UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

The Auto Board

Team #23: Nick Rappe, Kevin Villanueva, and Rafal Czech

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Meet The Team

Rafal Czech

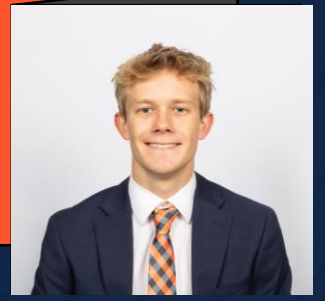
Senior in Electrical Engineering

Kevin Villanueva

Senior in Computer Engineering

Nick Rappe

Senior in Electrical Engineering



Dean Biskup

TA and Graduate Student

Main Objective

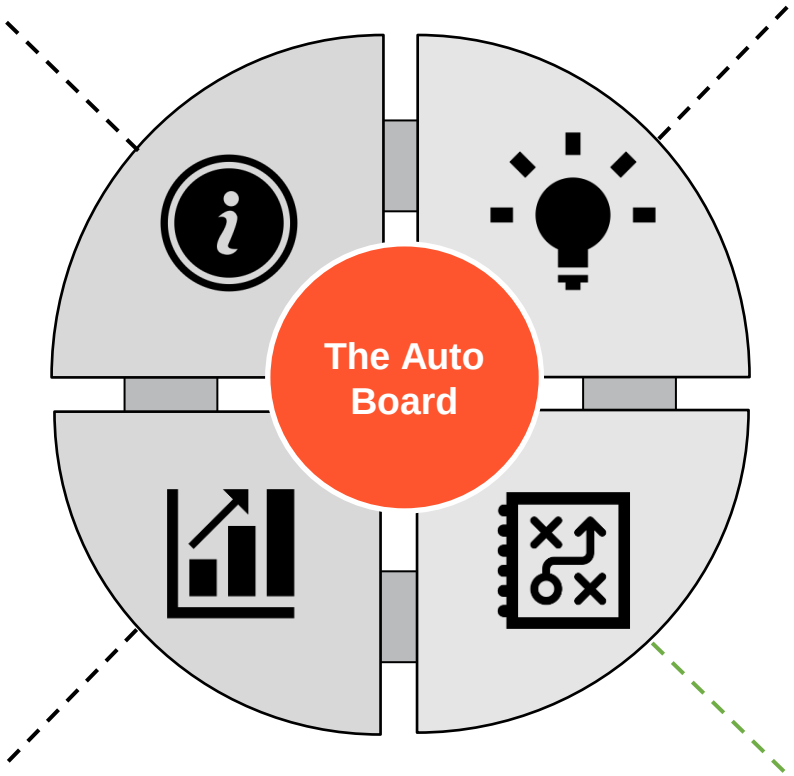
Project Overview

The Problem

- Anyone with restrictive moving or difficulty of control can **struggle to move game pieces**
- Those with disabilities can **feel alienated** when having to rely on others

Real World Data

- On average nursing homes have **one staff member for every 6 to 8 residents**, so something as simple as managing a board game between residents can become a tedious task



The Idea

- “The Auto Board” is a **voice controlled, automatic game board** that, once the pieces have been set up, would allow for seamless game play without physical contact or assistance

The Execution

- While our product is mainly designed to be **a tool to help physically limited people** play board games, it would also bring back the **novelty of family game night**

Project Overview

3 High-Level Requirements

Initial Setup

After the initial setup of the game and its pieces, players will be able to utilize voice command functionality to play the chosen game. They will **not have to physically interact with the game board** until the selected game is over.

Voice Commands

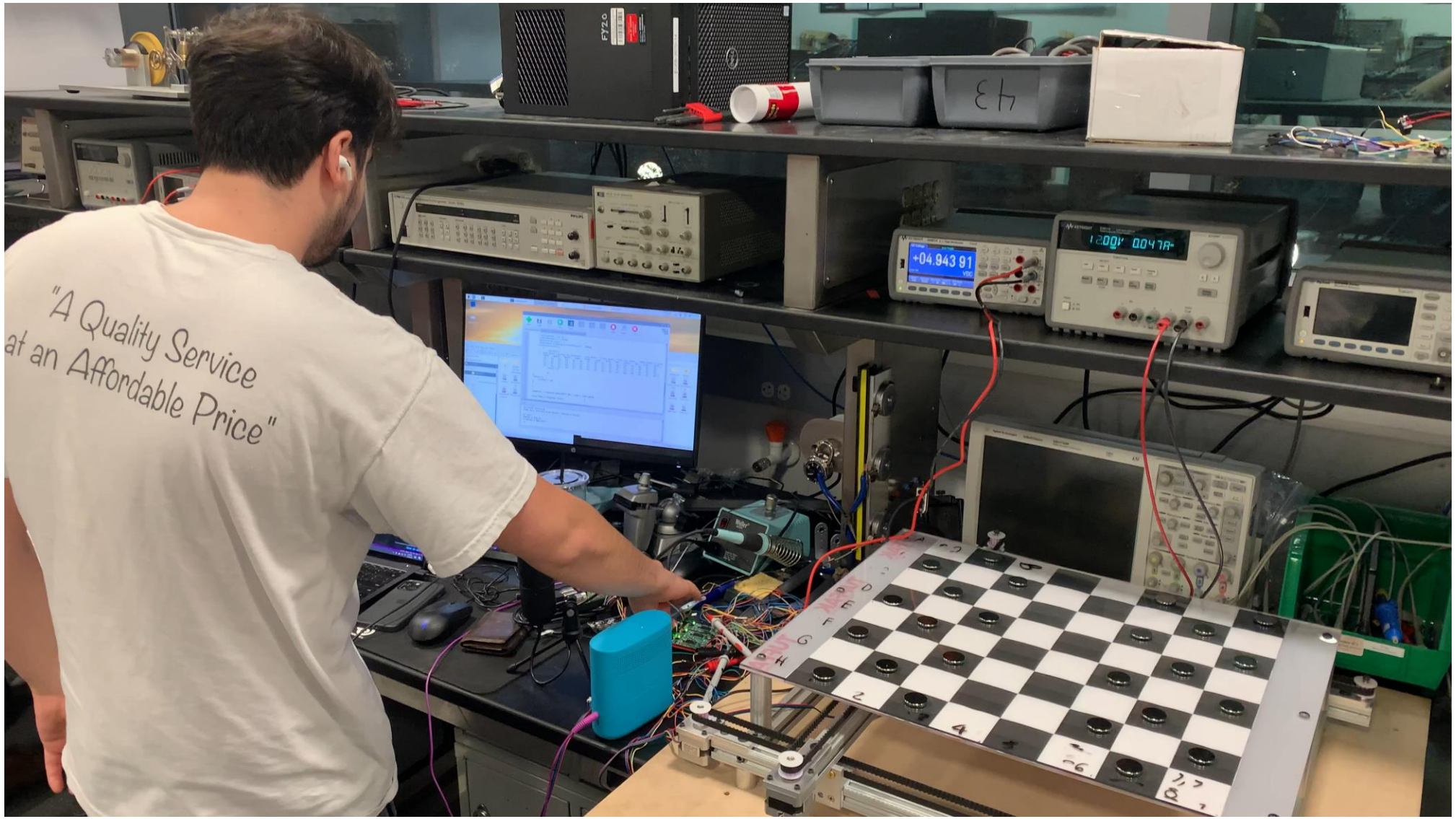
The product must be able to take the player's voice command in the input form “Move (Piece) at (location) to (location)” for all moves in the game as well as commands such as “roll the dice” or **“spin the wheel”**.

Multiple Games

The final product must be able to **support at least two games**. Depending on which game the user selects, the product will be able to perform the legal moves associated with each.

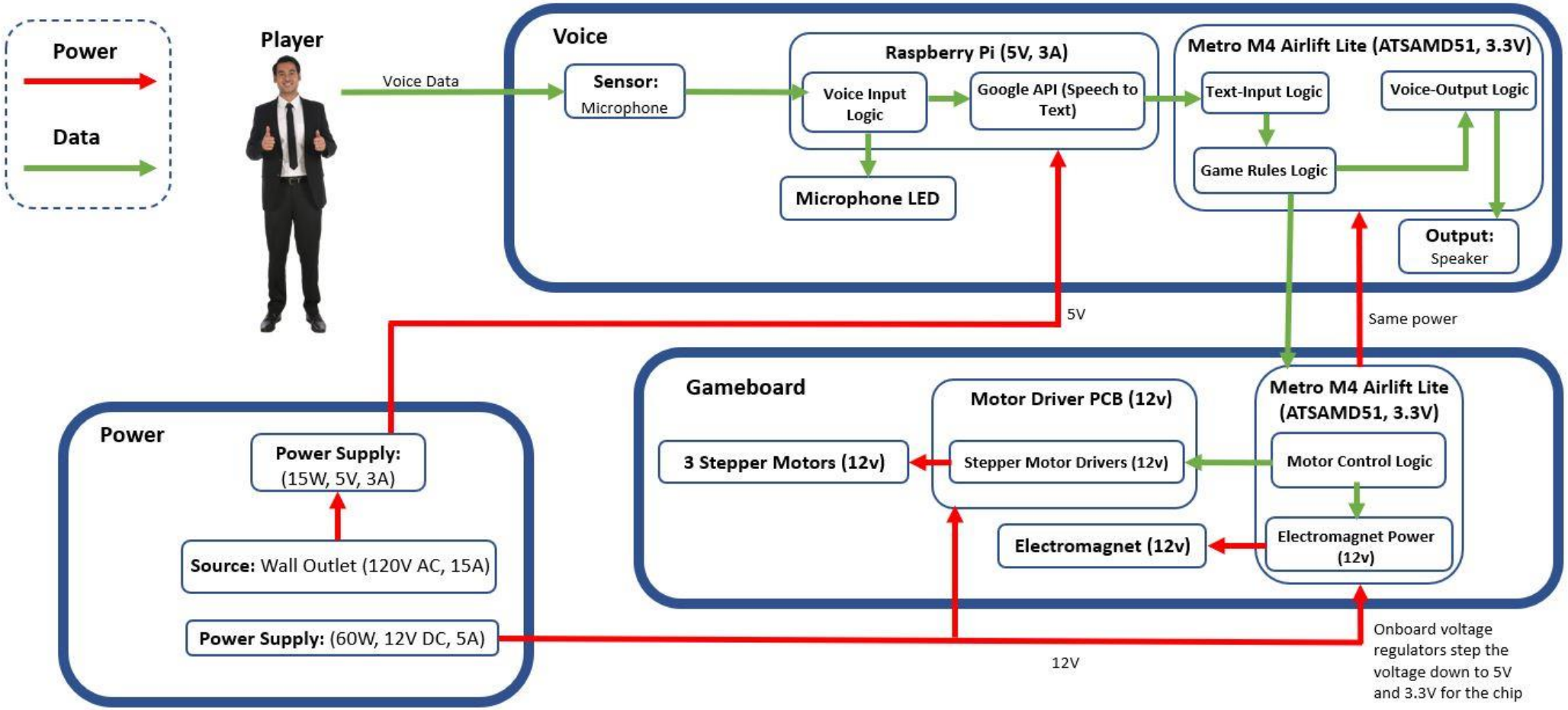
Design Consideration

Physical Demonstration



Block Diagram

Block Diagram



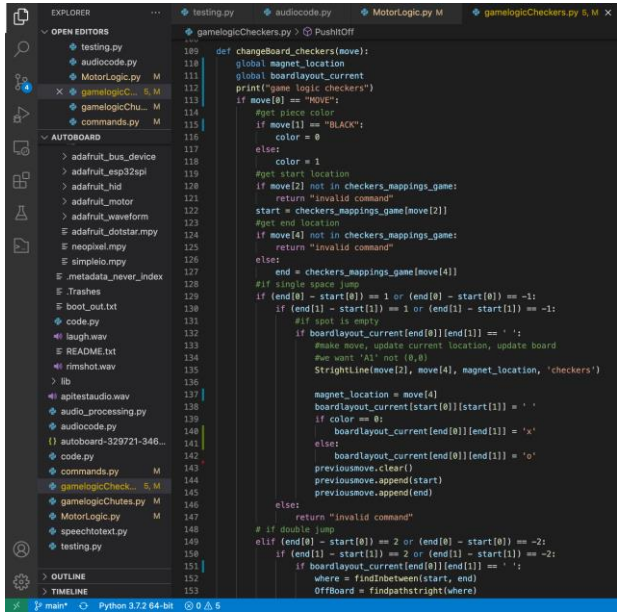
Voice Output and Board Game Rules Logic Verifications

Voice Output Logic

	Verification	Result
1	Test the logic by inputting valid and invalid commands to see when the **audio output is correctly describing the completed action**.	By defining key phrases as valid, our project was able to provide auditory feedback to the user describing the validity of their command.

Board Games Rules Logic

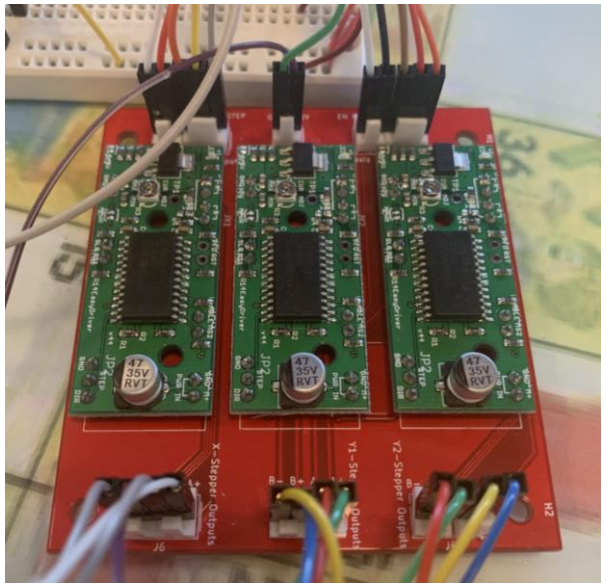
	Verification	Result
1	Attempt to move pieces by several spaces that are **impossible to reach** in the game.	By restricting the movement of game pieces, the program correctly observes when a piece is trying to illegally move
2	Attempt to move pieces in 4 directions to ensure that pieces will **stay on the intended track** for the game.	A form of edge detection was implemented to keep pieces in the playable zone.



Motor Control Logic and Power Supply Verifications

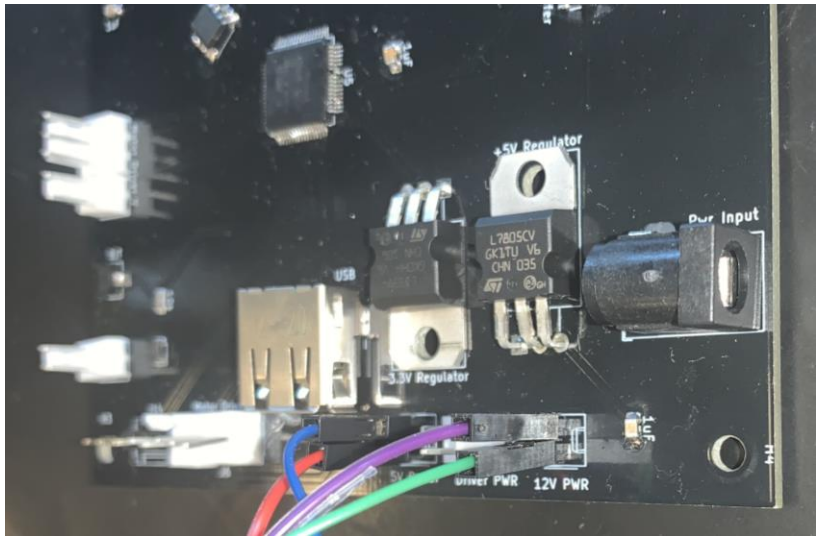
Motor Control Logic

	Verification	Result
1	Set up a **variety of "mazes"** in which there is only one valid path to get to a final space. Ensure that the system correctly identifies that path by observing its movement.	The algorithm that was written to test this was moving pieces forward one, to get onto an off-color square, then move diagonally to get around it.



Power Supply Unit

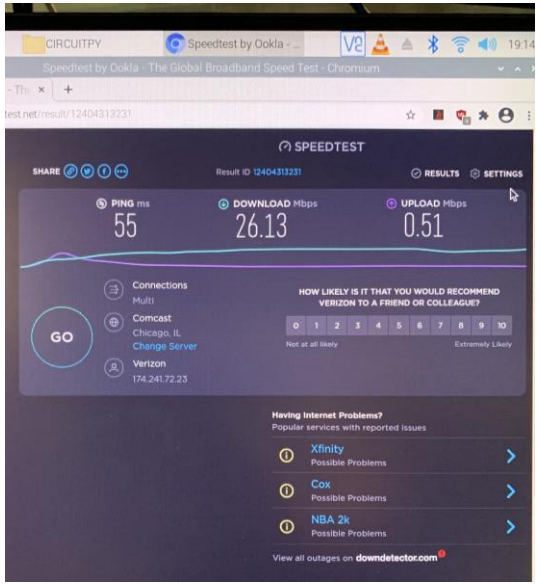
	Verification	Result
1	Probe around the voltage regulators with a multimeter to determine whether their **voltage outputs stay within the rated range**.	Although the PCB was not fully functional, the power output circuit worked and was used in the final demo.



Voice Input and Processing Verifications

Voice Input and Processing

	Verification	Result
1	Record samples from users at **1 foot away** in a quiet room and playback the audio on a laptop to determine the quality of the recording.	The microphone we selected had built in sensitivity adjustment, allowing us to record from various distances.
2	Test the **wake word functionality** by using a set of commands and observing how often the system initiates a recording.	A button and LED system was used in place of the wake word in order to initiate the recording and provide feedback to the user.
3	Stable connection will be tested over a minute long span **to see how volatile the connection is**, and how much data is retained.	An Ookla Speedtest was run multiple times from the Raspberry Pi, and results were acceptable.



Discussion of Testing

Project Build and Functional Tests

Phase 1: Discussions With Machine Shop

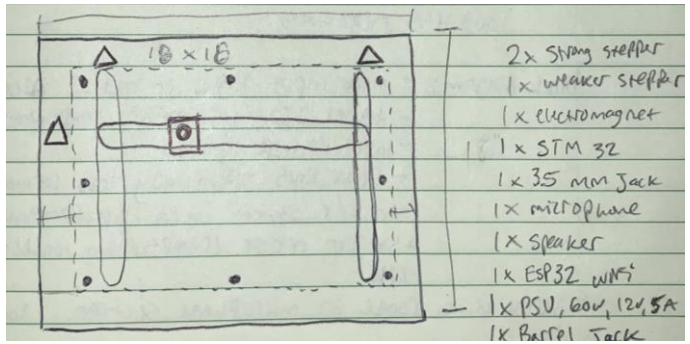
This phase involved creating multiple sketches and discussing the design with the machine shop.

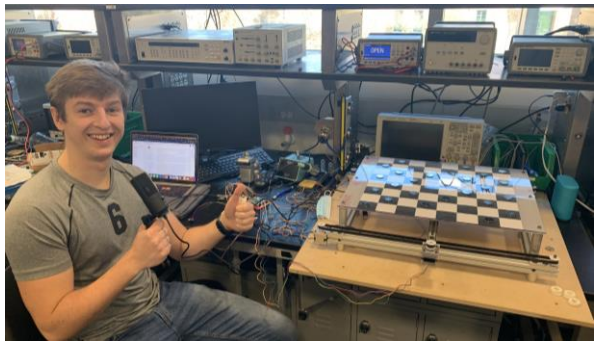
Phase 2: Mapping the Motors to the Board

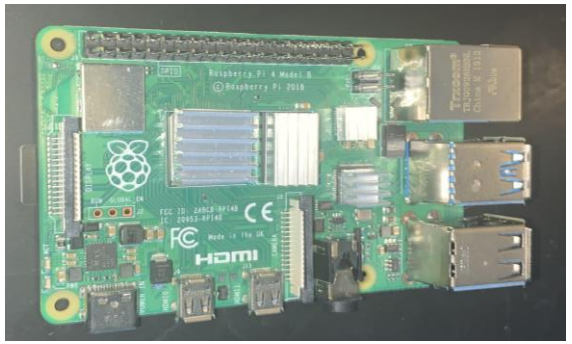
This phase was necessary for determining the playable area for our X-Y Motor System.

Phase 3: Debugging the Raspberry Pi and Metro M4

Getting the Google Speech-to-Text API to work consistently with our game logic took the most time to debug.







Successes and Challenges

Successes

Getting ‘Voice Input Processing’ to Function

The **most points in our demo** were dedicated to this subsystem. It was imperative that our system was able to take voice input and convert it to text to be used in our game logic.

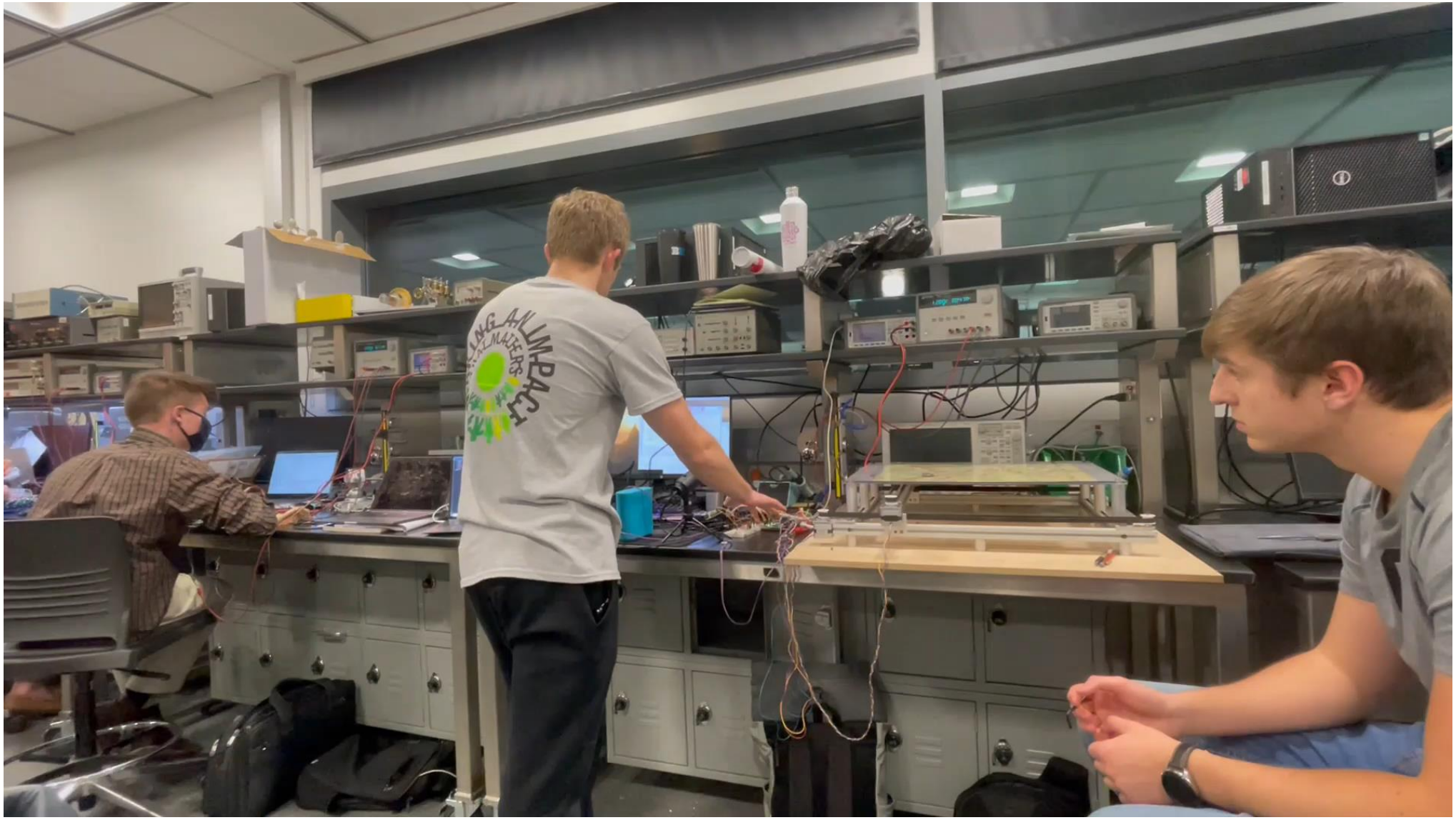
Accurately Moving the Stepper Motors

Understanding how to accurately move the stepper motors was integral in moving pieces from one intended location to another. A **game would not be playable if a piece could not be moved**.

Having 2 Games Function on the Same Board

This was one of the high-level requirements and is important to the products success as **not every person wishes to play the same game**. Offering the ability to switch games made this project into a powerful proof of concept.

Demonstration of Chutes and Ladders



Challenges

PCB Design

When designing the PCB there was a **major oversight** resulting in the debugger pins not being connected to the correct pins on the microcontroller.

Memory Limitations on Microcontroller

When dealing with the Google API we realized that **voice recordings were taking more memory than what was available** to us.

Inconsistency with Magnet Interactions

After our tolerance testing of the electromagnet, we thought that we would be able to use our neodymium magnets with one layer of felt. This proved to be a **bigger problem than expected due to unexpected variables**.

Conclusions

Conclusions

What did we learn?

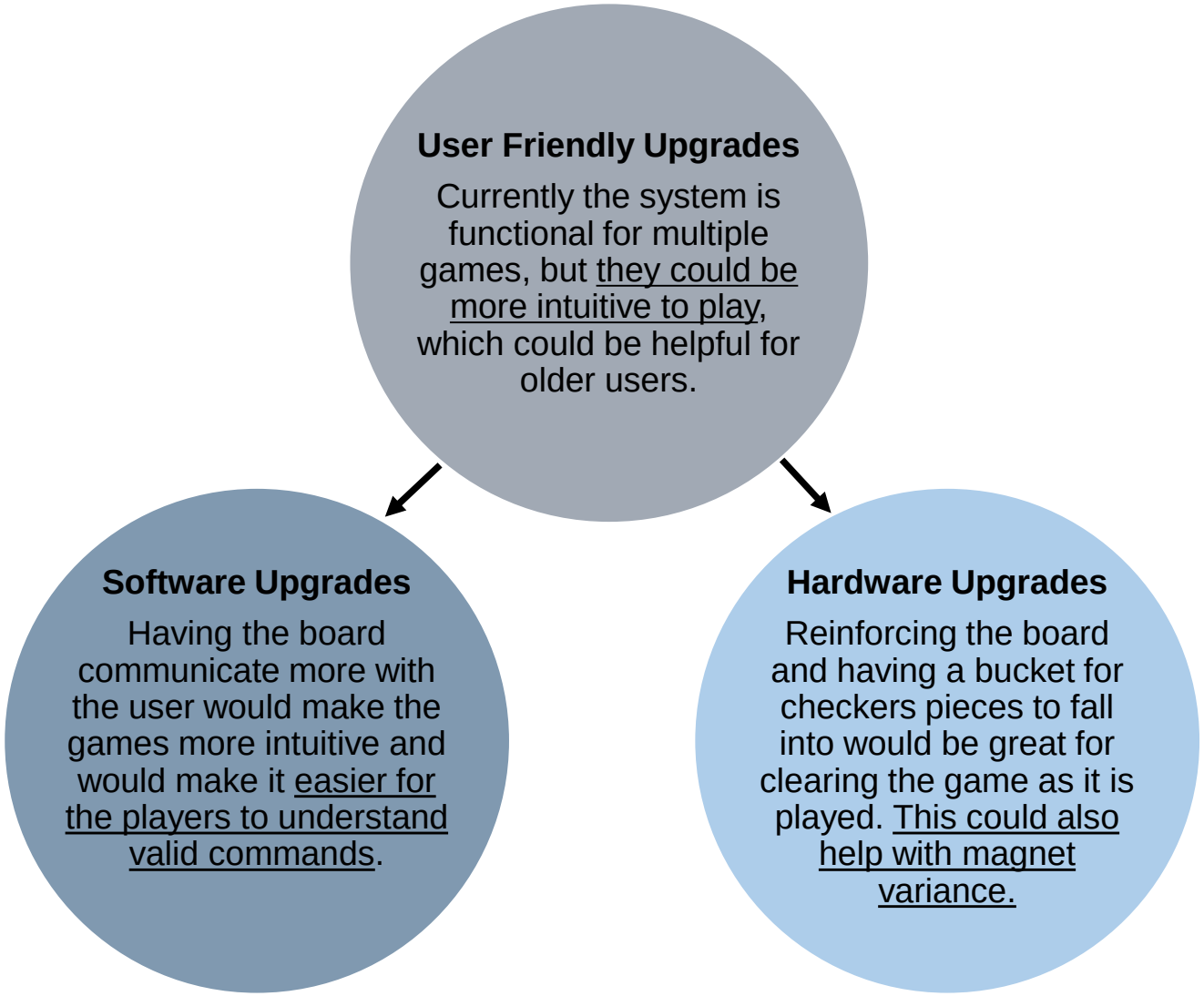
- No matter how the project is going, **always expect there to be unforeseen challenges** along the way
- **Double, triple, and quadruple check** important areas of the project before progressing with later phases
- It is **okay to pursue a complicated idea**, and, more often than not, it will all work out

What would we do differently?

- Implement a more **frictionless movement system** by including wheels or bearings for our X/Y System
- **Develop an enclosure** that would hide all boards and wires from the user
- **Reinforce the board and X/Y System** so that there is minimal board flex which contributes to problems with our motors and magnets

Future Recommendation

Future Recommendation



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