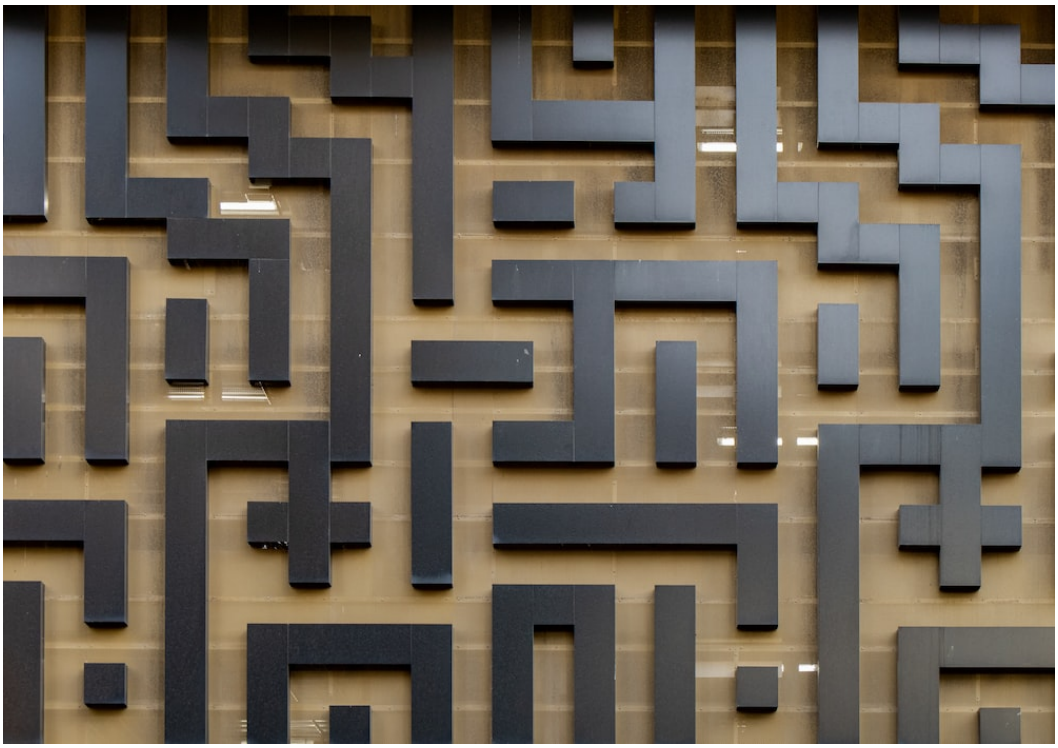
Arduino Project Report

Building an advanced Maze Game



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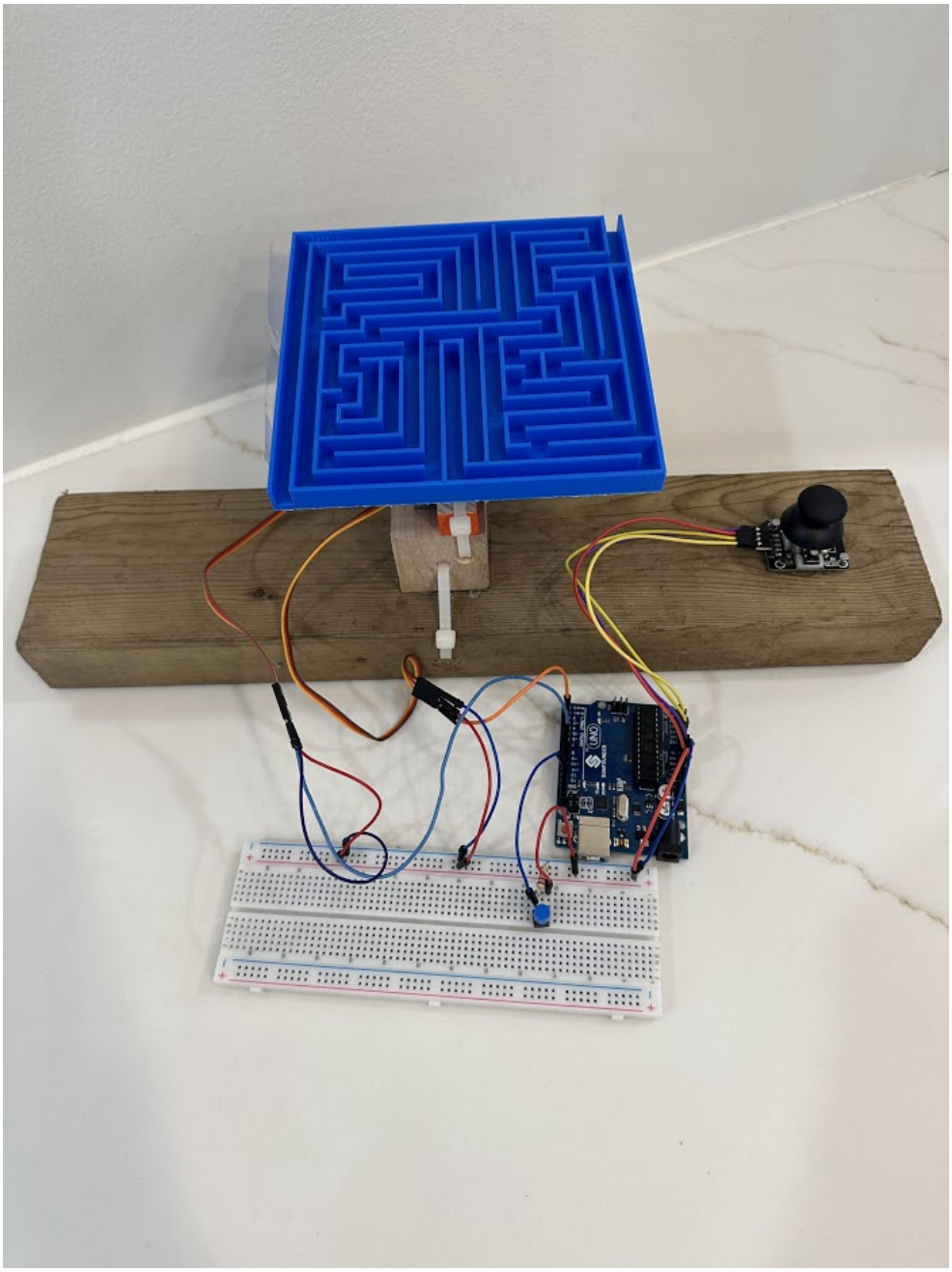
Device Overview:



For my Arduino project, I decided to make a Maze game in which the player controls the movement of the ball through the maze with a joystick. The objective of my game is to successfully complete the maze from one entry point to the other. I decided to create this creative game where the player can test their skill to successfully maneuver the ball. The user also has options of selecting what difficulty of level they want for the maze. A more difficult level requires finer movements of the joystick to successfully guide the ball.

The maze game has both a fun and practical application in the real world. Within the healthcare sector, the principles of my maze game helps patients practice their hand-eye coordination which is crucial for a strong and healthy brain. For example people recovering from brain traumas or even older people can utilize this maze game to maintain and improve their fine motor skills. The maze game provides a great resource for people doing physio activities and recovering from hand injuries as well. Overall, the use of this maze is beneficial in helping people recover using an innovative device.

The design of the device incorporates the components of 2 servos, a button, a joystick, and a 3-d printed maze. The 2 servos are responsible for the movement on both of the axes for the maze. One servo rotates the maze horizontally, while the other servo tilts the maze vertically. The joystick is used to guide the ball through the maze. Also the button available allows the user to change the difficulty of the maze for a harder challenge by increasing the sensitivity. The overall objective of the maze is to test the player's ability to successfully guide the maze as quickly as possible to the finish.

Safety Information:

The Maze project uses electronic components, wood, and nails. While assembling the components it is important to take in consideration the following safety precautions:

- Keep food and drinks away from electronic components
- Always unplug Arduino when working on the wiring of electronic components
- Work on a stable, non-metallic surface, preferably a table
- Wear safety glasses wherever possible when working with components
- Avoid touching the metal wires while Arduino is plugged in
- Do not pull a plug/wire by the cord, rather pull it from its base
- Do not stick your fingers into the outlets/plugs of the Arduino
- Do not interfere with the 3-d printer while it is running.
- Always upload your 3-d printed file into a software program to check the specifications of your model with the actual printer
- Always support the structure firmly when inserting a nail into the wood

User Instructions:

The Maze device is set up using an Arduino Uno, a breadboard, 2 servo motors, and a button. Please view the "parts needed" section on page 10 for a more detailed description of all the components required for this project.

The first step to create this project is to set up the electronic components as per the circuit diagram (Please check page 14). After setting up the Arduino and breadboard with all the wires/components, open the Arduino application and paste the provided code into the IDE. After uploading the code to the Arduino board, you should be able to see the two servo motors move as you navigate the joystick from one side to the other.

After the circuitry is complete, you can now download the provided 3-d maze and 3-d print it (Please refer to TinkerCAD link in references). You can also modify the maze to your liking in order to accommodate specific sizes of your available printer. It is recommended to use a software such as Ultimaker or Dremel to upload your file and see the estimated time and other important 3-d printer information. Please do not modify the maze more than 2 centimeters in each direction and keep the proportions of at least 5 millimeters in between the walls if using the provided ball from this kit.

Once the maze is done printing, you can now assemble the wood structure with all the other components. A 2 by 4 wood plank was used to support the weight and provide stability for the components. Use a hot glue gun to glue the servos on the block of wood in the two provided orientations; one on the x-axis and one on the y-axis. Screws were also used to secure the servos and provide extra strength for the added weight of the maze. Use the malleable metal to make an L-shape and

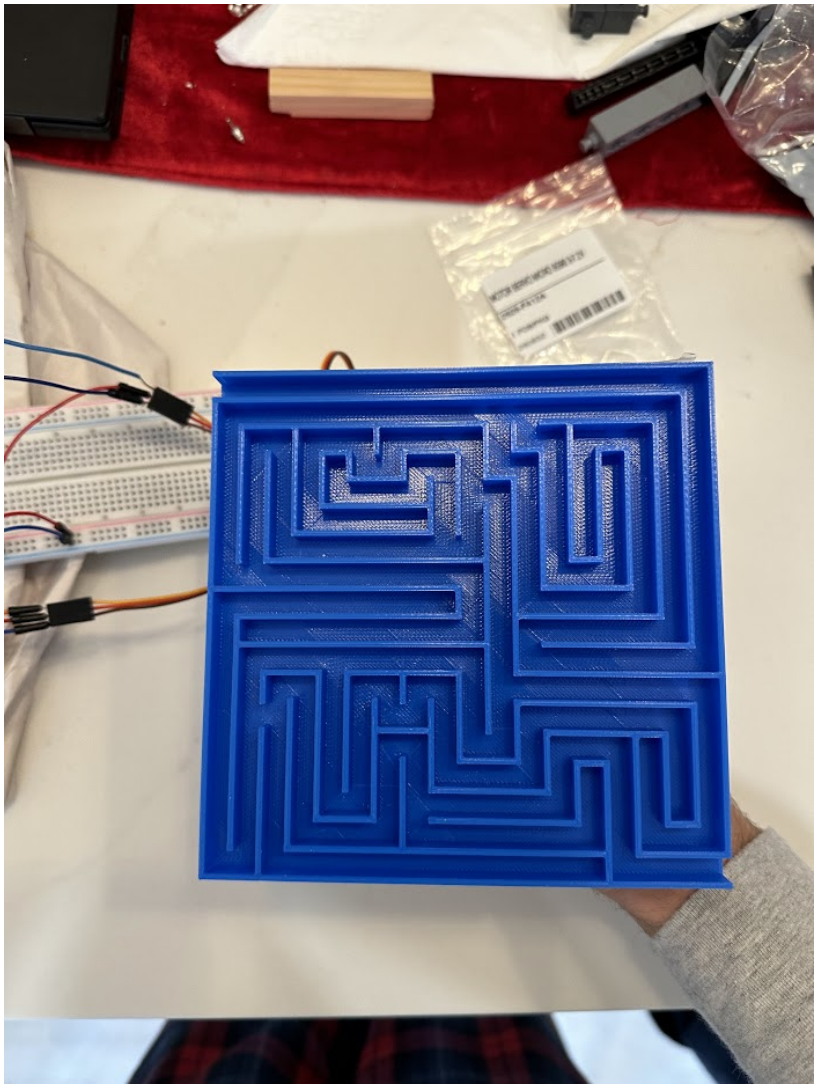
tape it to the back of the maze model. Now attach the L-shape to the vertically oriented servo motor using a hot glue gun. Wires were used as well to provide extra strength. You can adjust the position of the maze on the L-shape metal accordingly in order to create the best balance on the servo motors. Note that zip ties were also used to secure one of the servos more tightly and the block to the 2 by 4. It is recommended to do the same in order for the maze to stay strong for a longer period of time.

Now that all the components are assembled, you are able to test the maze! Use the provided metal ball to place it in your maze and play around with it. Use the joystick to maneuver the ball and press the button at the same time for an additional challenge!

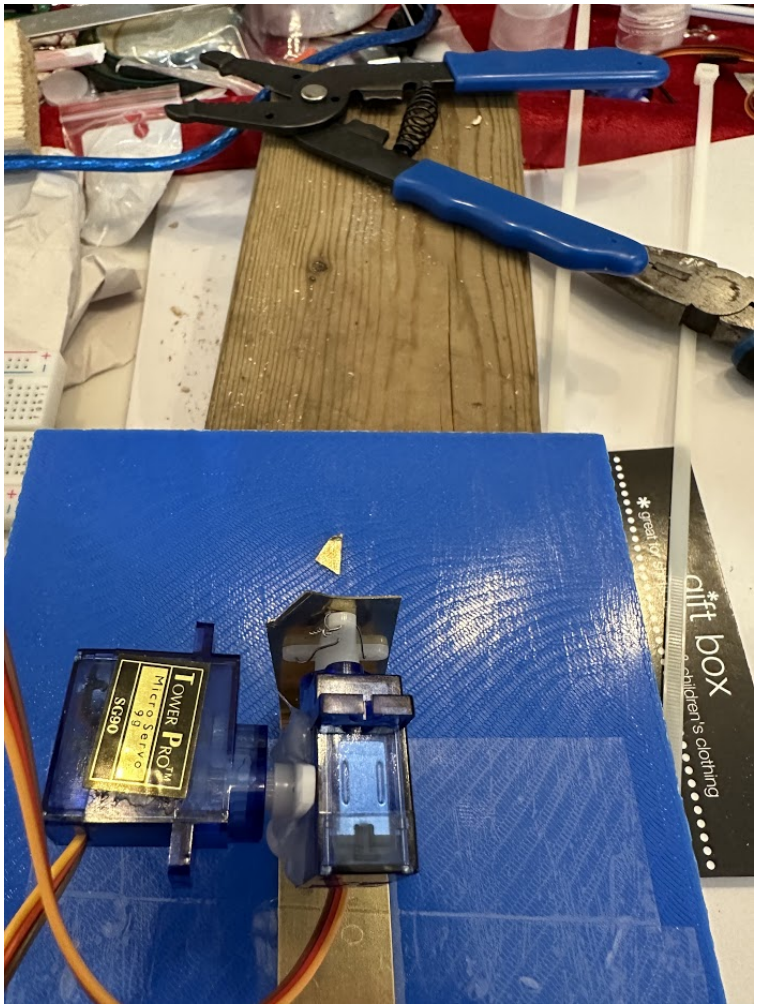
Research:

For my designed Arduino project, I took inspiration from a maze labyrinth project on the internet (link in reference page). Seeing the developed maze I decided to create an innovative maze that can be used for entertainment purposes but also has a practical application for people as well. Having my mother working in the healthcare industry, I was inspired to create a maze that can aid in people's lives as well. Through researching on the internet, I learned about the importance of fine motor skills for healthy people. The devices within the healthcare industry which help enhance and practice these skills are crucial for rehabilitation purposes. For example individuals who have experienced traumas to their brain or hand injuries benefit majorly from a device that practices hand-eye coordination. For this reason, I took this aspect into consideration by making a maze device which can be used to help individuals practice their fine motor skills in an entertaining manner.

My main objective was to create the actual maze. This is where I taught myself about 3-d printing. I used TinkerCAD as well as other softwares such as Ultimaker in order to create my model for the maze. I had to learn about grouping structures in order to create my desirable outcome. I then used Ultimaker to determine the appropriate sizing and fillings for the 3-d printer in the classroom. The whole process of designing the maze taught me about 3-d printing and the features which proved to be useful.

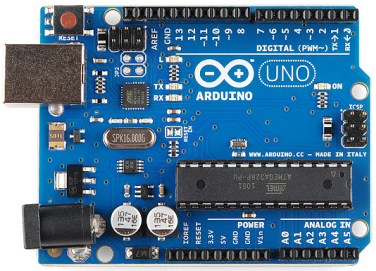
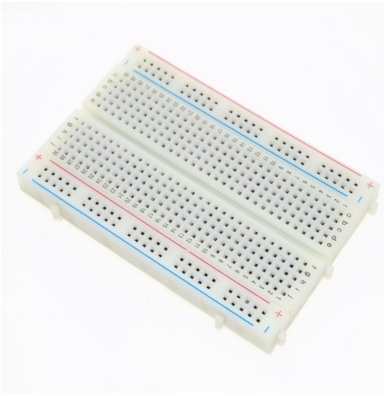


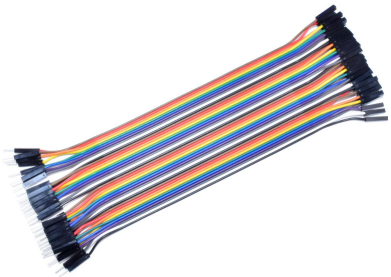
My next part of the project was to create a configuration for the servo motors to tilt the maze. This is where I used my engineering mindset to incorporate a strong structure for the servo motors. I initially used glue for the servos but through testing, I also added nails and wires for support. Additionally, I added zip ties for extra strength as well. I constantly tested and brainstormed the best solutions to create the project fully functioning.

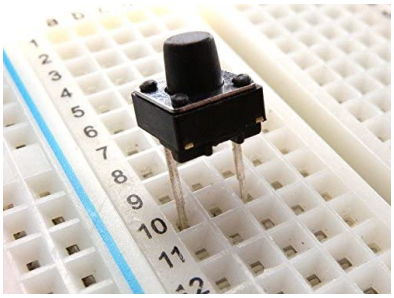


Finally, after creating the structure for the maze, I had to code the servo motors to tilt the maze. Initially, the maze was very sensitive but I managed to fine tune it by converting the joystick input to a reasonable angle to tilt the maze. Later through my design process I decided to make the maze have different levels that the user can select using the button. To add a challenge, I decided to add a button where the user must press it while also controlling the movement of the maze. This aspect really emphasizes the skill in order to maneuver the ball through the gaps of the maze successfully.

Parts Needed:

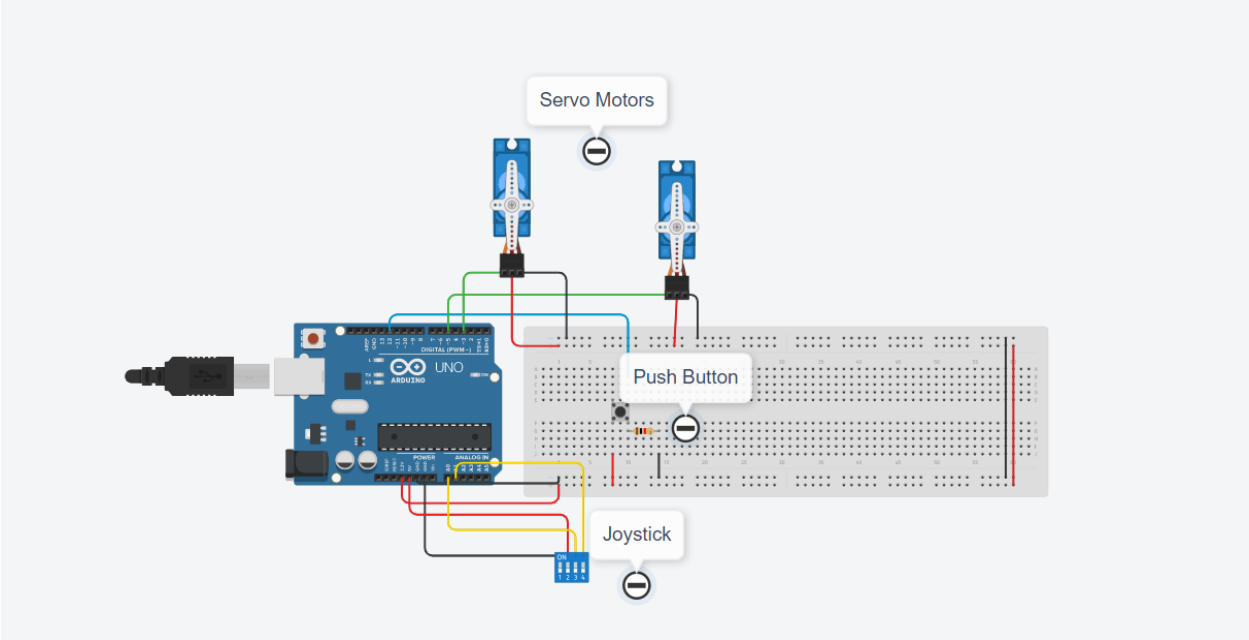
Part	# of parts needed	Photo of part
Arduino Uno	1	
USB 2.0 cable	1	
Breadboard	1	

Jumper wires (male to male)	10	
Jumper Wires (female to male)	4	
220 Ω Resistor	1	
Servo motor	2	

Button	1	
Wood Plank (2 by 4)	1	
Small wood block (4cm x 4cm x 4cm)	1	
Zip ties	3	

Hot glue gun	1	
Screw driver	1	
Nails (1 inch)	4	

Circuit Diagram:



Code Breakdown:

Code	Description
`#include <Servo.h>`	Importing the servo library to use for this program

`Servo servo1;`
`Servo servo2;`
`int joyX = 0;`
`int joyY = 1;`
`int buttonState = 0;`
`int servoVal;`
	Declaring the variables for:
	• First servo
	• Second servo
	• Joystick movement for x-axis
	• Joystick movement for y-axis
	• Button state
	• Servo value

`void setup() {`
`  pinMode(12, INPUT);`
`  servo1.attach(3);`
`  servo2.attach(5);`
`}`
	• Setting pin 12 as an input to be received from the button
	• Initializing the two servo motors to their corresponding pins on the Arduino board

`void loop() {`
 	
`  //read the state of the button value`
`  buttonState = digitalRead(12);`
	• Calling the loop function to decide the sensitivity of the maze based on the button's state.
	• If the button is pressed and held, then the maze will

```
  if (buttonState == HIGH) {  //
Rough movement sensitivity

    servoVal = analogRead(joyX);
    servoVal = map(servoVal, 0,
1023, 0, 35);
    servo1.write(servoVal);

    servoVal = analogRead(joyY);
    servoVal = map(servoVal, 0,
1023, 80, 110);
    servo2.write(servoVal);
    delay(15);
  } else { // Fine movement
sensitivity
    servoVal = analogRead(joyX);
    servoVal = map(servoVal, 0,
1023, 0, 23);
    servo1.write(servoVal);

    servoVal = analogRead(joyY);
    servoVal = map(servoVal, 0,
1023, 80, 100);
    servo2.write(servoVal);
    delay(15);
  }
}
```

have a higher sensitivity

- If the button is not pressed then the maze will have the default sensitivity.

Reflection:

Throughout the building process of my project, I used various problem-solving techniques in order to create the desired working project. My first objective was to 3-d print the maze. Although I did not have any prior experience with 3-d printing, I used my innovative skills and motivation to learn how to use the Ultimaker software in order to print my model. I also used techniques of reverse engineering to analyze specific electrical components of the circuit such as the servo motors. Once I wired the circuit, I tested within the Arduino code the different angles to tilt the servo motors. By using the trial and error process, I was able to fine tune the servo motor to tilt the maze at the desired angle. This technique of trial and error also helped me overcome various issues regarding the support structure needed. I constantly experimented with different shapes and sizes for the structure of the project. With the use of divide and conquer technique, I was able to split the tasks into smaller sub-tasks and combine them at the end to create my overall project. I first worked on creating the orientation of the servo motors and then I focused on attaching them onto a wooden block. After this, I started testing the angles of the maze with the joystick to determine the optimal tilt position and once I got the maze to work, I attached my block to a wooden plank for extra stability. With further experimentation, I decided to also add zip ties and screws into the servo motors in order to further support the weight of the maze.

In the end, I achieved my goal of creating a functional and fun Maze project which is guided by the joystick. I also achieved my goal of adding a more challenging aspect which I implemented with the use of a push button. This challenge adds a higher sensitivity for the user to play with when the button is pressed. I am also very content with the base sensitivity

of the maze as it proves to be successful in guiding the ball through the maze.

If I had more time to enhance this project, I would add an additional course level which would be at the end of the original maze. This idea would require an additional set of servo motors as well as a design for the 3-d model in which the ball will be guided through.

Overall, throughout the project I used various techniques including reverse engineering and diagnostics which essentially helped to make the advanced maze game. I learned about important skills such as how to use 3-d printing and the software which definitely proved to be useful. Putting the whole project together also taught me the importance of experimentation as an engineer in order to create the best possible product to display which I have achieved.

References

Ahmedazouz, & Instructables. (2019, December 11). *Arduino Marble Cardboard Maze Labyrinth*. Instructables. Retrieved January 24, 2023, from https://www.instructables.com/Arduino-Marble-Maze-Labyrinth/

A. (2018, March 22). *How to control servo motors with an Arduino and joystick : Arduino*. Maker Pro. Retrieved January 24, 2023, from https://maker.pro/arduino/tutorial/how-to-control-servo-motors-with-an-arduino-and-joystick

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