TrashKIT

A Creative Fusion of Trash, Technology, and Vision, transforming discarded materials into treasure through electronics, mechanics, and computer vision for a playful musical experience.

Physical Computing Portfolio

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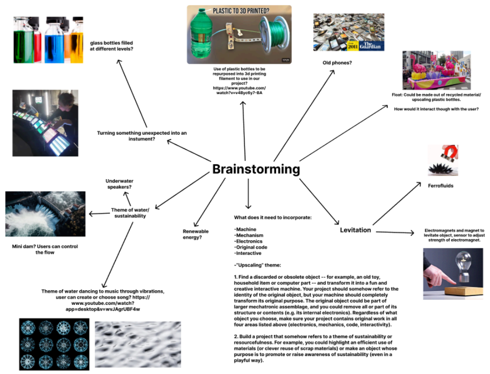
Brainstorming

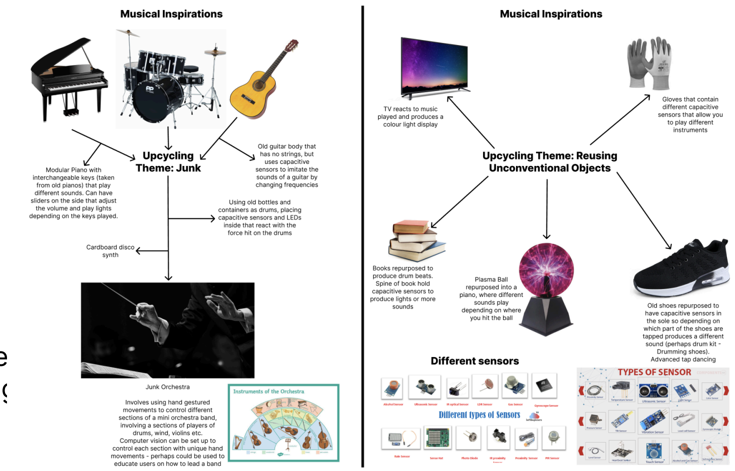
Introduction

TrashKIT is an innovative art project that transforms **discarded items** into a captivating blend of sound and visual art. By combining the power of **computer vision with upcycling and engineering**, we've reimagined trash as a sonically and visually unique experience. TrashKIT showcases how creativity and technology can breathe new life into what's often **overlooked**.

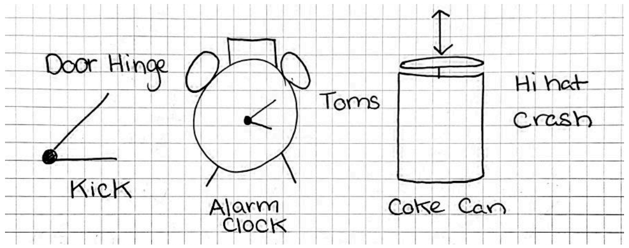
Brainstorming



1. During our initial brainstorming, we focused on thinking **broadly** and exploring a wide range of creative ideas for our project.



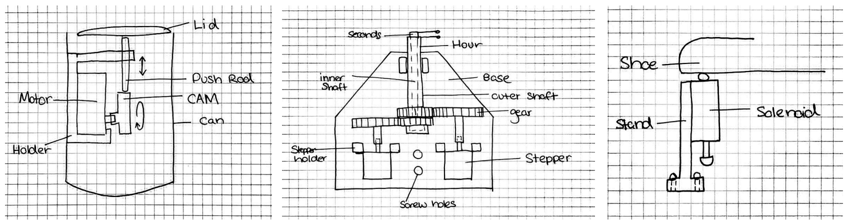
2. On the second page of brainstorming, we began to converge on ideas and were particularly drawn to the concept of using **old objects**, embracing the theme of upcycling. We also wanted to create a **musical experience**, which led us to combine both ideas and explore emulating a drum kit using discarded items and computer vision. A **drum kit** stood out as the perfect instrument because its diverse range of sounds allowed for greater creativity in selecting and repurposing objects to replicate those sounds.



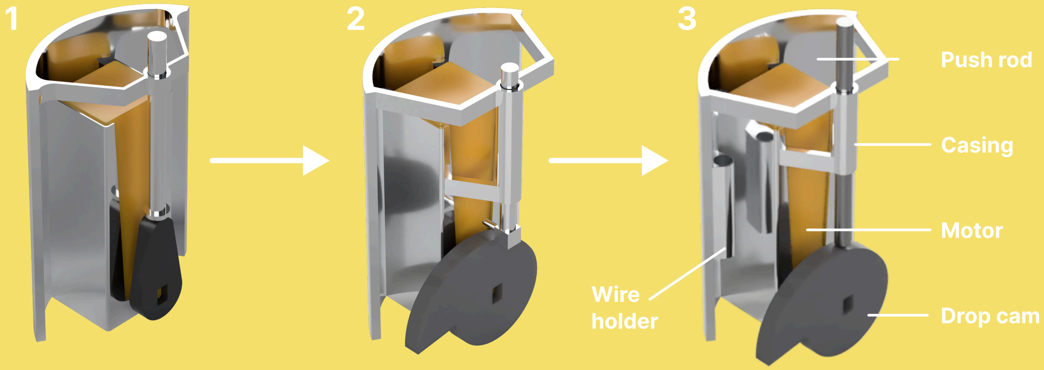
3. The above figure illustrates our initial brainstorming of various trash items that could **mechanically** replicate each sound of a drum kit.

4. We then moved on to designing the mechanical systems:

- Coke Can: We developed a **cam** system to create the desired motion.
- Clock: Stepper motors were used to turn gears connected to two central shafts, enabling **independent control** of each clock **hand**.
- Shoe: Initially, we considered a door hinge but opted for a **shoe for better functionality**. Although we planned to use a solenoid to strike multiple systems, safety concerns with the ordered solenoid (8A, 12V) led us to implement a drop **cam** with a pivot in the middle of the shoe instead.

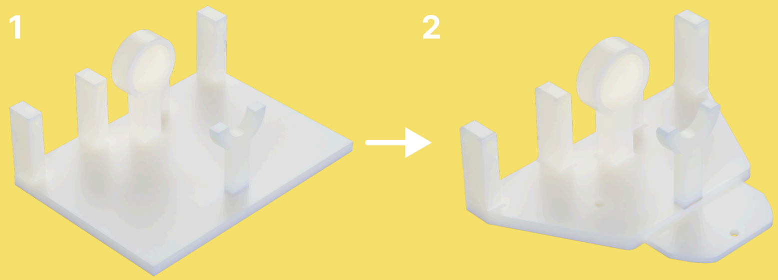


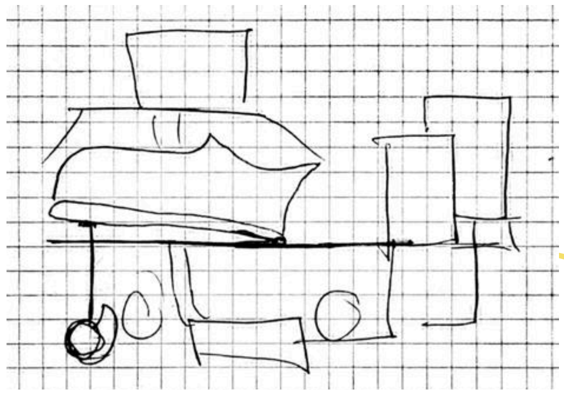
Iteration



It took **three** iterations to optimize the cams for our project. The main changes included using a **drop cam, adding wire holders, and tweaking the dimensions** to ensure the can lids moved perfectly.

It took **two** iterations to perfect the clock stand. The main changes involved adjusting the **dimensions, reducing excess plastic, and adding screw holes** for stability.



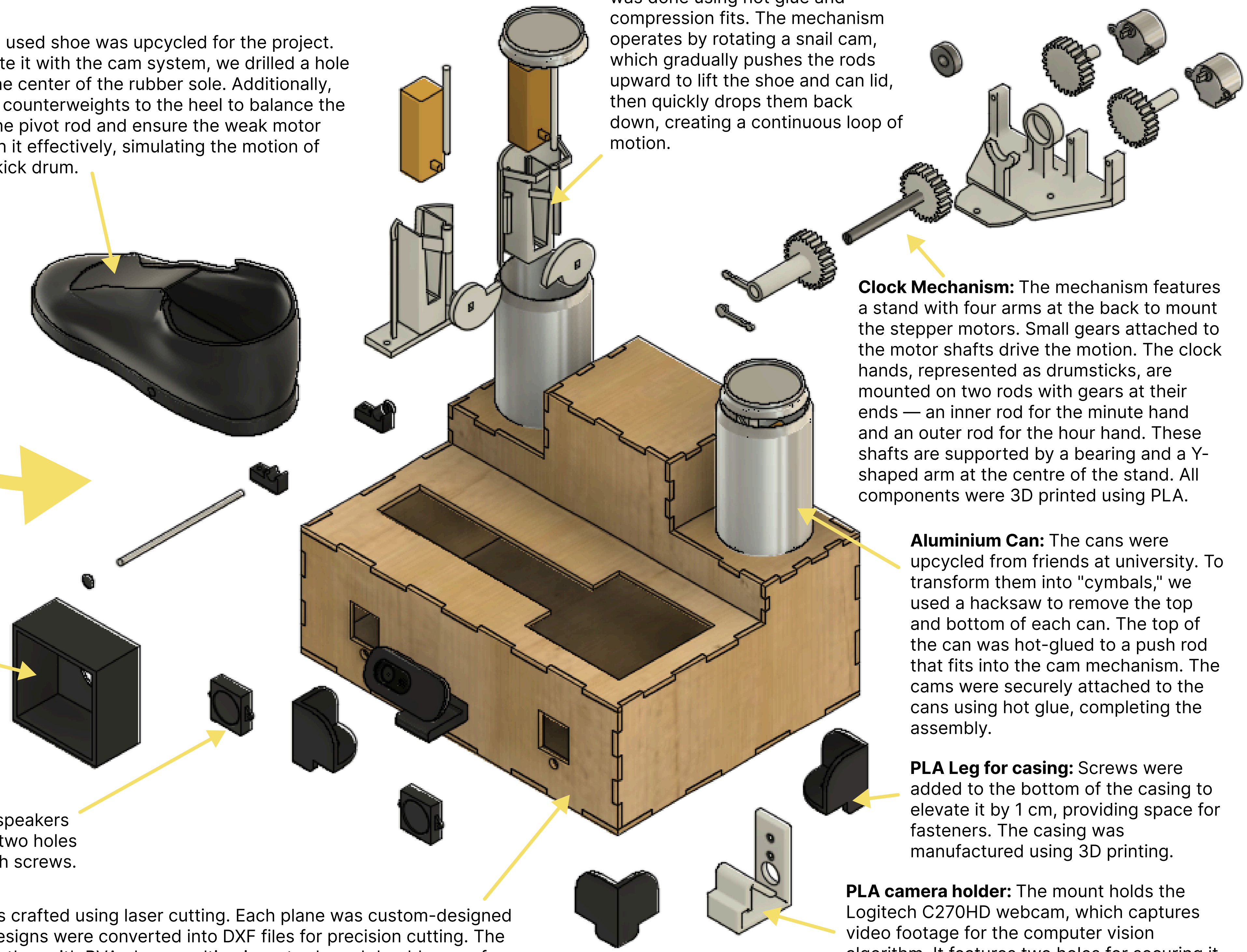


5. We then iterated on how to present these items and decided to arrange them in the **layout of a typical drum kit**, using the trash items as substitutes.

Components & Mechanisms

Shoe: The used shoe was upcycled for the project. To integrate it with the cam system, we drilled a hole through the center of the rubber sole. Additionally, we added counterweights to the heel to balance the shoe on the pivot rod and ensure the weak motor could push it effectively, simulating the motion of kicking a kick drum.

Shoe and Can CAMs: All the cams were 3D printed in PLA. Assembly was done using hot glue and compression fits. The mechanism operates by rotating a snail cam, which gradually pushes the rods upward to lift the shoe and can lid, then quickly drops them back down, creating a continuous loop of motion.



Clock Mechanism: The mechanism features a stand with four arms at the back to mount the stepper motors. Small gears attached to the motor shafts drive the motion. The clock hands, represented as drumsticks, are mounted on two rods with gears at their ends — an inner rod for the minute hand and an outer rod for the hour hand. These shafts are supported by a bearing and a Y-shaped arm at the centre of the stand. All components were 3D printed using PLA.

Clock casing: The original clock casing was upcycled and repurposed for TrashKIT. The clock hands were redesigned to mimic drumsticks and tom drums. Using a hole saw, we drilled a hole in the back of the casing to allow the 3D-printed hands to fit seamlessly through it.

Aluminium Can: The cans were upcycled from friends at university. To transform them into "cymbals," we used a hacksaw to remove the top and bottom of each can. The top of the can was hot-glued to a push rod that fits into the cam mechanism. The cams were securely attached to the cans using hot glue, completing the assembly.

PLA Leg for casing: Screws were added to the bottom of the casing to elevate it by 1 cm, providing space for fasteners. The casing was manufactured using 3D printing.

4 Ohm mini speaker: We purchased these speakers to play the beats created by TrashKIT. The two holes on each side allowed for easy mounting with screws.

PLA camera holder: The mount holds the Logitech C270HD webcam, which captures video footage for the computer vision algorithm. It features two holes for securing it to the plywood casing and was manufactured using 3D printing.

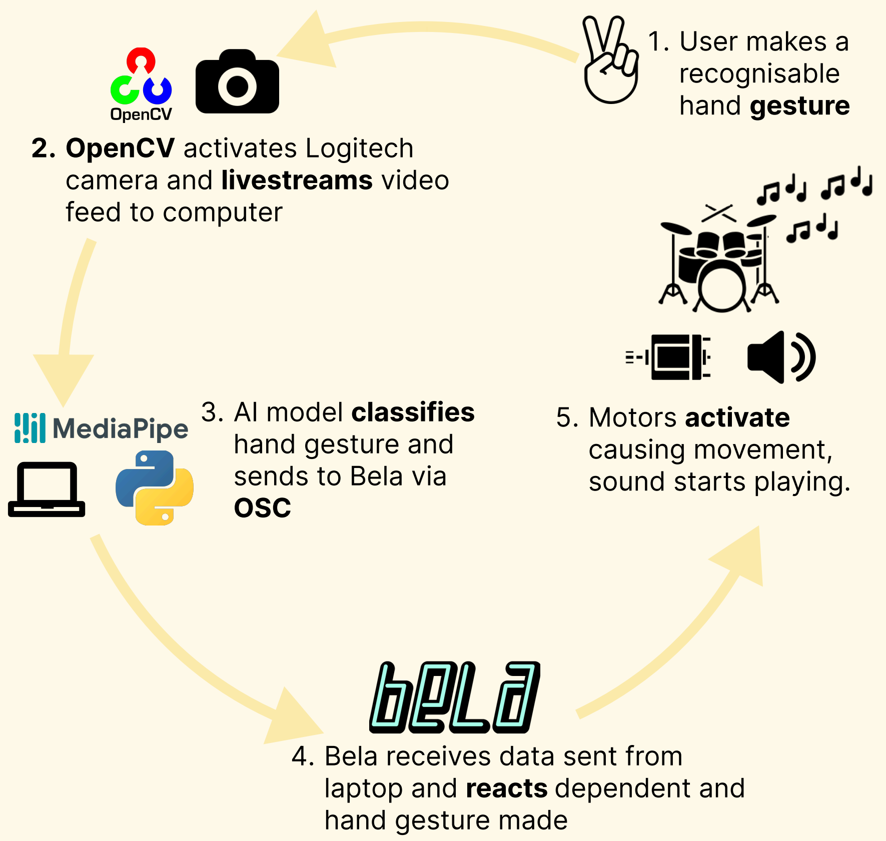
Plywood casing: The case for TrashKIT was crafted using laser cutting. Each plane was custom-designed with tailored joints for each face, and the designs were converted into DXF files for precision cutting. The pieces were then assembled and glued together with PVA glue, resulting in a sturdy and durable case for our project.

Electronics

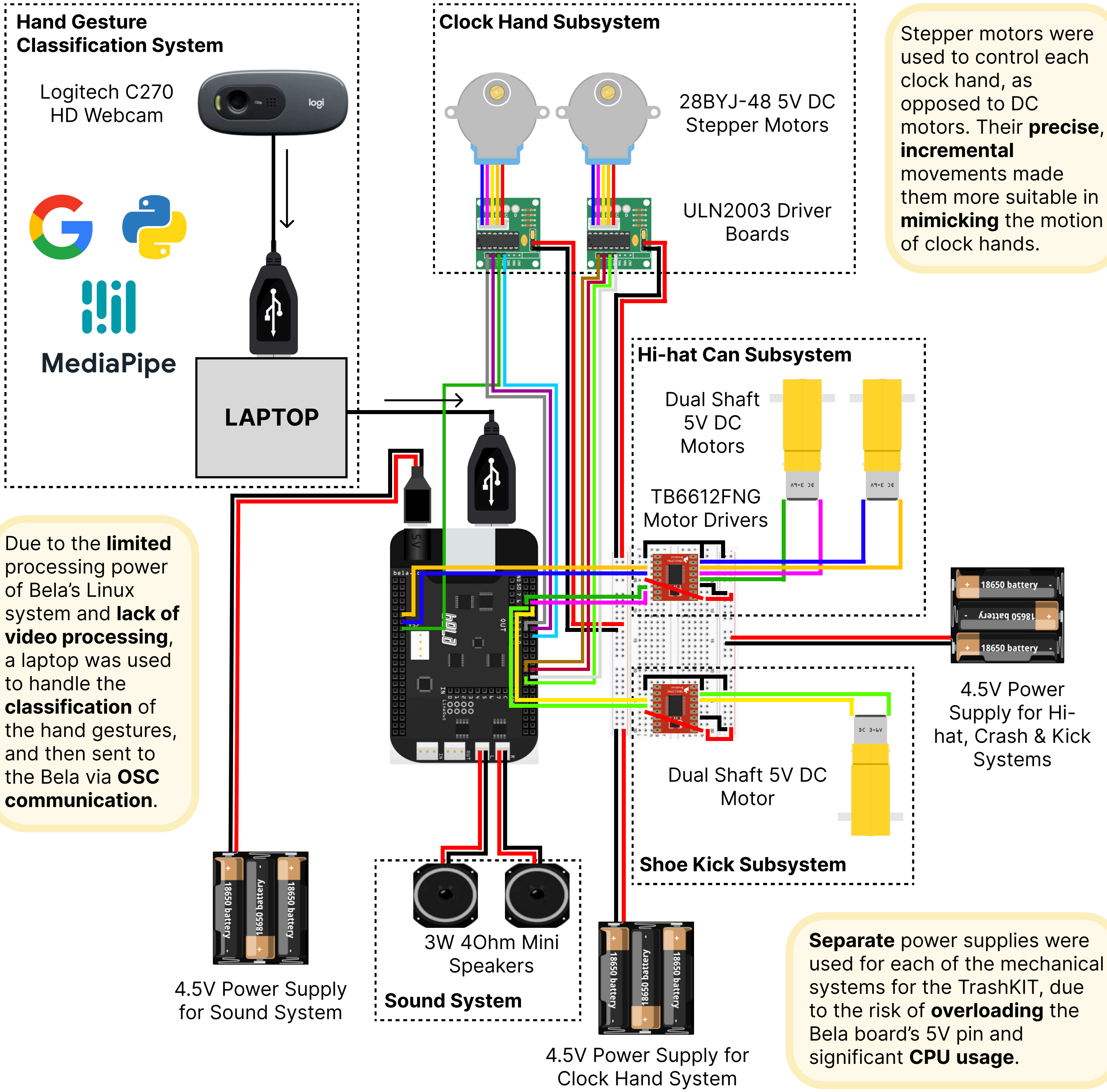
Overview

The electronics architecture that operates within TrashKIT holds an **OSC pipeline** that transforms the hand gestures performed by users to **digital signals** (using Google's HandGestureClassifier model) that determine the movements performed by the **actuators** in the interactive product.
Through **careful planning** of required components and **safety considerations**, we designed various systems and subsystems that breathes life into our mechanical marvel.

Workflow



Circuit Schematic



Stepper motors were used to control each clock hand, as opposed to DC motors. Their **precise**, **incremental** movements made them more suitable in **mimicking** the motion of clock hands.

Due to the **limited** processing power of Bela's Linux system and **lack of video processing**, a laptop was used to handle the **classification** of the hand gestures, and then sent to the Bela via **OSC communication**.

Separate power supplies were used for each of the mechanical systems for the TrashKIT, due to the risk of **overloading** the Bela board's 5V pin and significant **CPU usage**.

Summary

Specification

1. Utilizes computer vision to **track** participants' hand movements for **real-time** interaction.
2. Recognizes **specific hand gestures** to trigger different trash pieces, each corresponding to distinct musical sounds, simulating an instrument.
3. Equipped with **mechanical systems to move upcycled items**, replacing the initial concept of old toys, and integrating sound capabilities.
4. Built with **original code** and implemented on the Bela platform for **optimized** performance.
5. Designed to provide an **enjoyable** and **creative experience** for users.

Evaluation

1. **Real-time interaction** with Bela via computer vision was successfully implemented, although, in the future, there's greater opportunity in transmitting a wider range of **analogue signals**, such as spatial positioning of hands and fingers. This would grant users **greater freedom** in their interactions and create a more unique, personal playing experience.
2. Musical simulation of a standard drum kit was achieved, however it would have been better if we could produce **more intricate** songs and beats. Unfortunately, our lack of the necessary information and tools to mimic these complexities in music prevented us from producing a truly **dynamic** audio experience.
3. **Replacing** the stepper motors with **servos** to control the clock mechanism would **improve** the precision for tracking and positioning the clock hands (drum sticks), as they have encoders that provide feedback on the motor shaft's variables.
4. **Solenoids** present an opportunity for more **explosive** movement of the shoe, but safety concerns prevented us from using them.
5. Users have given very **positive** feedback on their interactions with the product.
6. The **syncing** of music and motion could have been further improved through the use of **piezoelectric sensors** placed within the instruments to ensure harmony between the mechanical actions and audio experience. However, **limitations** in the no. of pins available on the Bela forced us to **manually** sync sounds with the part motion.