Design Document

Hatter Bot

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Date: November 13, 2022

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Revision Record

Date	**Author**	**Comments**
Sep 23, 2022	Laird	Created the document, created outline, wrote project description section, added system level block diagram
Sep 24, 2022	Laird	Added schedule, BOM, mechanical subsystem section
Sept 25, 2022	Vansh	Added Software architecture diagram
Sept 25, 2022	Vansh	Added Software Simulation results and test code example.
Sept 25, 2022	Vansh	Added Microcontroller subsystem diagram
Oct. 14, 2022	Laird	Updated system design diagram and mechanical subsystem with updates since PDR.
Oct. 14, 2022	Mehul	Updated User Input Subsystem section
Oct 16, 2022	Vansh	Added Pinout Diagram for Microcontroller

Oct 16, 2022	Spencer	Updated Power Subsystem Section and Fixed Figure Numberings & Font Consistency
Nov 13, 2022	Laird	Finalized system design diagram and mechanical subsystem section. Fixed up language throughout from proposal wording to final product wording
Nov 15, 2022	Spencer	Changed the diagram for Audio/Visual Subsystem, updated the Bill of Materials, and organized the Figure numbers

Project Description

We built an animatronic Mad Hatter from Lewis Caroll's "Alice's Adventures in Wonderland". The hatter pops up from behind his tea table to pour tea for his guests. His eyes light up and body jiggles while he recites his lines received via Wi-Fi from the play's director.

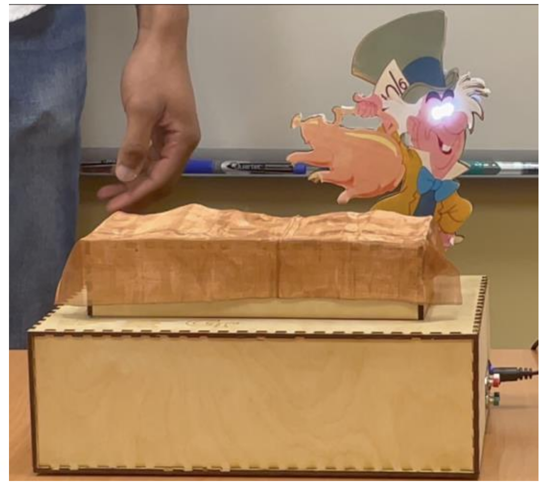


Figure 1: Our initial proposal for hatter Bot and Final Design

System Design

Hatter Bot receives power from a standard 120V outlet, performance instructions via Wi-Fi from the "Director" and user input via four pushbuttons and two switches. The robot outputs mechanical movement, lighting, and audio. The system is divided into 5 subsystems. "User Input" subsystem relays signals from the buttons and switch to the "Micro-controller" subsystem which controls the "Mechanical" and "Audio/Visual" subsystem with a combination of the user input and Director instructions received via Wi-Fi. The power subsystem converts and distributes power from the wall outlet to the other subsystems.

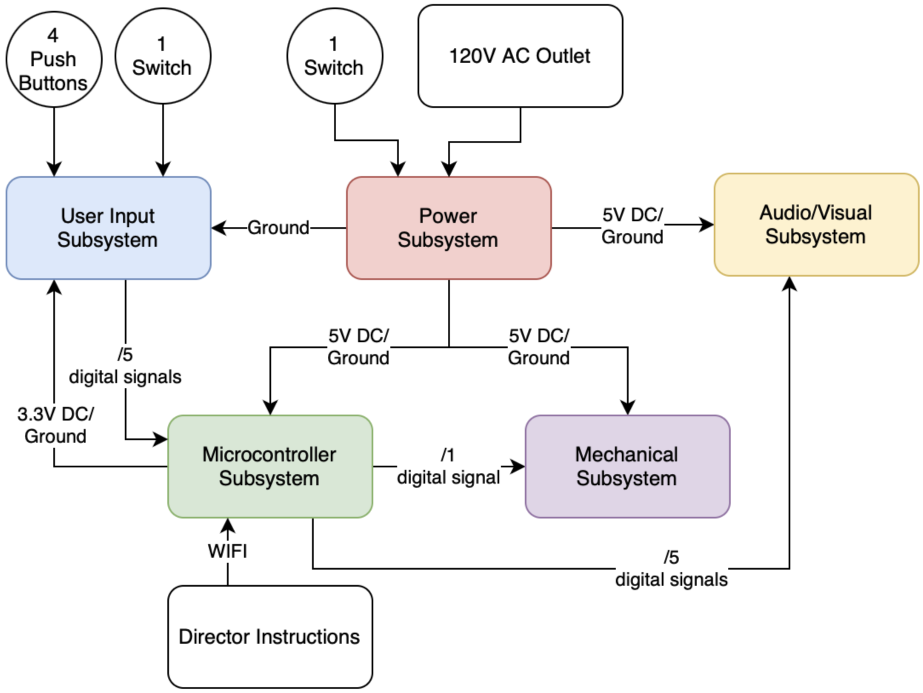


Figure 2: System Diagram with Subsystem Interfaces

Subsystems

User Interface Subsystem

The user interface subsystem consists of four push buttons and a toggle switch. The toggle switch when flipped toggles between an acting mode and a testing mode. When in acting mode, the system takes commands from the Director. When in testing mode, the device takes commands from the four push buttons. Each of the push buttons are pulled down and when pressed triggers a system test for a given group of components.

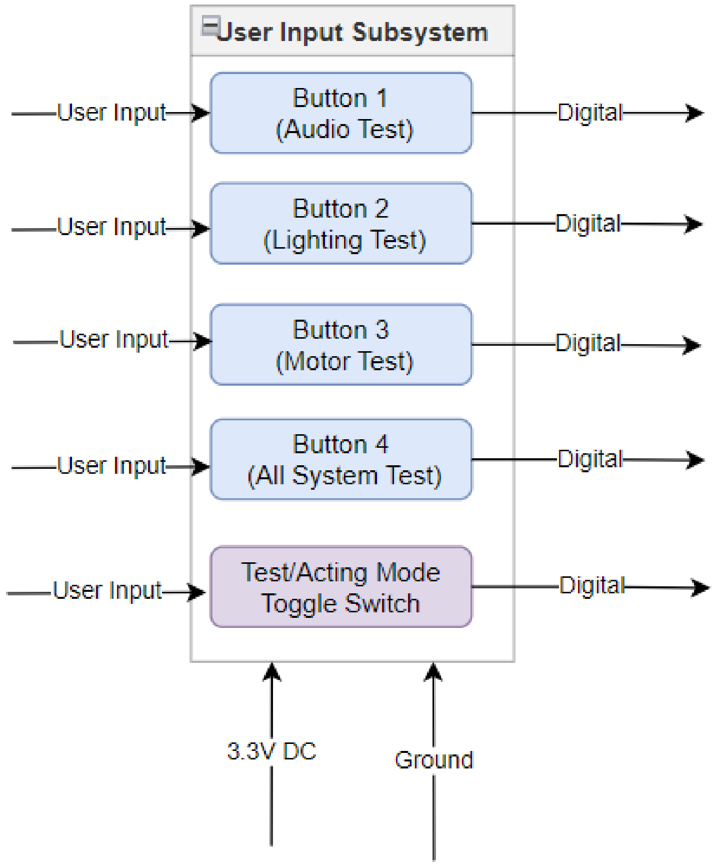


Figure 3: User Interface Sub-system Block Diagram

Each pushbutton is debounced in hardware using the circuit shown in Figure 4. C is a capacitor of 1 uF. R1 and R2 are both resistors of 123 Ohms. D is a simple p-n junction diode. Vcc is the 3.3V control voltage from the microcontroller. This debouncing results in an output signal as displayed in Figure 5.

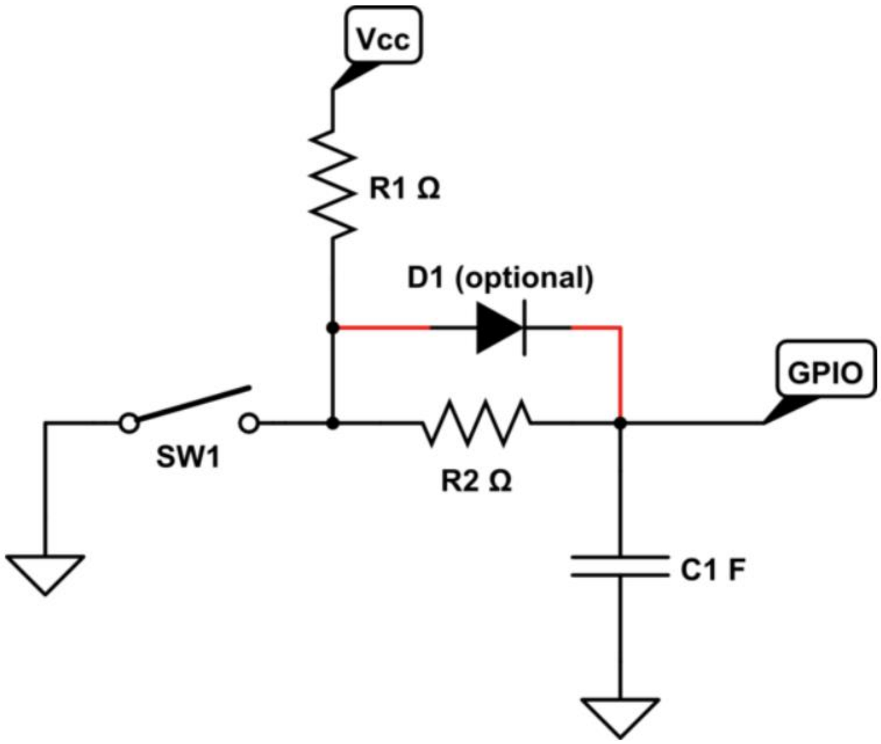


Figure 4: Circuit used for debouncing pushbuttons.

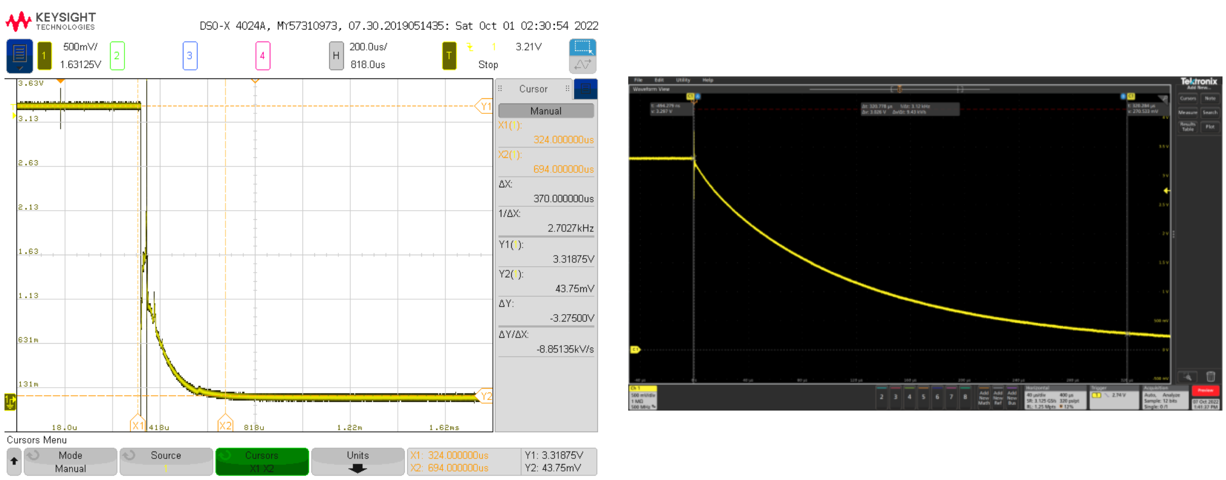
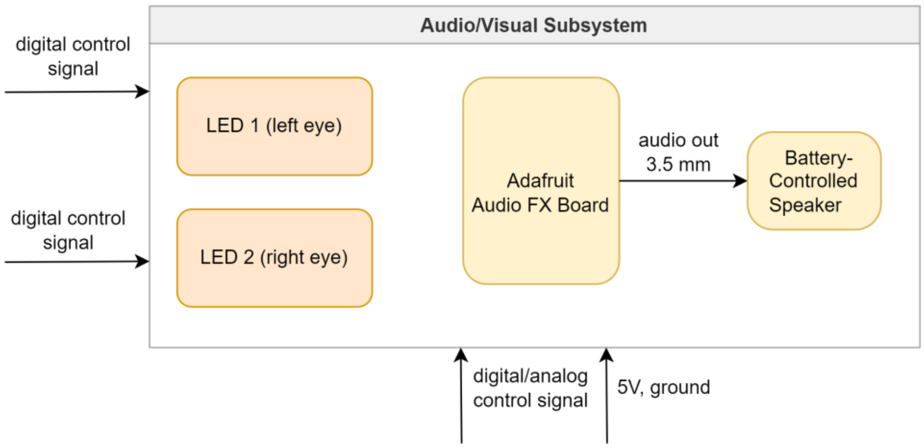


Figure 5: Output signal of pushbutton before (left) and after (right) debouncing.

Audio/Visual Subsystem

The audio/visual subsystem consists of LEDs, an Audio FX Board, and a speaker. LED 1 is found in the Hatter's left eye and LED 2 is found in his right eye. All components are to be controlled by digital control signals. The Audio FX Board feeds into the speaker giving it a stronger signal and both are powered by a 5V voltage source.



Figurer 6: Audio/Visual Subsystem

Mechanical Subsystem

The mechanical subsystem consists of the chassis, motor, and hatter figure. The chassis is a laser cut wooden box with the tea party scene from Alice in Wonderland constructed on top. The Hatter is a painted, thin, plywood cutout connected to the motor mounted underneath the tea party table. The Hatter can rotate into a slit in the chassis hidden from the audience. The components of all the other subsystems are mounted within the chassis.

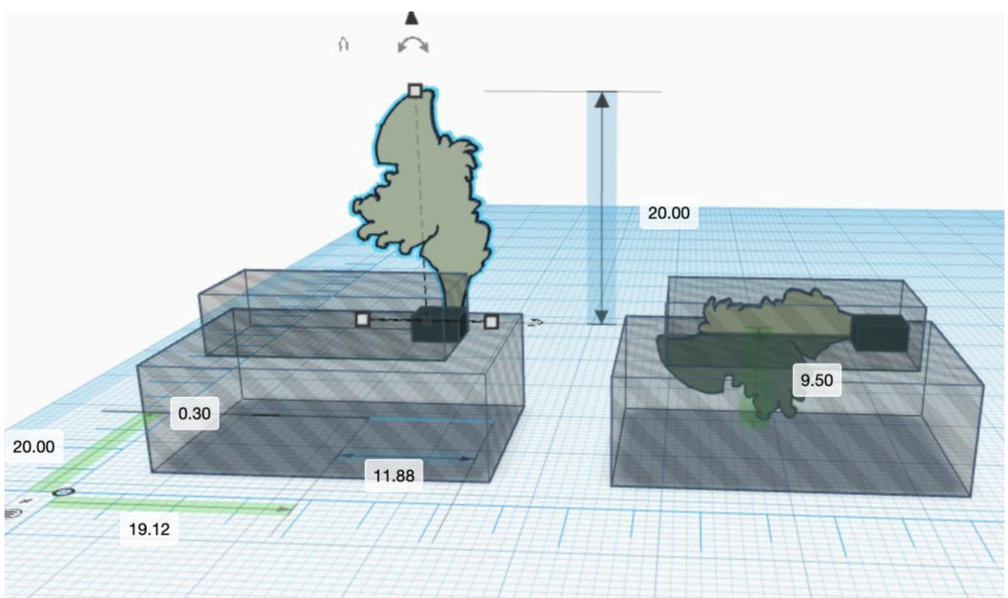


Figure 7: CAD Design of Chassis, Motor, and Hatter Figure

The Hatter's movement is performed by a mid-sized servo motor. Servo motors are precise and easily controlled through software and provide 180˚ of rotation, plenty for our uses. Power is routed to it via the Power subsystem and controlled by the Raspberry Pi.

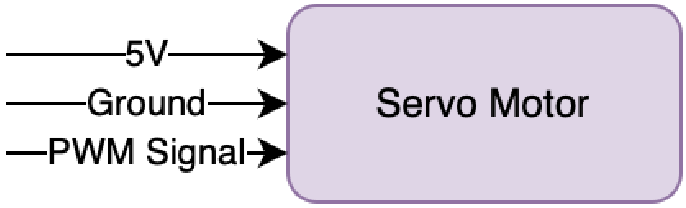


Figure 8: Electronic Diagram of Mechanical Subsystem

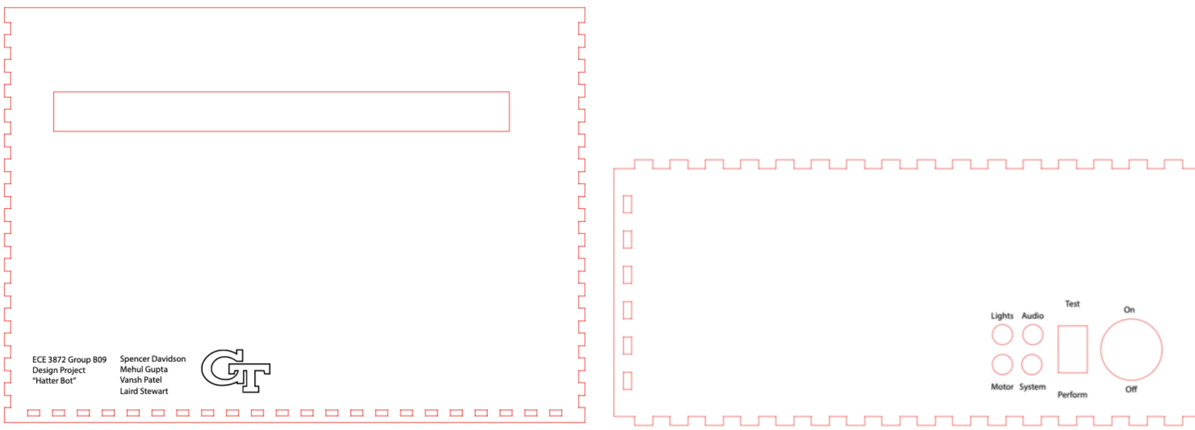


Figure 9: Laser Cut Designs of the Top and Right Faces of the Chassis

The rear face of the box is made of acrylic and is hinged to provide easy access into the body. The right face of the chassis contains cutouts and labels for the User Input Subsystem, and the top is engraved with our team's name, details, and Georgia Tech's logo.

Figure 10: Assembled Chassis with Figure Attached

Microcontroller Subsystem

The microcontroller, Raspberry PI, will be used to embed the software into the hardware, and using different python files to control the subsystems will allow the system to operate efficiently as a whole. The diagram below shows how the raspberry pi interacts with the software and hardware components, and acts as an interface to transmit the instructions from software to the hardware components. The raspberry pi will also take user inputs and transmit them to the state machine manager, which will then process and perform the appropriate functions

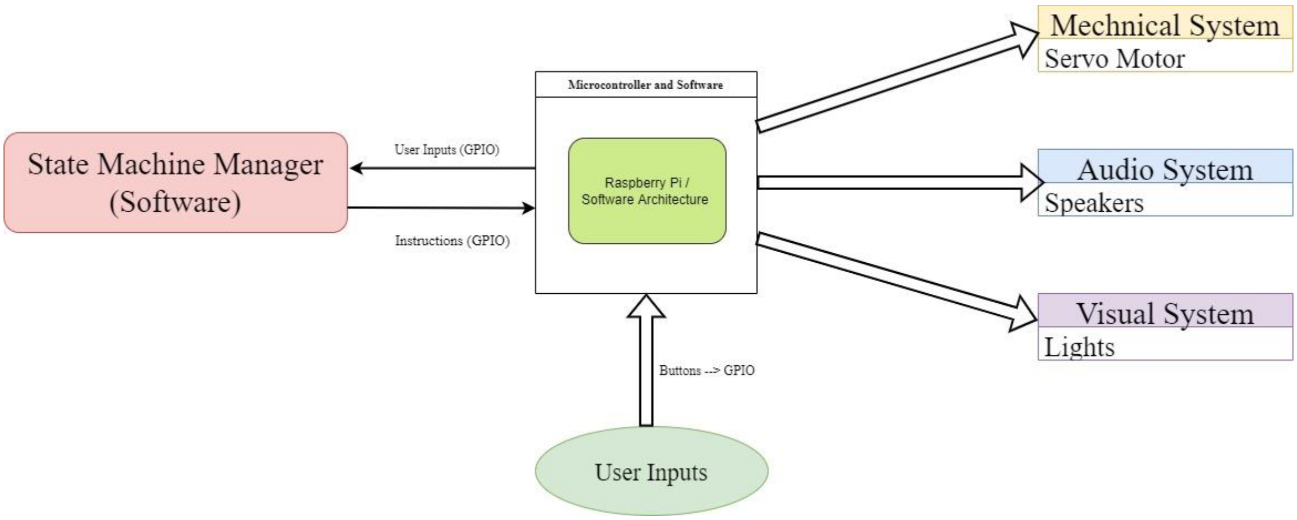


Figure 11: Microcontroller Sub-System

Below is a diagram to explain the GPIO PINOUT for the Microcontroller sub-system. Each of the components will be connected by 5V power and GND distributed by the PCB. While the power will be distributed by the PCB, the Microcontroller will send the logic signals to the other components.

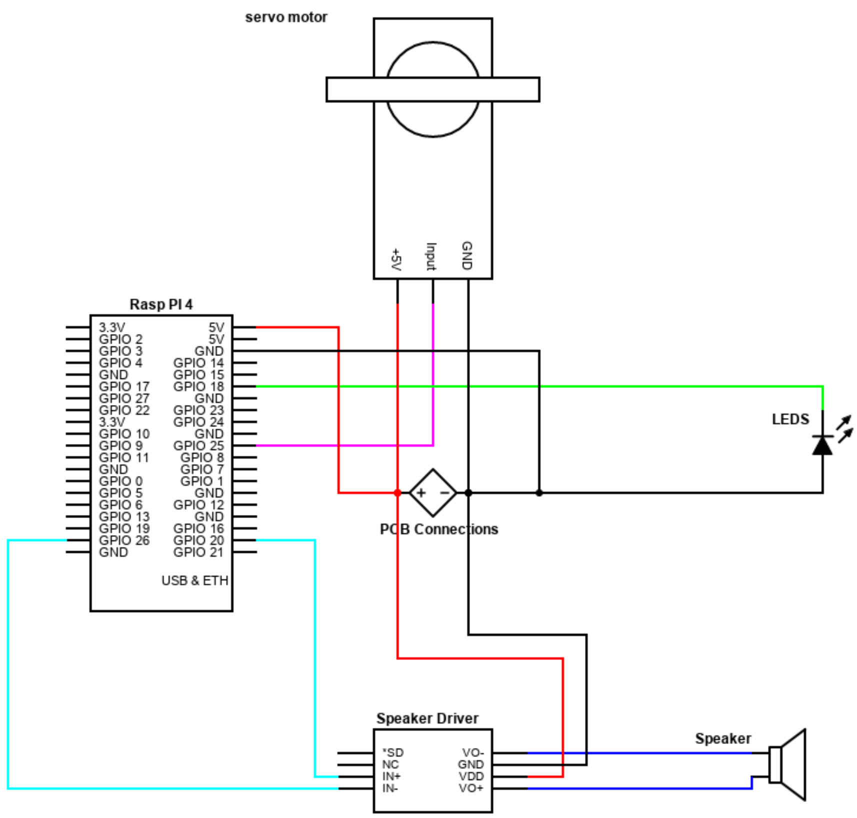


Figure 12: GPIO Pinout Diagram

Power Subsystem

The power subsystem is what allows all other subsystems to function; it consists of a 120V AC outlet, power switch, and fuse which together output to the Microcontroller Subsystem, Speaker, and Servo Motor. The power supply will be plugged into an AC outlet which will supply the robot with 120V. The power switch will take in 5V and will be operated on by the power supply. The fuse will prevent too much current from flowing. When the power supply is plugged in and the power switch is flipped, power will then be supplied to the robot.

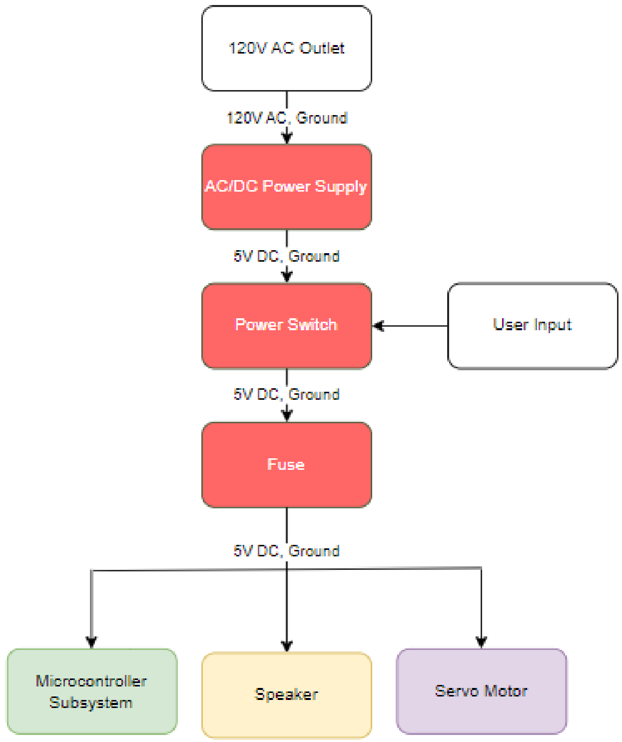


Figure 13: Power Sub-System

Software Design

This is python-based architecture that will utilize an object-oriented scripting approach, to minimize and re-use functions. At the heart of this architecture is the state machine manager, which will comprise of two functions: Test and Action. Within these functions, the code will implement a hierarchal code that will call functions from various python files programmed to perform system functions. This approach of coding will also allow efficient debug, and allow more throughput, as we won't have to wait for the entire architecture to be complete, to start testing, and integration. Below, is an example of test and simulations, as an outcome of this software architecture.

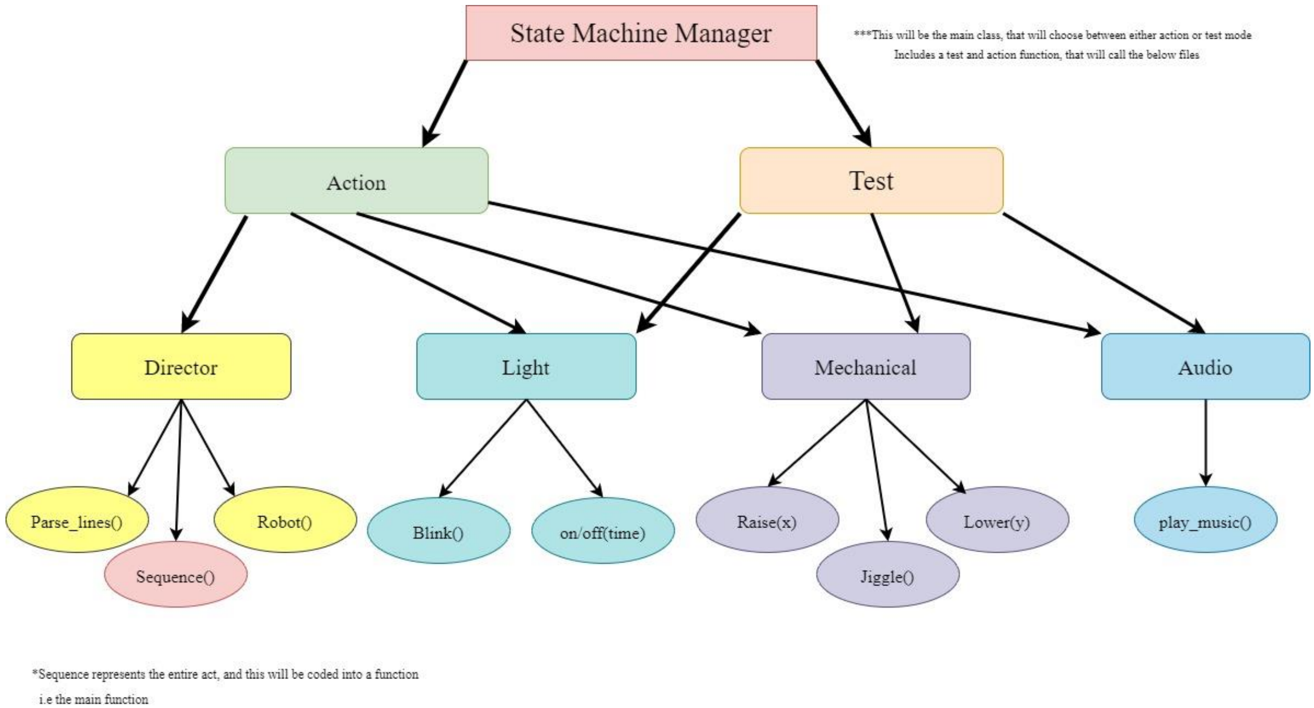

State Machine Manager
***This will be the main class, that will choose between either action or test mode
Includes a test and action function, that will call the below files
Action
Test
Director
Light
Mechanical
Audio
Parse_lines()
Robot()
Sequence()
Blink()
on/off(time)
Raise(x)
Lower(y)
Jiggle()
play_music()
*Sequence represents the entire act, and this will be coded into a function
i.e the main function

*Figure 14: Schematic design used for **software** architecture created in draw-io with functions, and their input parameters, coded onto the Microcontroller.*

Simulation History:

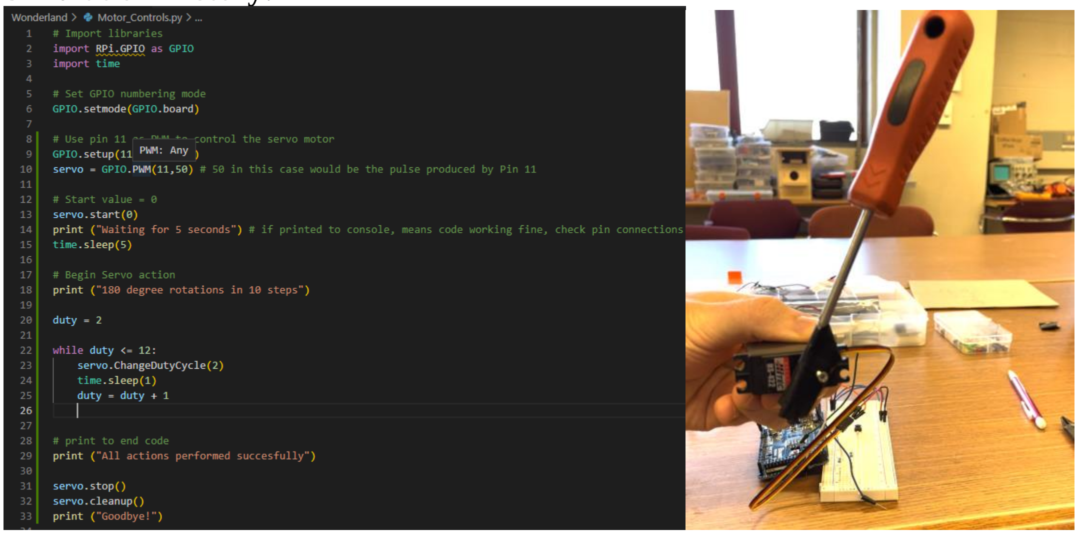


Figure 15: Test code to test the Servo Motor

In the above code, I used the Motor Controls function to control the servo motor, with the GPIO pins, by proving an angle of rotation and pulse.

Project Schedule

Group B09 Schedule		Week Number												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Overall System	Brainstorm	Spencer												
	Design Top Level Block Diagram	Spencer												
	System Integration												Laird	
	System Test													Laird
Software	Design		Vansh	Vansh	Vansh		Vansh							
	Simulate/Prototype					Vansh		Vansh						
	Build								Vansh	Vansh				
	Test										Vansh			
	Integrate											Vansh		
Microcontroller Subsystem	Design		Mehul	Mehul	Mehul		Mehul							
	Simulate/Prototype					Mehul		Mehul						
	Build								Mehul	Mehul				
	Test										Mehul			
	Integrate											Mehul		
Audio/Visual Subsystem	Design		Spencer	Spencer	Spencer		Spencer							
	Simulate/Prototype					Spencer		Spencer						
	Build								Spencer	Spencer				
	Test										Spencer			
	Integrate											Spencer		
Power Subsystem	Design		Spencer	Spencer	Spencer		Spencer							
	Simulate/Prototype					Spencer		Spencer						
	Build								Spencer	Spencer				
	Test										Spencer			
	Integrate											Spencer		
User Input Subsystem	Design		Mehul	Mehul	Mehul		Mehul							
	Simulate/Prototype					Mehul		Mehul						
	Build								Mehul	Mehul				
	Test										Mehul			
	Integrate											Mehul		
Mechanical Subsystem	Design		Laird	Laird	Laird		Laird							
	Simulate/Prototype					Laird		Laird						
	Build								Laird	Laird				
	Test										Laird			
	Integrate											Laird		
Milestones	**Proposal**		Proposal											
	PDR					PDR								
	CDR								CDR					
	Final Inspection and Demons													Final Demo

Table 1: Project Schedule by Task and Task Lead

Bill Of Materials

Item No	Description	Vendor	Vendor Part Number	Link to data sheet	Quantity	Unit cost	Total Cost	ECE Stock Y/N	Obtained Parts Y/N
1	Servo Motor	Hi-Tec	HS-422	http://cdn.sparkfun.com/datasheets/Robotics/h	1	$12.99	$12.99	Y	Y
2	Switch	Carling	2GK51-73	https://www.carlingtech.com/sites/default/files	1	$4.12	$4.12	Y	Y
3	Raspberry Pi 3 Model B	Raspberry Pi	RASPBERRYPI3-MODE	https://www.terraelectronica.ru/pdf/show?pdf_	1	$135	$135	Y	Y
4	Pushbutton	NTE Electronics	2368-54-556-ND	https://www.nteinc.com/switches/pdf/pushbut	4	$1.57	$6.28	Y	Y
5	Speaker Driver	Adafruit	PAM8302A	https://media.digikey.com/pdf/Data%20Sheets/	1	$3.95	$3.95	Y	Y
6	Speaker	Adafruit	KS-3008	https://cdn-shop.adafruit.com/datasheets/P18	1	$1.85	$1.85	Y	Y
7	Power Supply	Triad	WSU050-3000	http://catalog.triadmagnetics.com/Asset/WSU0	1	$8.88	$8.88	Y	Y
8	Rocker Switch	E-Switch	EG5693-ND	https://sten-eswitch-13110800-production.s3.a	1	$0.45	$0.45	Y	Y
9	Sound Board	Adafruit	VS1000	https://gtvault.sharepoint.com/sites/ECE-3872E	1	$14.95	$14.95	Y	Y
10	Speaker	Tihebeyan	PS-035	https://gtvault.sharepoint.com/sites/ECE-3872E	1	$11.45	$11.45	Y	Y

Table 2: Bill of Materials