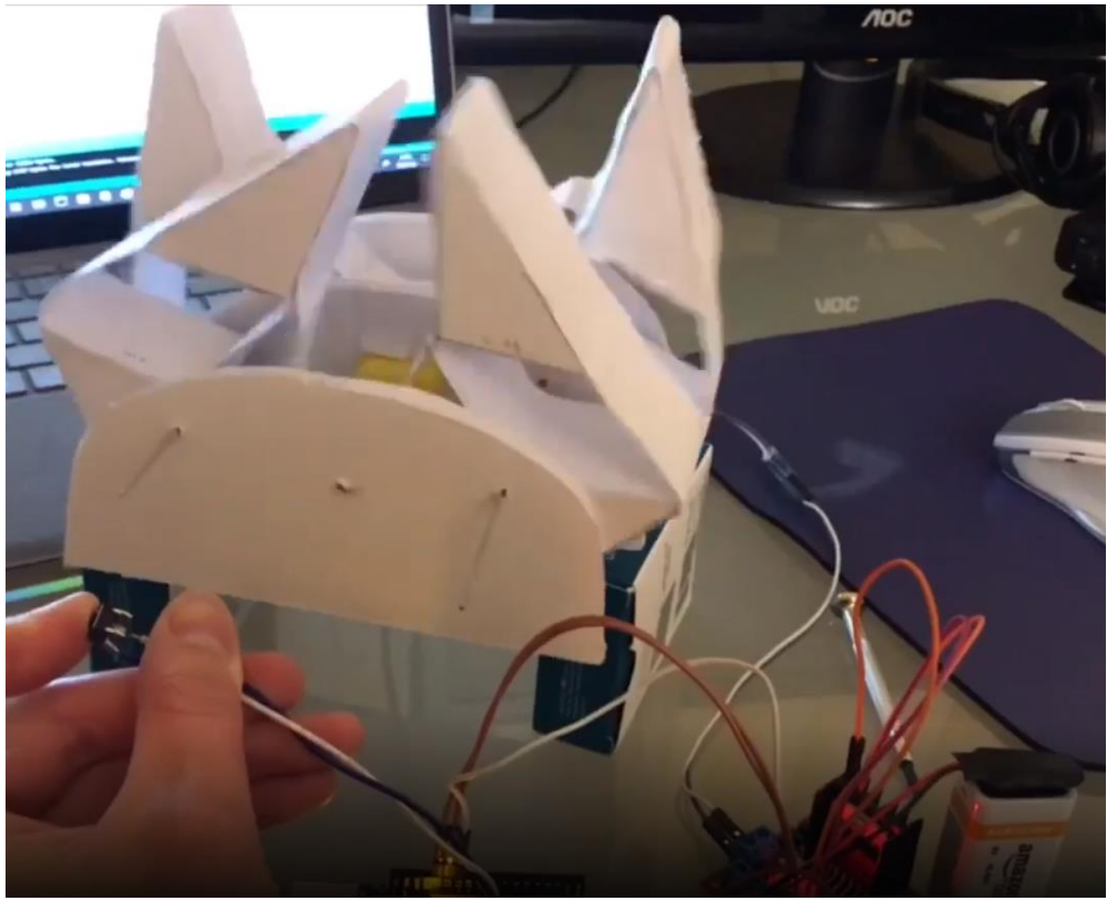
3D Modeling

The entire crab, everything from the leg mechanism to the crab shell to the electronics, was modeled in Autodesk Fusion360.



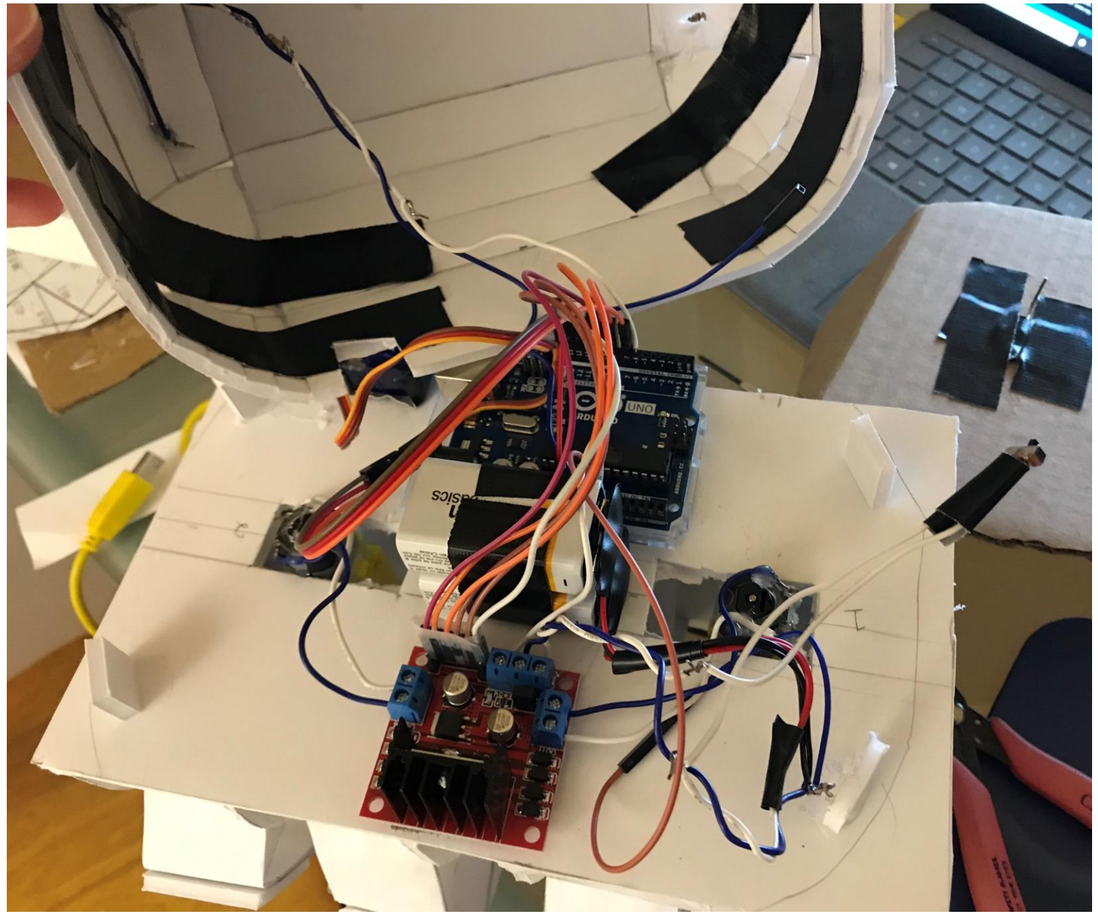


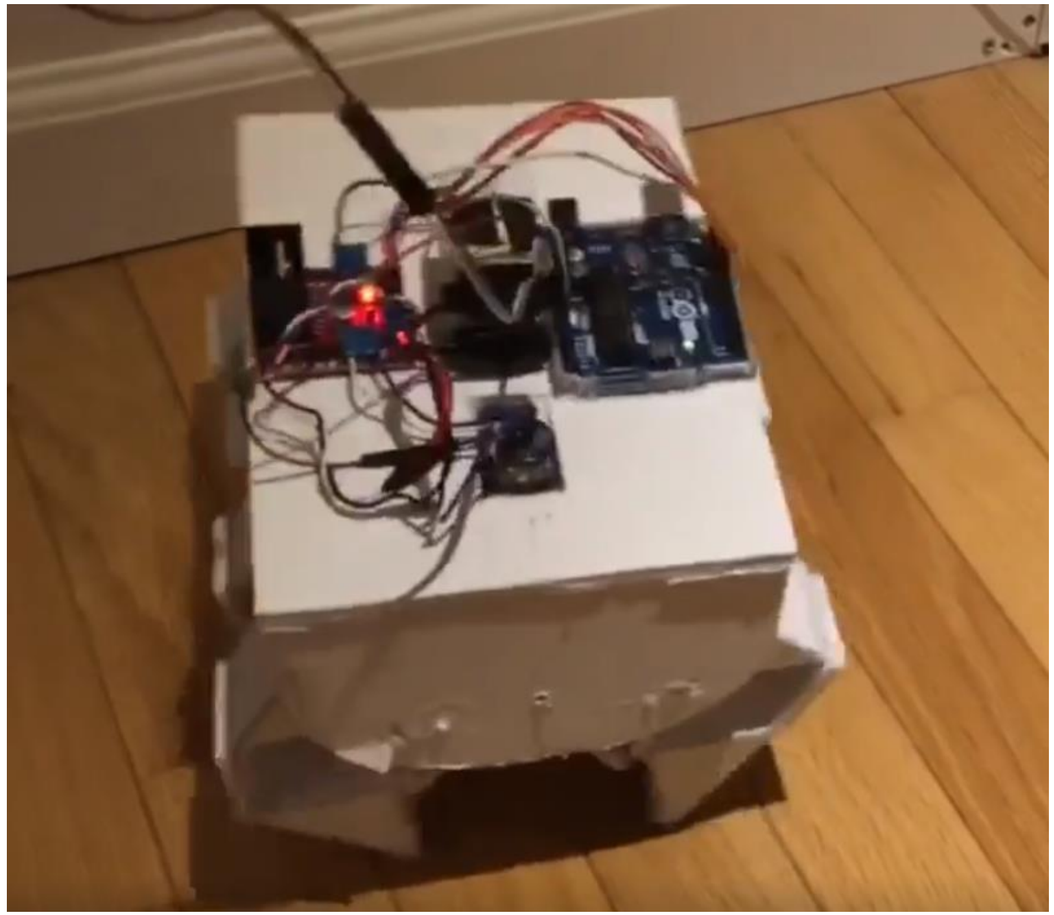




Prototyping

The biggest challenge of prototyping was optimizing the crab's walking curve by tweaking the dimensions of Jansen's linkage for the crab legs. Some linkage segments were reduced to shrink the size of the crab's walking curve, which was important so that the crab could maintain its balance, especially with a high center of gravity.





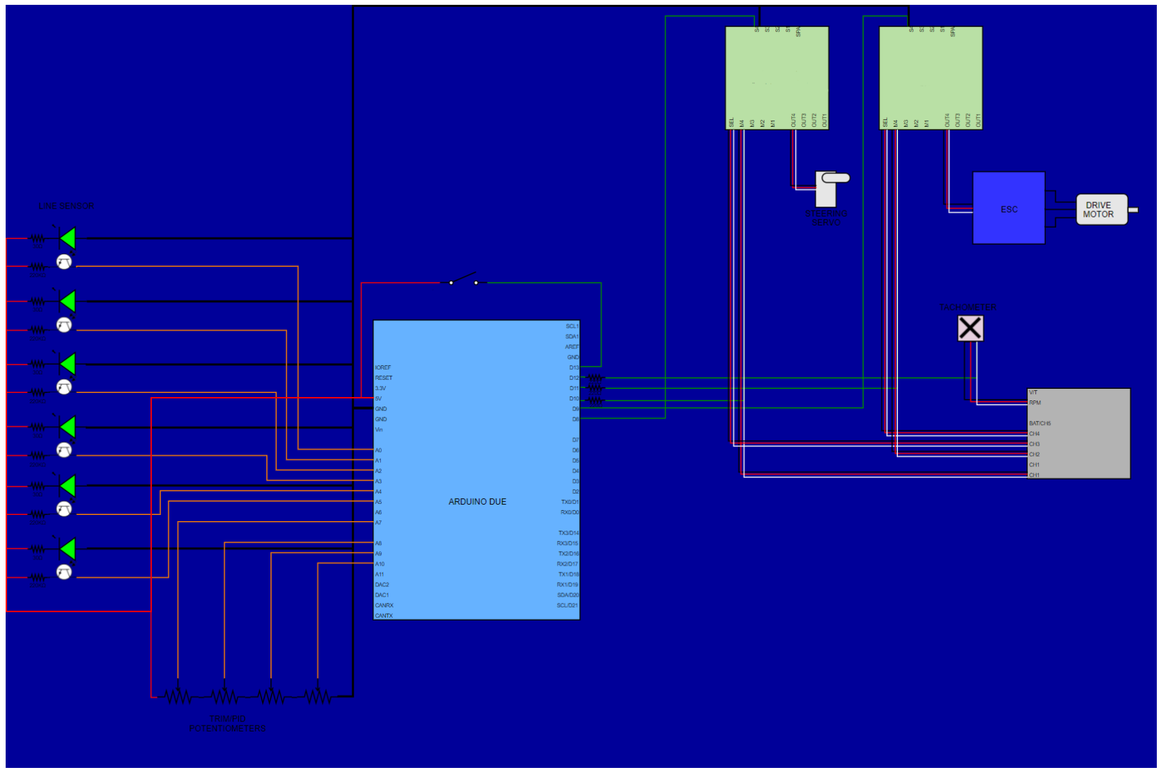
Prototyping

The main crab electronics included an Arduino Uno R3, L298N Motor Driver, NRF24L01 Transceiver, SG90 Micro Servo Motor, two Antrader Dual Shaft Gear Motors, and two 9V batteries.

BeatBot

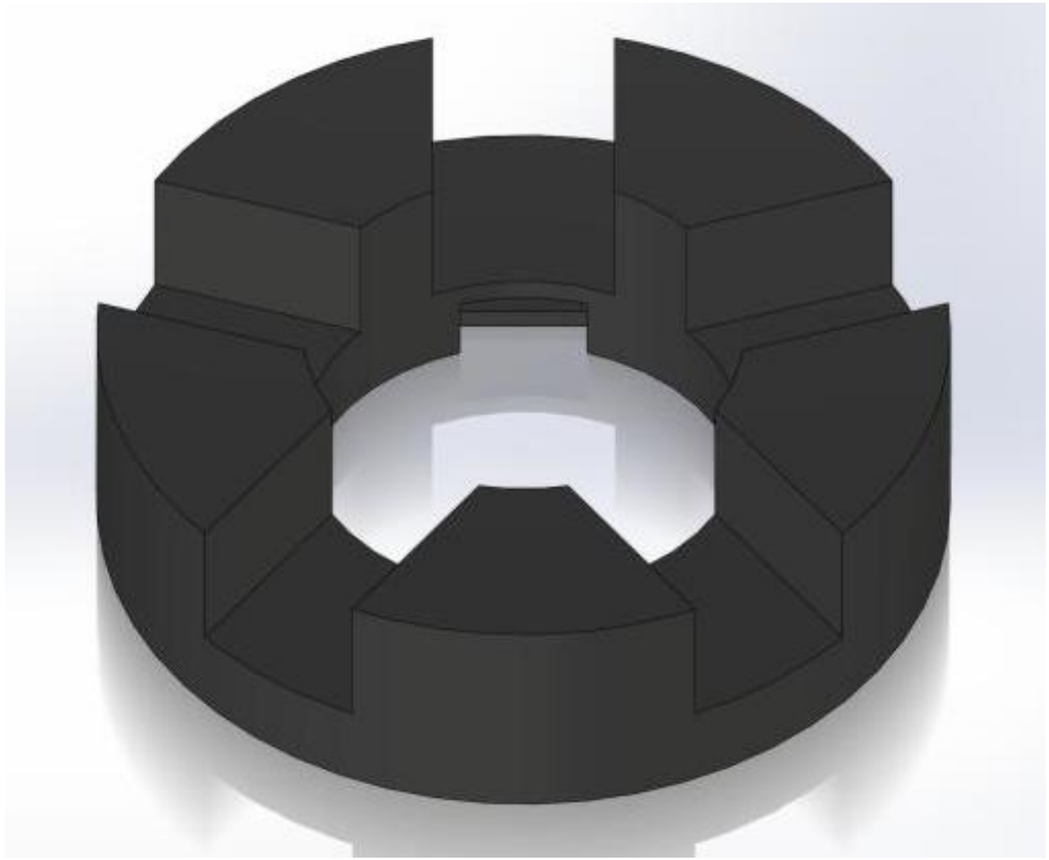
10XBeta
October 2018 – June 2019

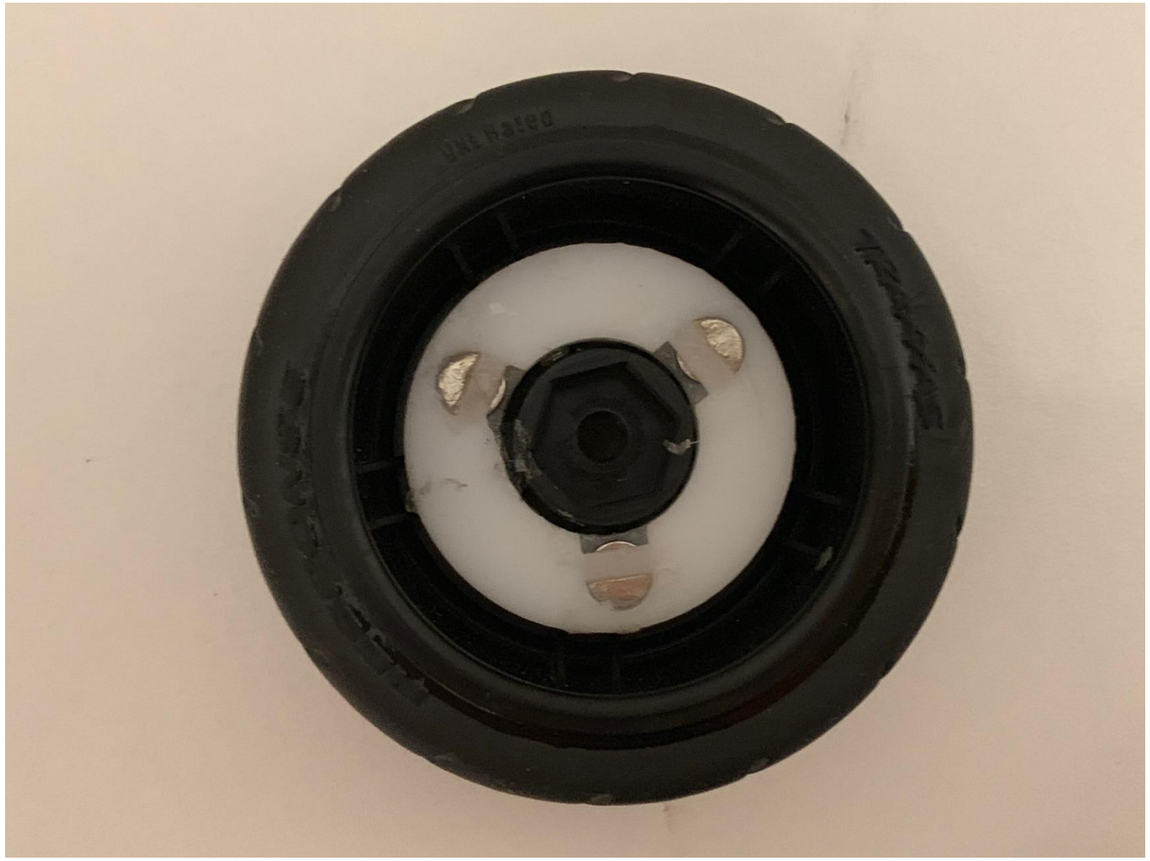
An autonomous line-following car that paces long distance runners along a running track. This was a prototype of the second version for the original PUMA BeatBot built by 10XBeta, JWT, and PUMA in 2016.



Ideation and Designing

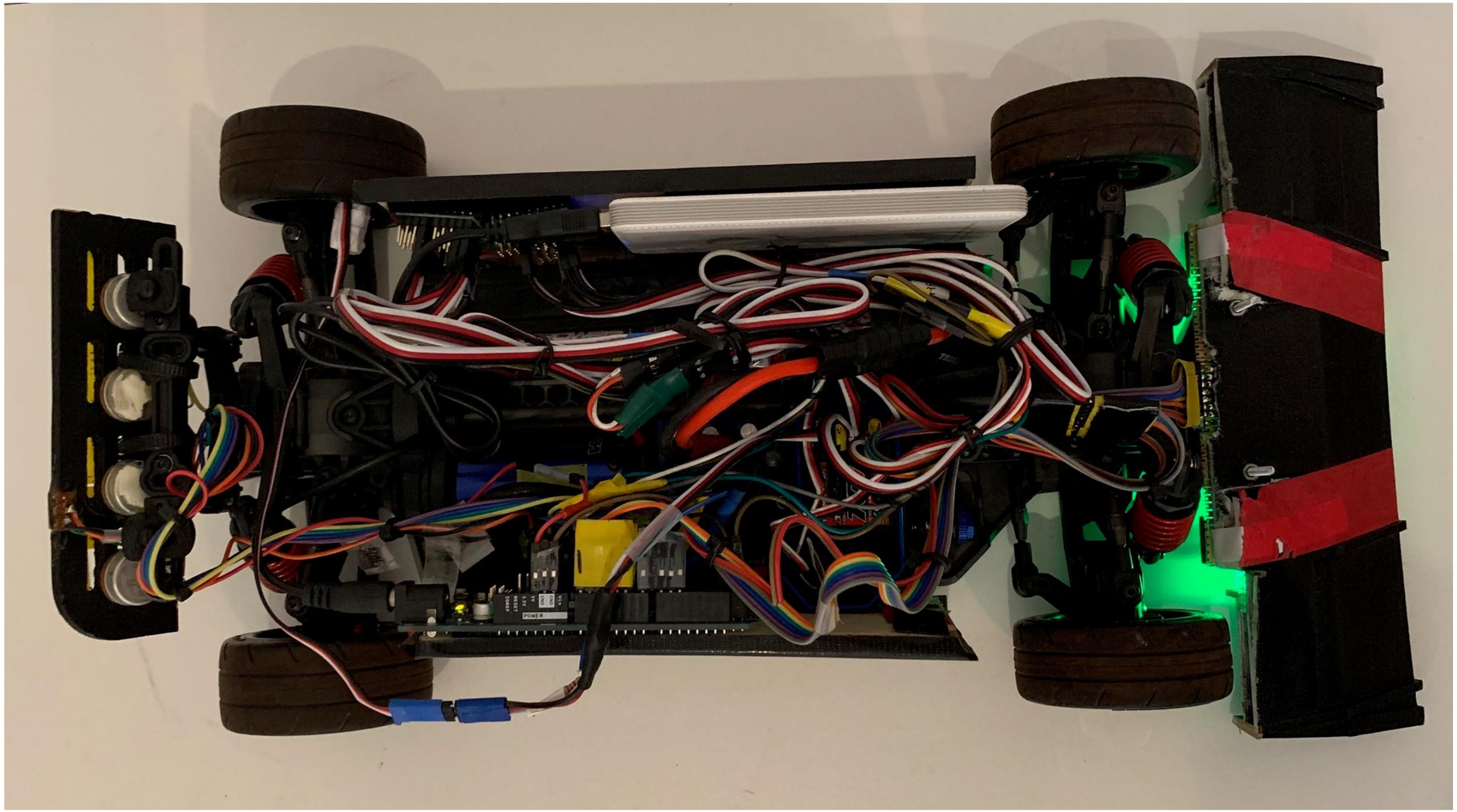
The previous BeatBot had been built on a large, heavy remote-controlled car chassis, which was limiting its maneuverability at high speeds. For the new BeatBot, I decided to go with a smaller and lighter chassis. The challenge thus became fitting the numerous electronic components on a smaller chassis.





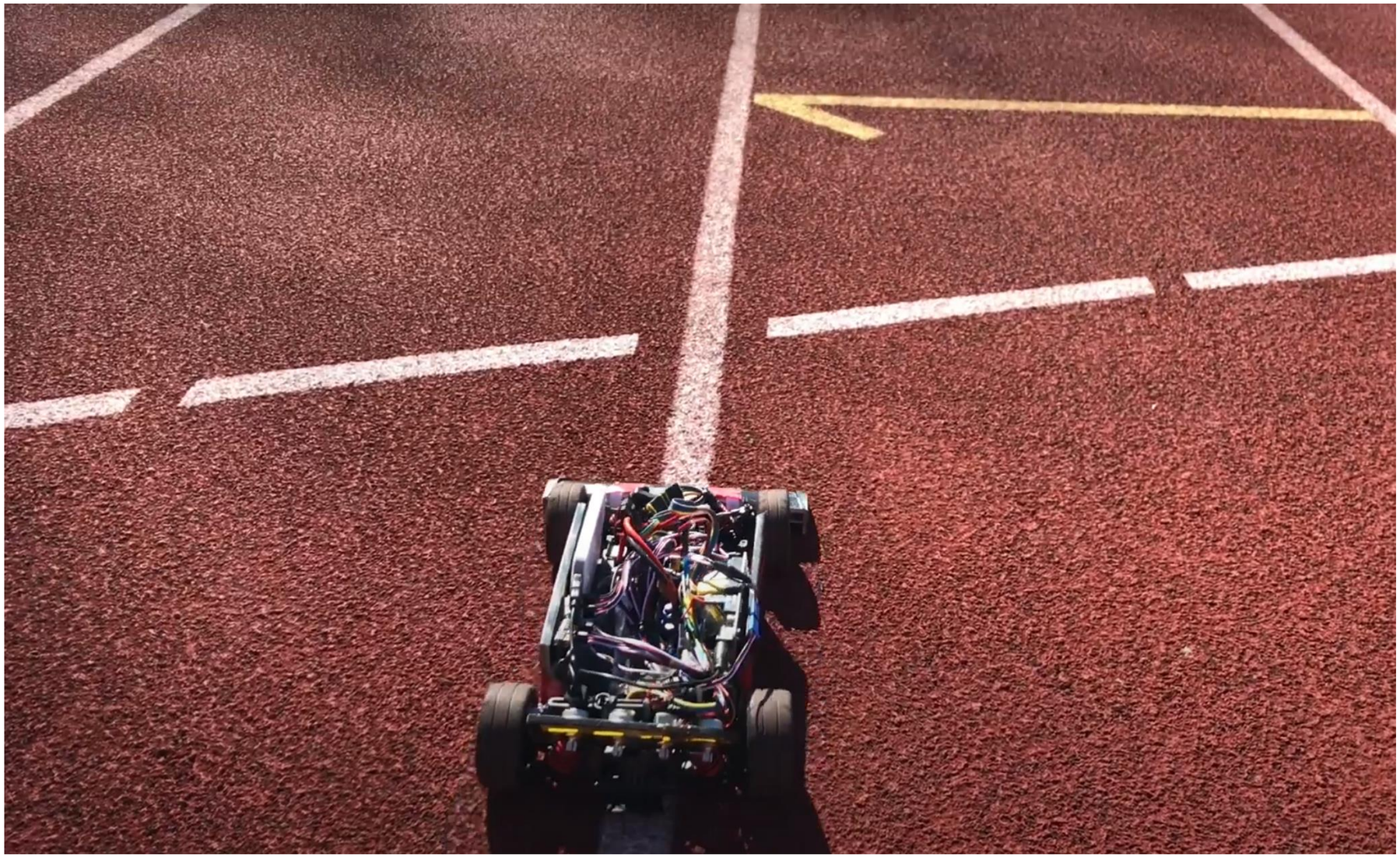
3D Modeling

Because a new chassis was being used, I had to redesign many sensor mounts in Solidworks. For instance, the tachometer magnets used to measure wheel rotations would be housed in a new custom SLA 3D-printed wheel mount that would clip onto the car wheel spokes.



Prototyping

In addition to changing the chassis, I switched many metal pieces of the old BeatBot to 3D-printed plastic pieces that were strong yet light. This change ultimately reduced the prototype weight by 34% and size by 40%.



Programming

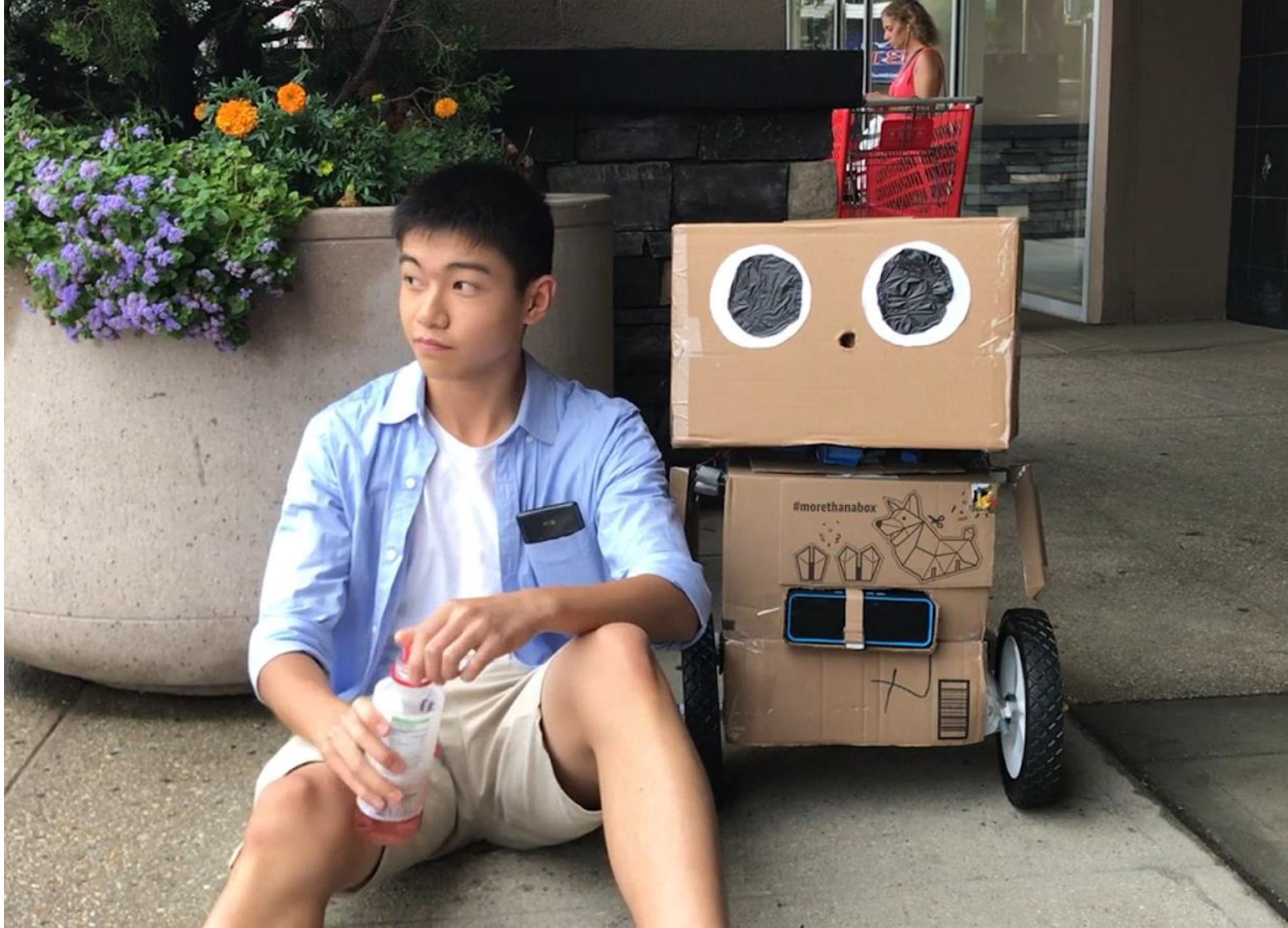
The line-following feature of the BeatBot relied on a PID loop in its software. A large portion of the prototype development cycle was dedicated to retuning the PID values for the new car chassis.

Toby

Personal Project
July – September 2018

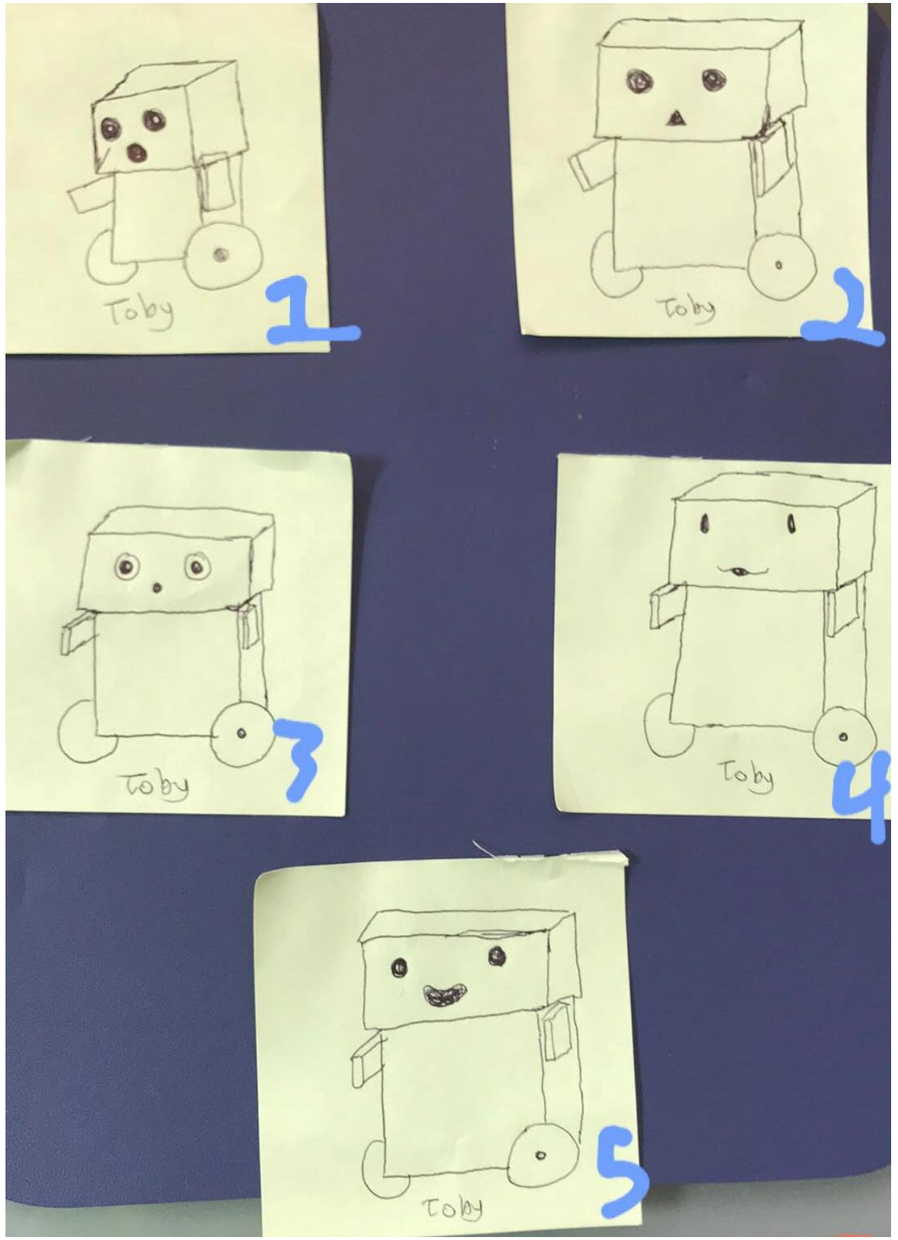
A homemade robot built primarily out of ordinary items: cardboard, paper, Legos, cordless drills, and a smartphone.

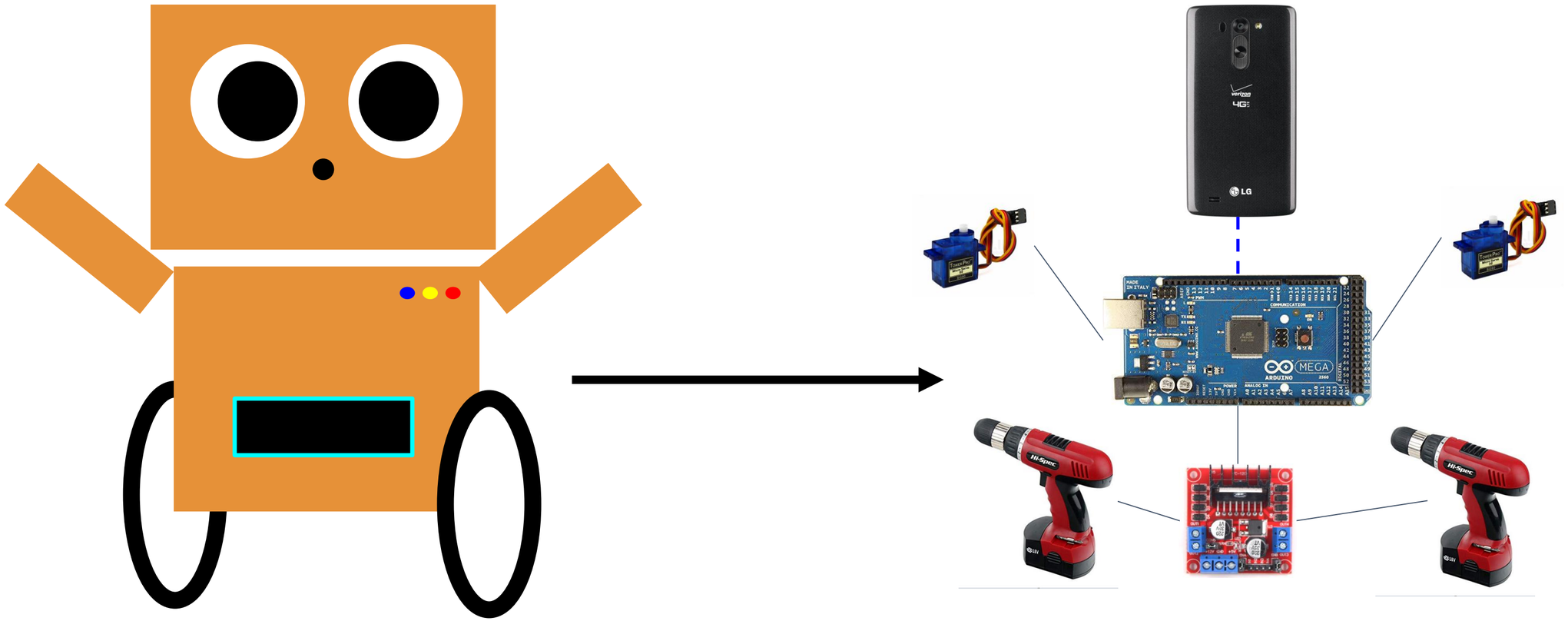
Demo:
youtube.com/watch?v=3ILHPyHL_tg
Arduino Code:
github.com/michaellu2019/Toby
Android Code:
github.com/michaellu2019/Annice-Brain-App



Ideation and Sketching

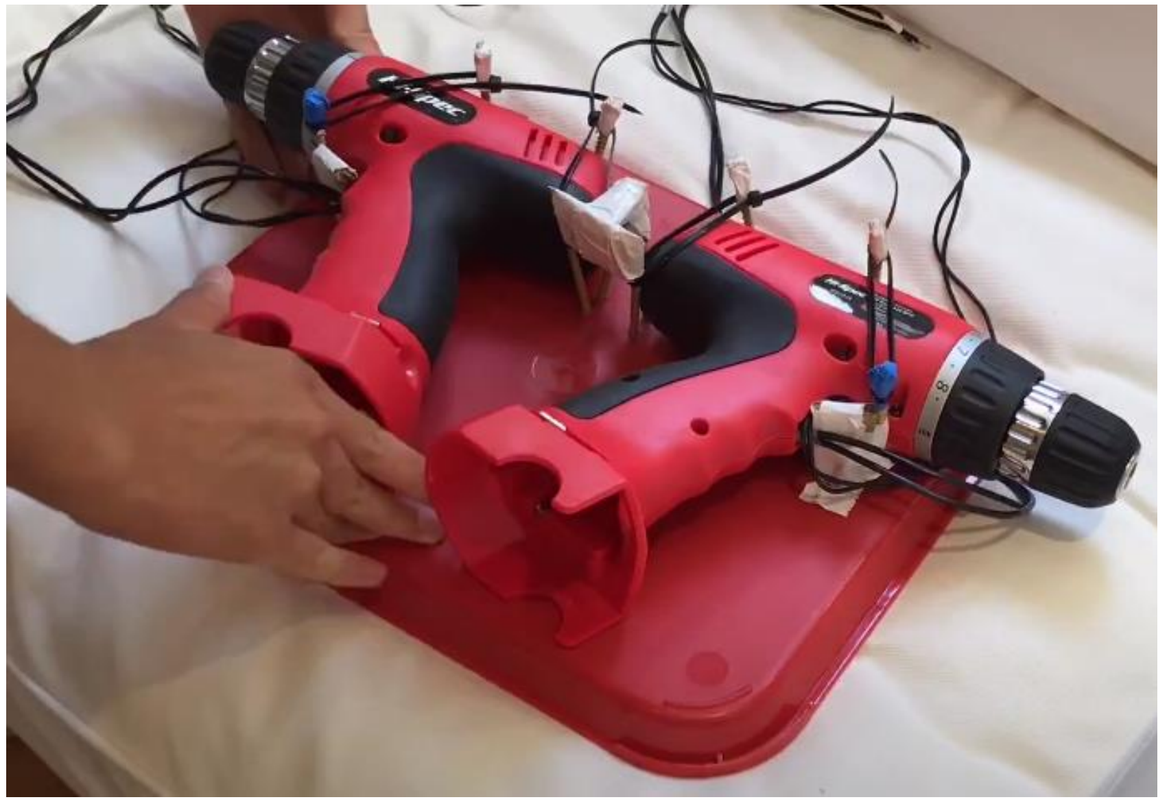
I noticed this #morethanabox illustration on one of my Amazon packages over the summer, and it inspired me to push the limits of what a simple cardboard box could become, so I decided to create a giant robot named Toby out of ordinary items. I especially explored through many post-it sketches how to make Toby seem as friendly as possible.

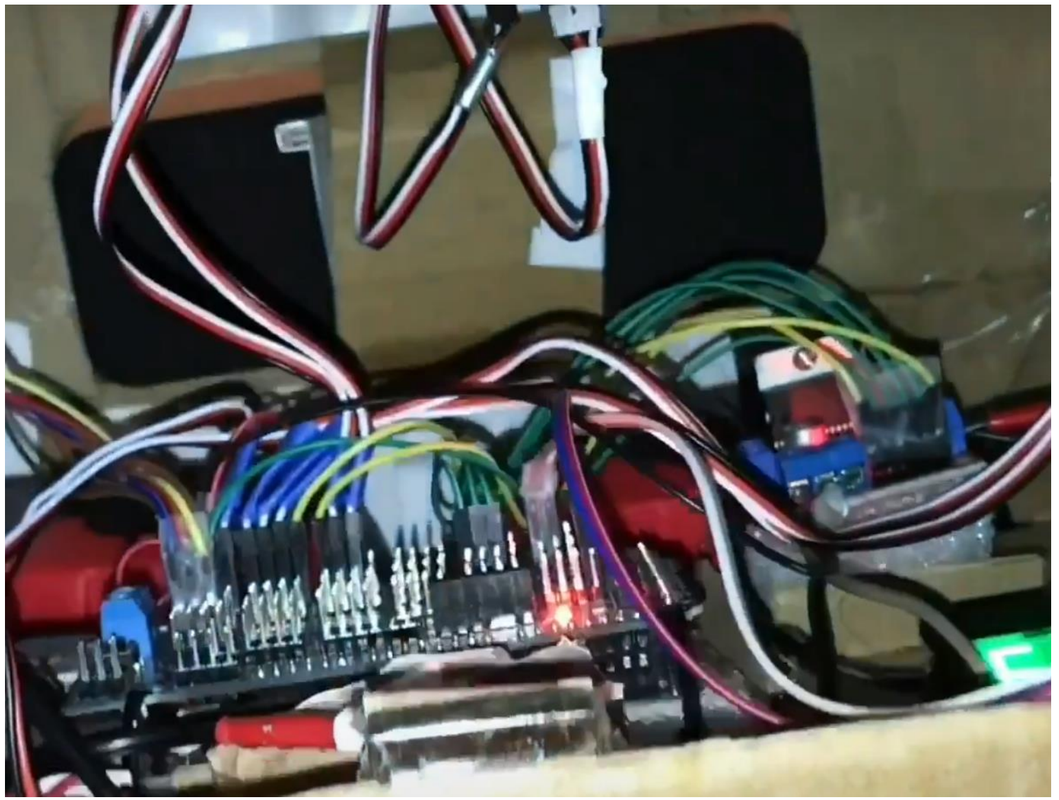




Ideation and Designing

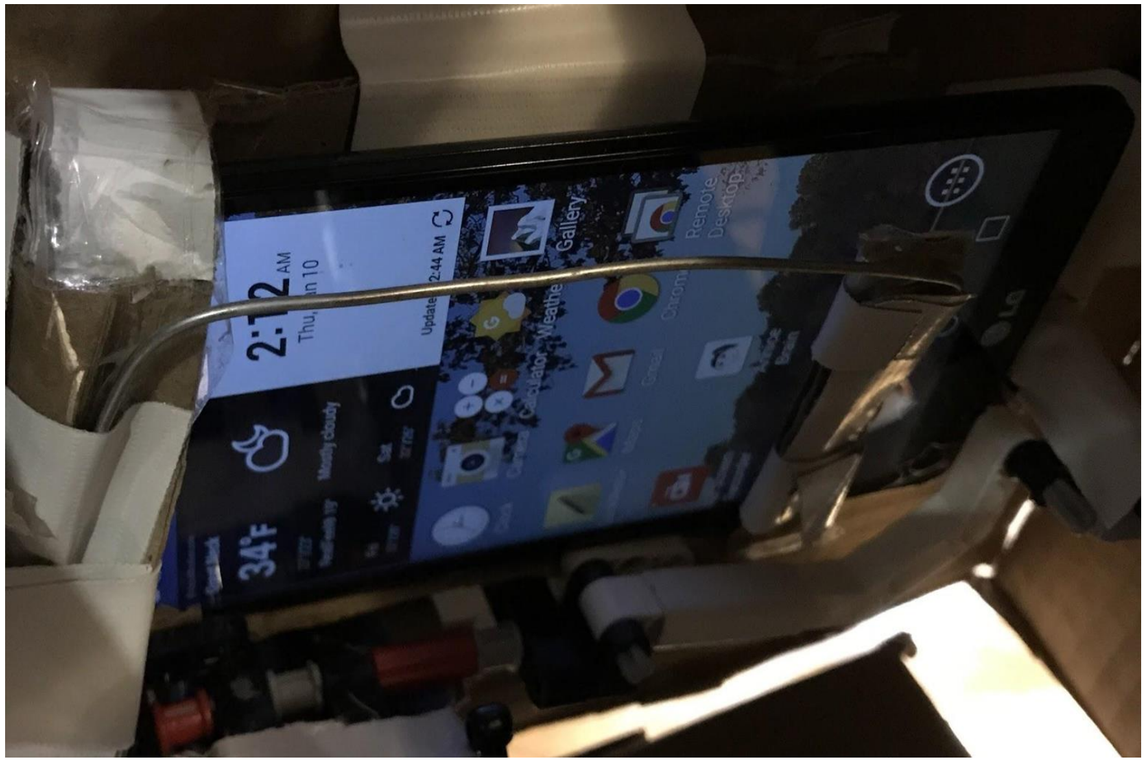
The crux of Toby’s design was that computationally-heavy processes would be handled by a smartphone, which would communicate over Bluetooth with an Arduino Mega to control the movement of Toby with servo motors that controlled his arms and cordless drill motors that controlled his wheels.





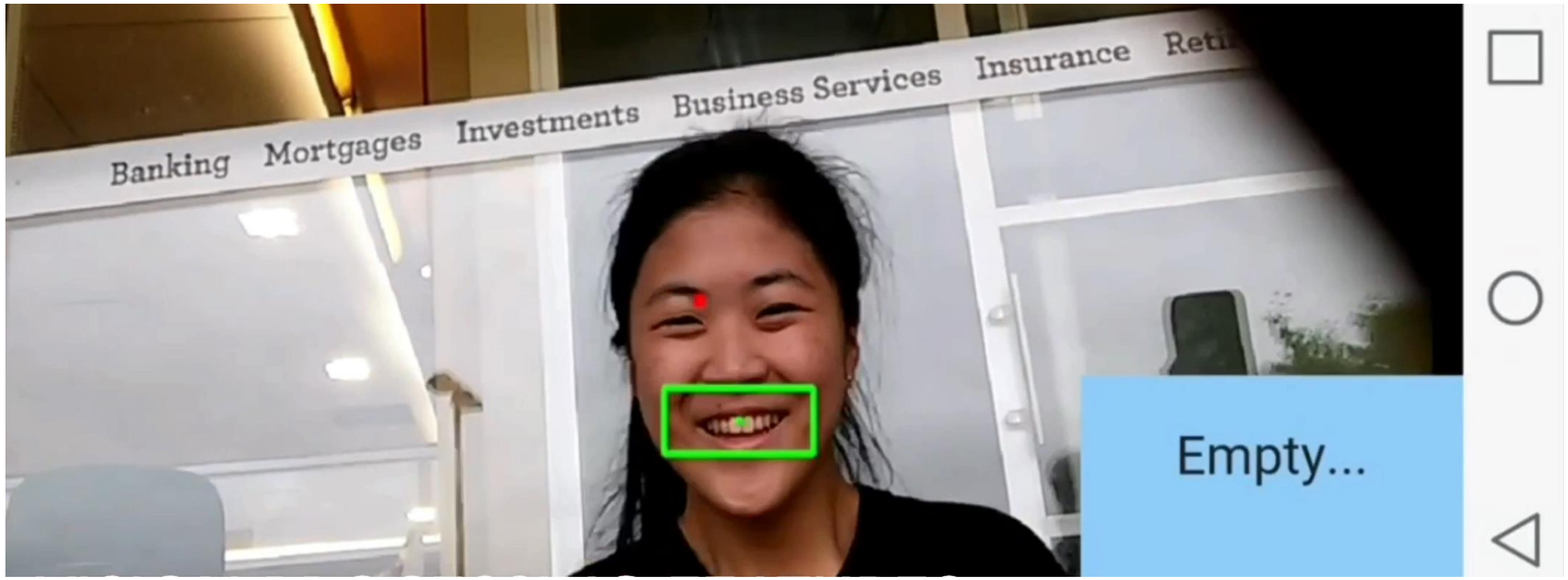
Prototyping

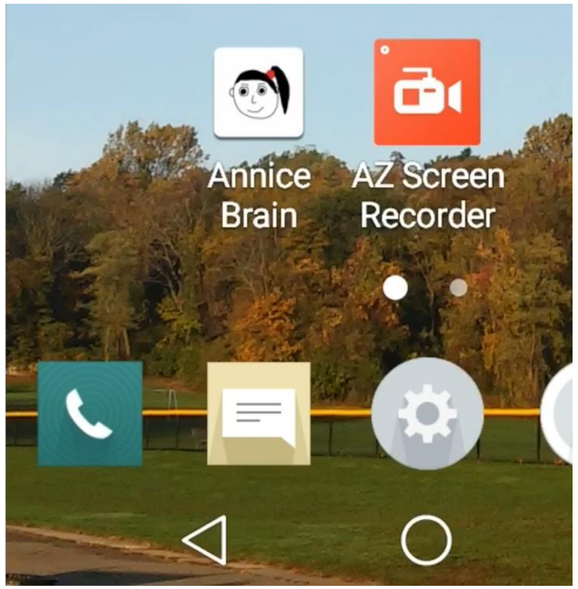
The drive train chassis for Toby consisted of two cordless drills bolted to a plastic lunch tray. The main electronics included an Arduino Mega and Servo Shield, L298N Motor Driver, HC-06 Bluetooth Module, SG90 Micro Servo Motors, and two Hi-Spec Cordless Drills.



Prototyping

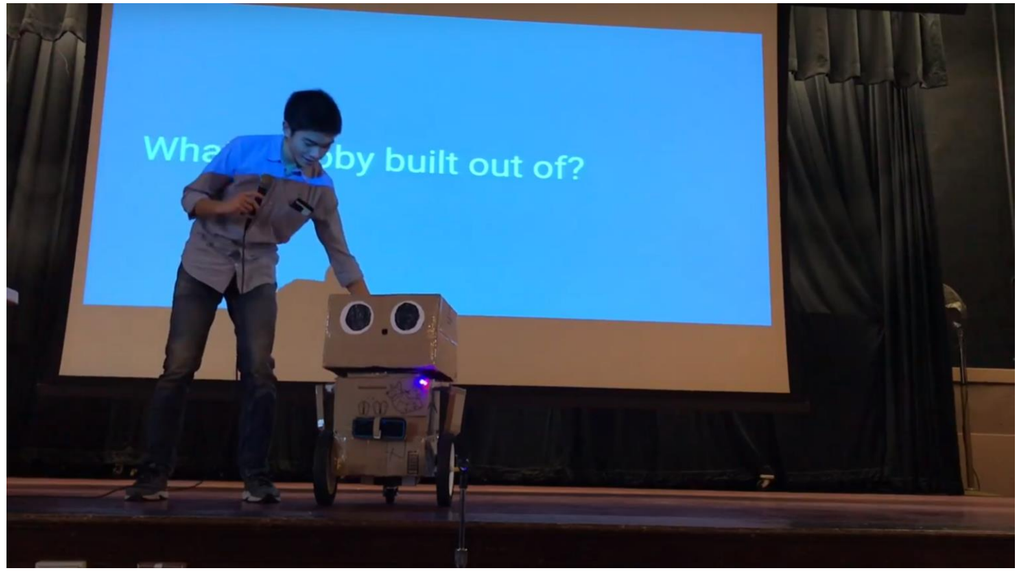
The smartphone was mounted inside Toby’s head and the camera was put behind Toby’s little mouth opening. This would allow Toby to observe his surroundings with the smartphone’s built-in camera and to run computer vision algorithms to respond to his environment.





Programming

The smartphone inside Toby's head ran a custom Android app that I wrote called "Annice Brain" so that Toby could carry out intensive computer vision (OpenCV Haar Cascade Classifiers) and speech recognition (CMU PocketSphinx) algorithms.



Presenting

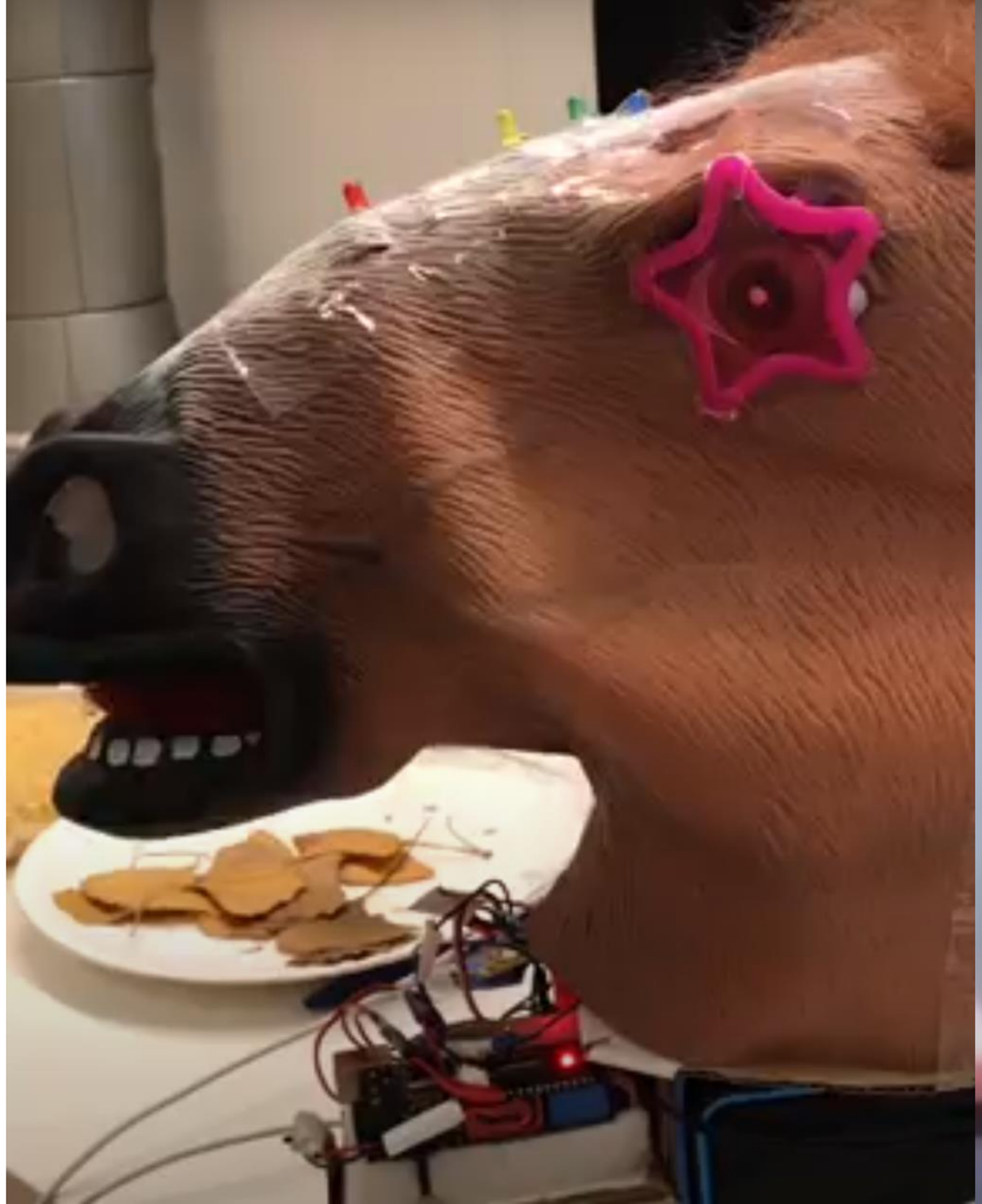
Because of the relatively simple materials used for Toby, multiple local elementary schools asked me to present my project to their students to pique their interest in robotics. This was a great way to reconnect with my local community before I left for MIT and to share with other students my passion for STEM.


RANCHMA
CHOLAR
EXP

Robot Horse Head

Personal Project
August 2018

An animatronic horse head that mimics the movements of my mouth based on real-time data from OpenCV algorithms that would track my mouth position.



RC Tank

Personal Project
May 2018

A remote-controlled Arduino toy tank built out of cardboard.

Trash Mobile

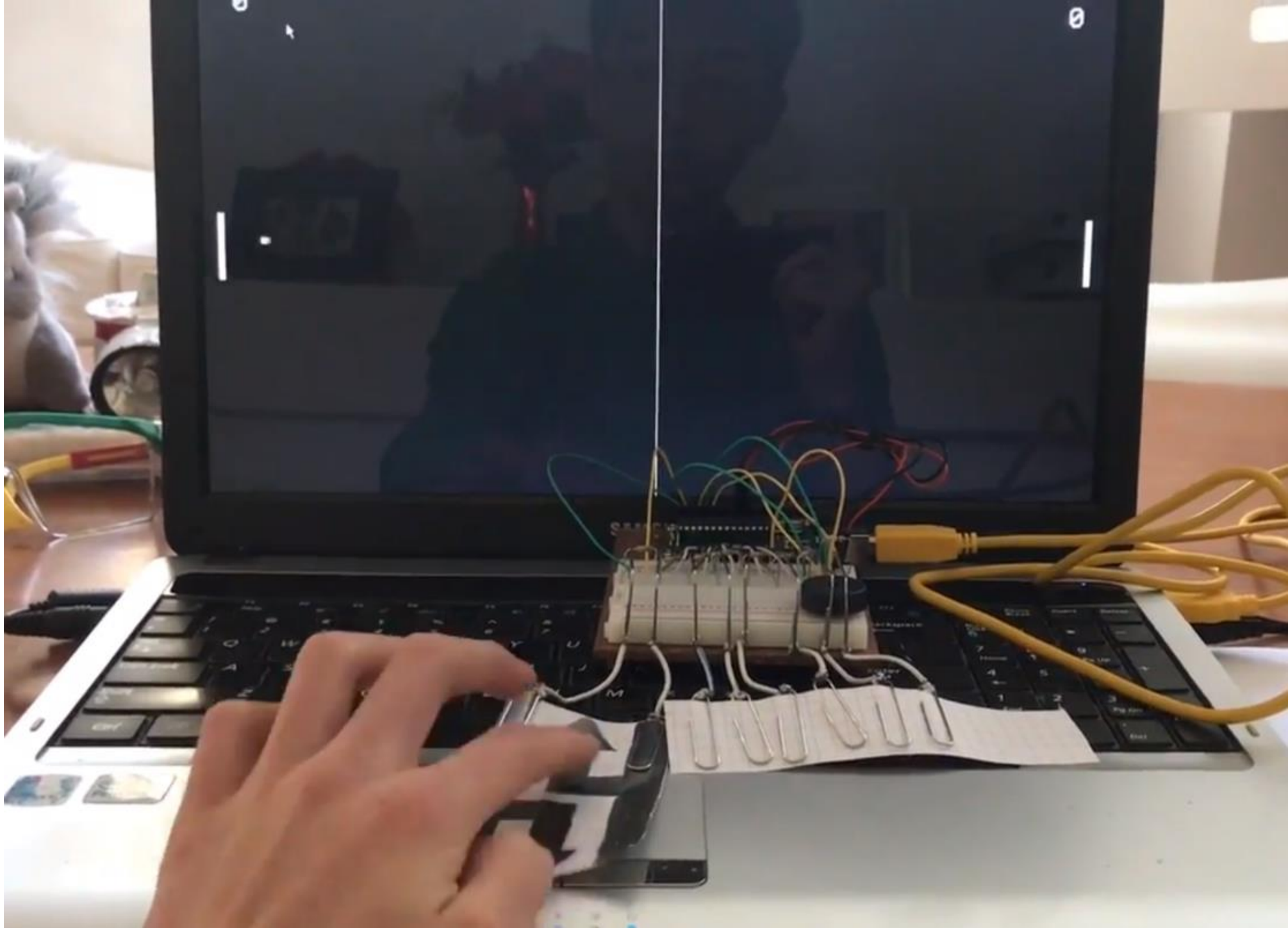
Personal Project
July – August 2017

A homemade electric trash can vehicle built out of “trash”: scrap wood, cardboard, old cordless drills, and wheelbarrow wheels.

Capacitive Touch Controller

Personal Project
February 2017

A circuit that used capacitive touch to control a computer. A user would draw a custom controller on paper with a pencil and hook it up to the circuit with several paper clip connectors. They would touch the pencil-shaded sections of their controller to send signals to control the computer.



Thank You

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