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Robotic Bartender Control Using DC and Servo Motor with The Aid of Rectifier as Power Source

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Abstract

The study focuses on building a design and implement of robotic bartender with rectifier power source and embedded with volt-amp display to monitor supply voltage and load current. The usage of robotic bartender in the market make ease to the worker staff in food and beverage industries so that they can prepare drinks to customer in short of time. For this paper, the design of robotic bartender is constructed using 3D printed components and use Arduino UNO as microcontroller to control input signal of rotary encoder and switches to commodore DC Motor rotation and servo motor deflection. The prototype of robotic bartender will be constructed, programmed with C language, tested with Proteus simulation software and hardware will be tested by using tachometer laboratory equipment for speed testing. Lastly the overall system is powered by rectifier with embedded volt-amp display for convenient use. Ironically the development of robotic bartender hardware is to fulfil two objectives which are to propose a new model of robotic bartender compatible with DC motor and servo motor and objective two to design and assemble rectifier circuit power supply with embedded volt-amp display meter to energize motor load.

1. Introduction

Modern machines in Food and Beverage Industries must deal with the increasing number of demands from customers who come to their shops [1]. During peak hours such as lunch time, a large amount of customer will come to their shop causes the food and beverage shop to be crowded resulting the staff in the shop will be not enough to handle the customer because lack of machine efficiency to aid their work. Manu food manufacturers are now investing more heavily in quality control and automated handling processes to increase their products quality, improvement in repeatable production [2] and ease worker burden in handling customer needs.

One of the most recent technology advances is robotic bartender that enables the user to semi-automatic control the machine. This machine allows the user to dispense drink based on how many milliliter per cup [3] depending on how the machine is programmed and controlled by the user. With the aid of Rectifier as power supply attached with the volt-amp display meter bar it gives the machine easy to be monitor and maintenance because it provides how much voltage supply and current monitoring of the motor load used.

The method used before in developing the robotic bartender is less efficiency because during machine is running there are no portable tools used to monitor supply voltage and current of motor loads used to determine whether the robotic bartender machine consume high amount of power or not and it also cause

difficulties for the technician to troubleshoot and conduct maintenance on the machine. Most of these robots consist of two kinds of platform which are linear mechanics or rotary mechanics to substitute the placement of DC motor to enable the movement of the machine [4]. It may be easy to arrange the components of robot, but it requires a large workspace and complex control.

The previous design of robotic bartender requires large space to be installed inside the shop. Although it has robust design, but it is not practical to use in shop with small confinement which need a lot of space to put their raw materials and other stuff. Based on the finding the accomplishment of this project is to create a robotic bartender with low-cost prototype using 3D printed components [5] with suitable conveyor type robotic bartender and monitored power supply during machine is running.

2. Materials and Methods

The section will explain the hardware part and software part used to build the prototype implementation.

2.1 Software Implementation

Hardware and software components build the core design for the robotic bartender prototype. Components needed to create the robotic bartender prototype are by using 3D printed components which origin from nylon materials. The shape used to create the robotic bartender prototype is imported from the Things Inverse software the file is converted into SKP files to adjust and merge components so that the design meet specifications to integrate with other component such as DC motor, servo motor and timing belt.

Once the design is imported through Things Inverse open-source software, the components parts are inserted through SketchUp software to determine the exact measurements and do some trimmings to merge DC motor housing through the 3D components. The measurement taken is also important to merge the timing belt and linear ball bearing so that it can be integrated with the 3D printed components. Hence, the 3D printed components is printed by using ENDER 3D printer which can read g-codes file to export nylon bullet producing firm 3D printed material. As shown in Fig. 1 from left to right is X-Axis DC Motor mount, Slider base attached with timing belt housing and Rod clamp component.

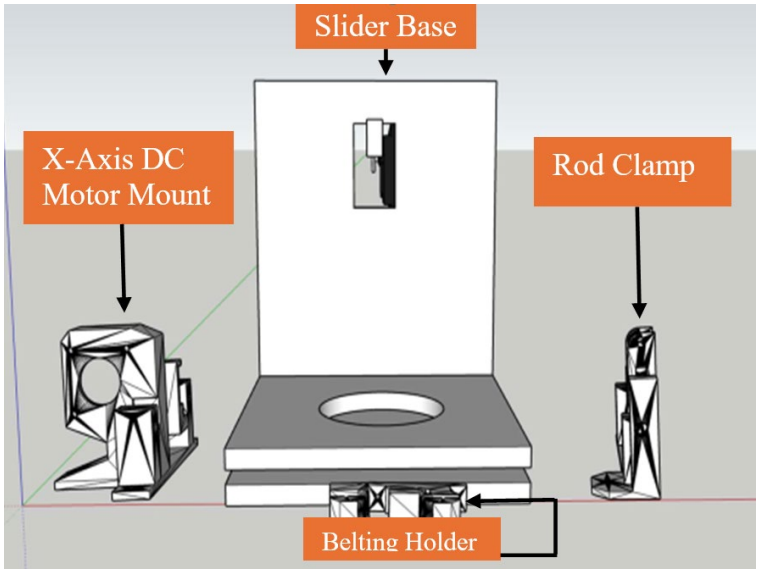

Fig. 1 *Robotic bartender prototype arrangement on SketchUp software*

2.2 Rectifier Circuit

Fig. 2 (a) displays the electronic in schematic while Fig. 2 (b) shows the electronic circuit part stored inside box. These are the electronic components that will be used to assemble the rectifier circuit as a power source [6]. The power transformer type input is 230-volt AC received from power entry module. The power entry module contains 15 Amps fuse to protect the input in case there is large current flow to the input. The power transformer output is 24V-0V-24V type which combine can produce 48V output DC voltage. The purpose of the Bridge Rectifier is to convert step down AC voltage received from the power transformer into DC voltage. The voltage regulator's purpose is to make the output DC voltage become constant carrying the effect from the filter capacitor. Hence, the selection of potentiometer range also able to produce variety range of output DC voltages to energize the DC motor load, for this prototype application 25 Volt is sufficient to power up the DC Motor load.

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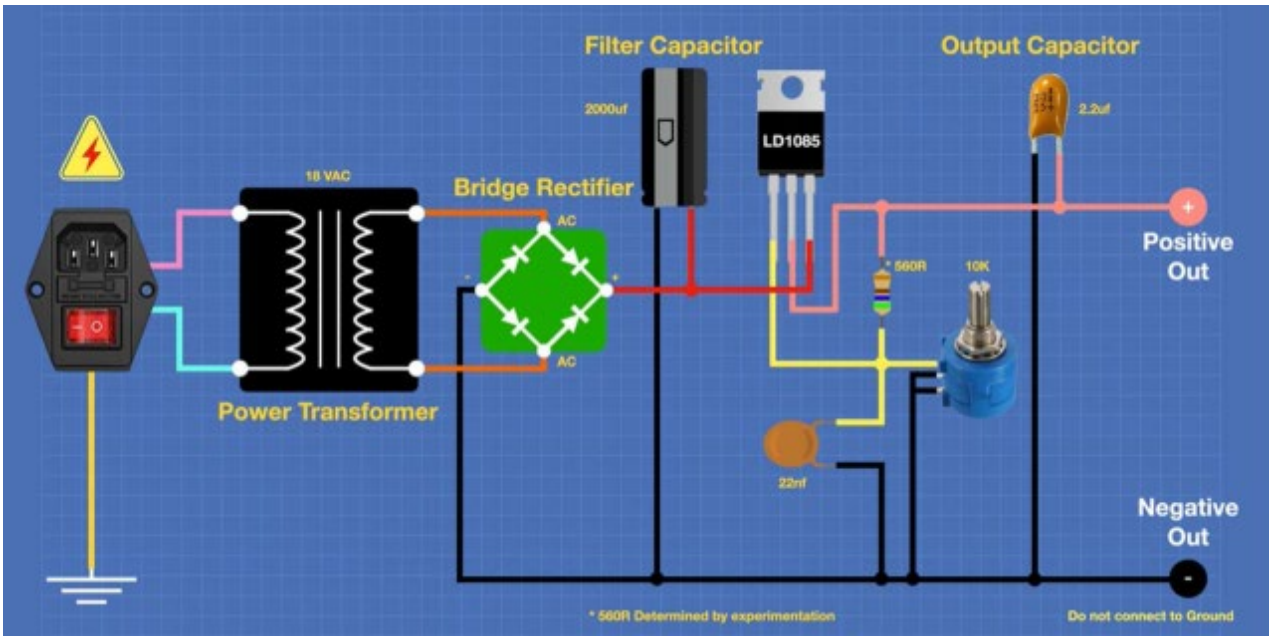
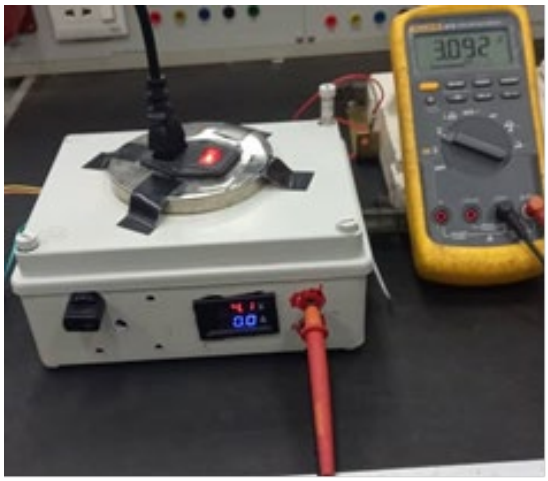


(a)



(b)

Fig. 2 *Rectifier circuit (a) Rectifier circuit sketch on one-note diagram; (b) Hardware circuit box*

3. Functional Flow and Process Used to Build The Prototype

The prototype of robotic bartender machine offers simple features and functionality, including movement of horizontal slider base to left and right direction, and deflection of servo motor to push light type of load. Based on Fig. 3, once the rectifier power supply turned on 12-volt DC output voltage can be observed from a digital dc voltammeter embedded through the circuit box. If the DC output voltage is more than or equivalent to 15 volts and adjustment on potentiometer knob is mase to prevent DC motor load from being damaged. After the motor control circuits receives power from rectifier circuit it will act as input for the DC motor load and servo motor through DPDT switch and rotary encoder to allow rotation of these two-motor load.

3.1 Flowchart for Electrical Process

Based on Fig. 4, the process will start with sketch electronic AC-DC (rectifier) converter power supply circuit using one note diagram. Moreover, the sketched circuit will be simulated inside proteus simulation software to determine whether the simulation indicates output of 25 volt to energize the motor load if not the simulation will be adjusted until desired output is achieved, if yes electronic component can be assembled and soldered through the stripboard and lastly observe the output of DC voltage using multimeter and DC voltammeter. The flow of electrical process used to build the prototype is shown in Fig. 4.

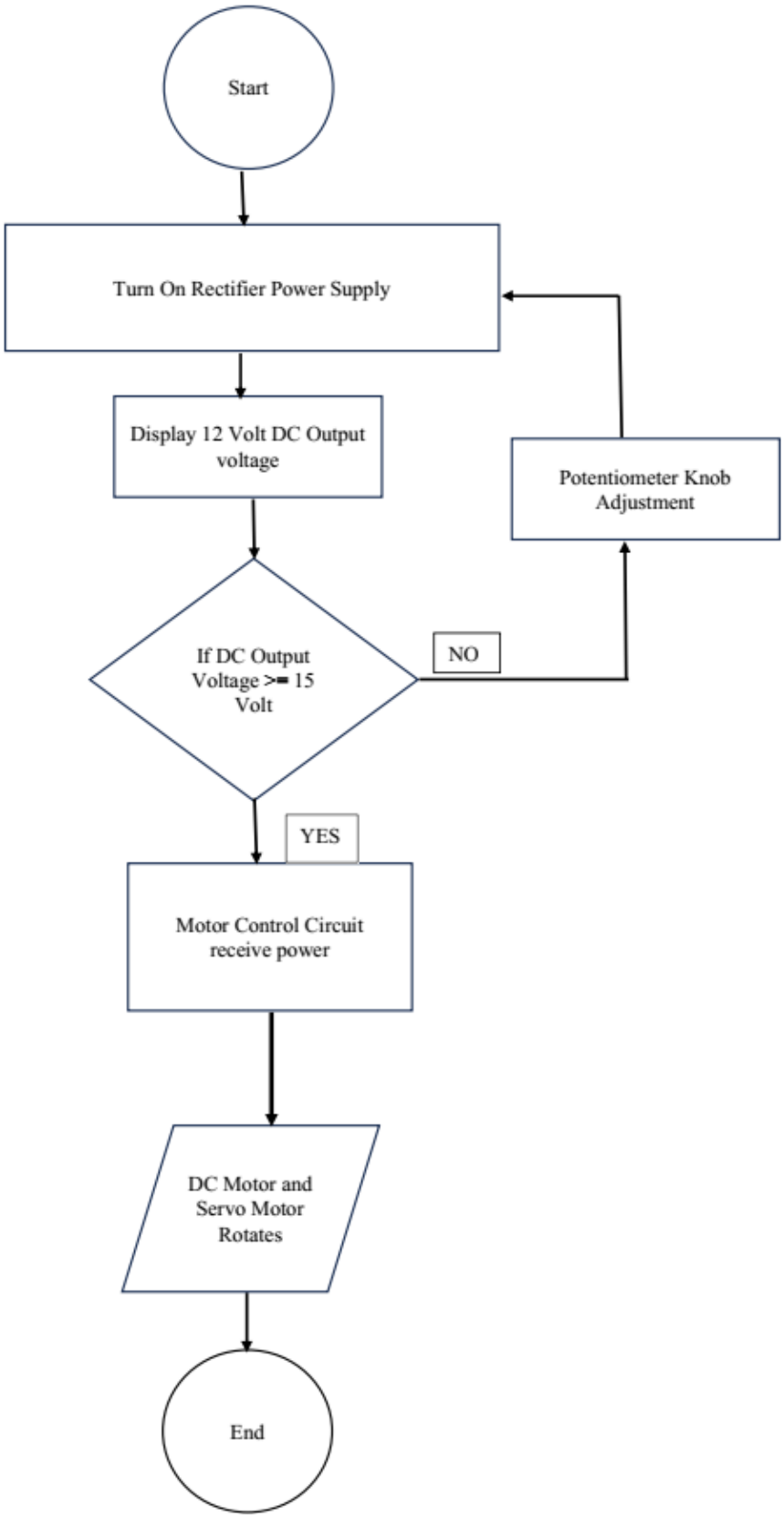


Fig. 3 *Flowchart to control robotic bartender prototype*

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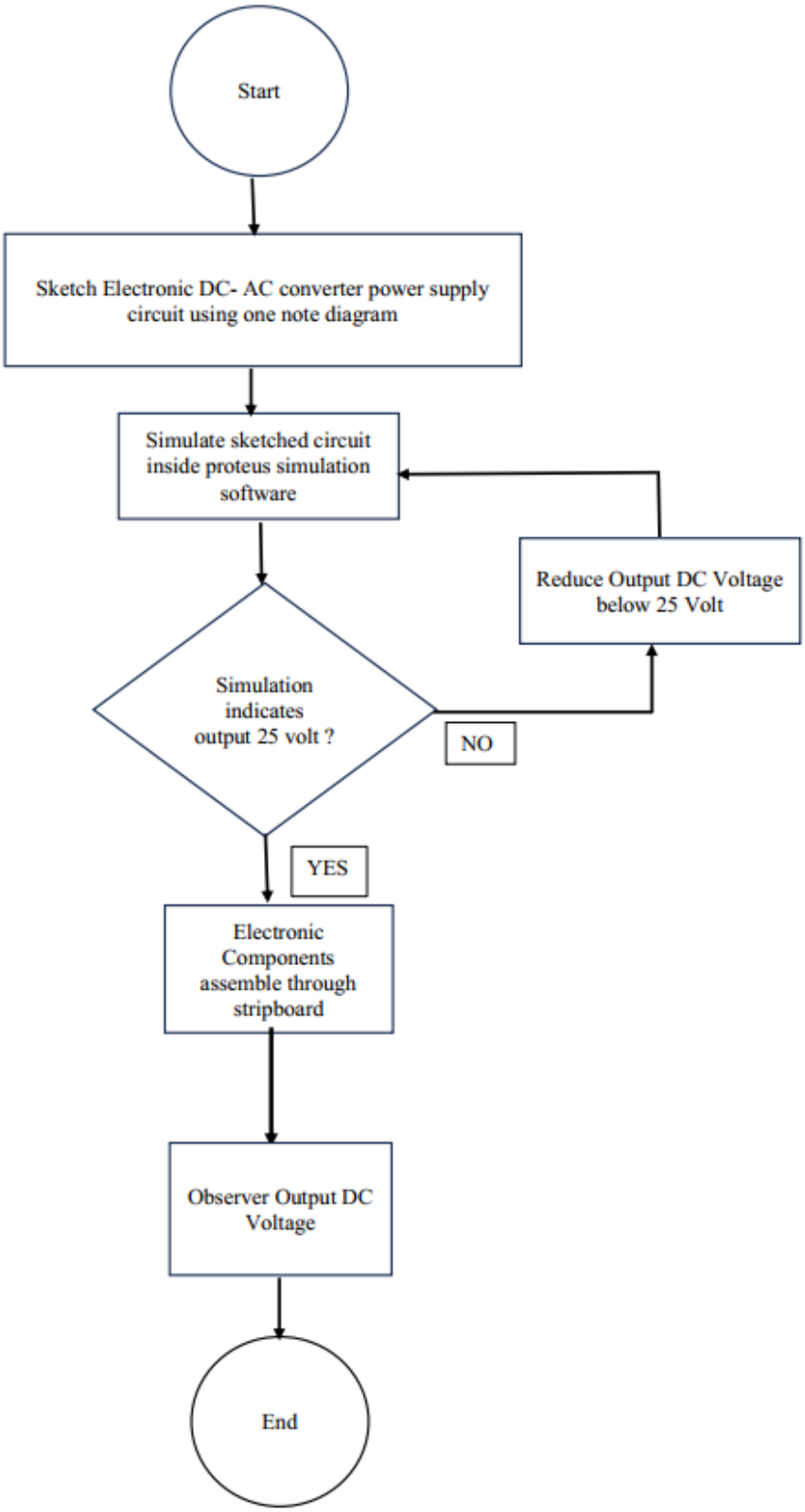

Fig. 4 *Flowchart for electrical part to build the rectifier circuit power source*

3.2 Flowchart for Mechanical Process

Based on Fig. 5, the process will start by importing 3D design shapes from Things Inverse open-source website. Once the design is completely imported through the website the extract design is adjusted into Sketchup software converting it into SKP files to merge design with other components such as DC motor and servo motor.

If the design meet specification after adjusting it on Sketchup software will proceed to 3D printing but if design does not meet specification adjusting on Sketchup software will be carry on until the 3D design meet specification. Hence, after 3D printing is complete, the 3D printed component is merged with conveyor belt and linear ball bearing to create the robotic bartender prototype. The flow of mechanical process used to build the prototype is shown in Fig 5.

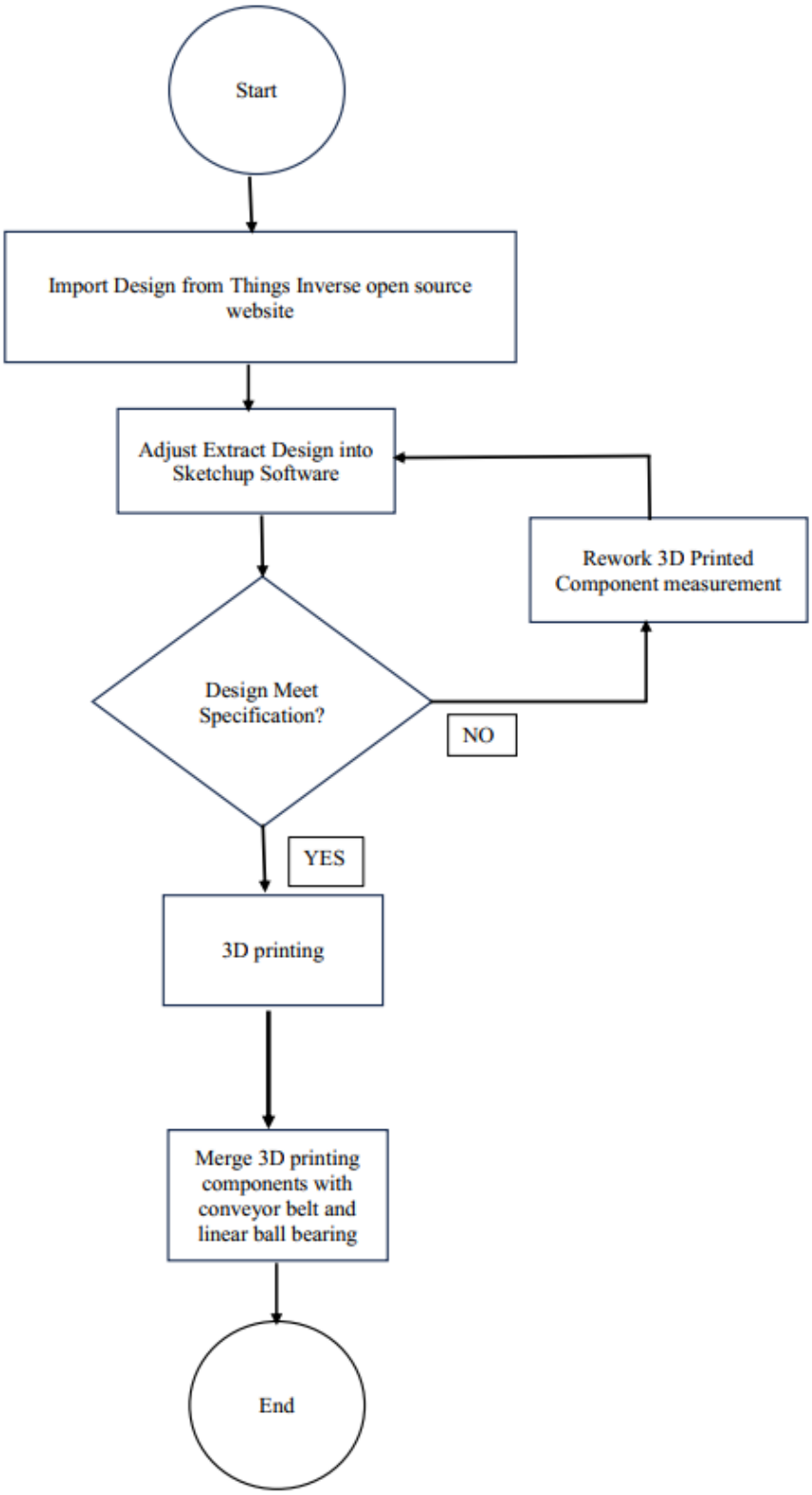

Fig. 5 *Flowchart for mechanical part to import and produce 3D printed component for robotic bartender*

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3.3 Block Diagram

The work aims to design and build a robotic bartender prototype using 3D printed components and adding custom rectifier circuit as the power source to control the DC and Sero motor loads. The robotic bartender prototype consists of 4 sections which are input from the motor controller circuit, power supply, Arduino UNO as microcontroller and output section which consists of two type of motor to control two types of load which is translational load slider base and rotational load deflection from servo motor to push dispenser paddle. The block diagram of the robotic bartender prototype is shown in Fig. 6.

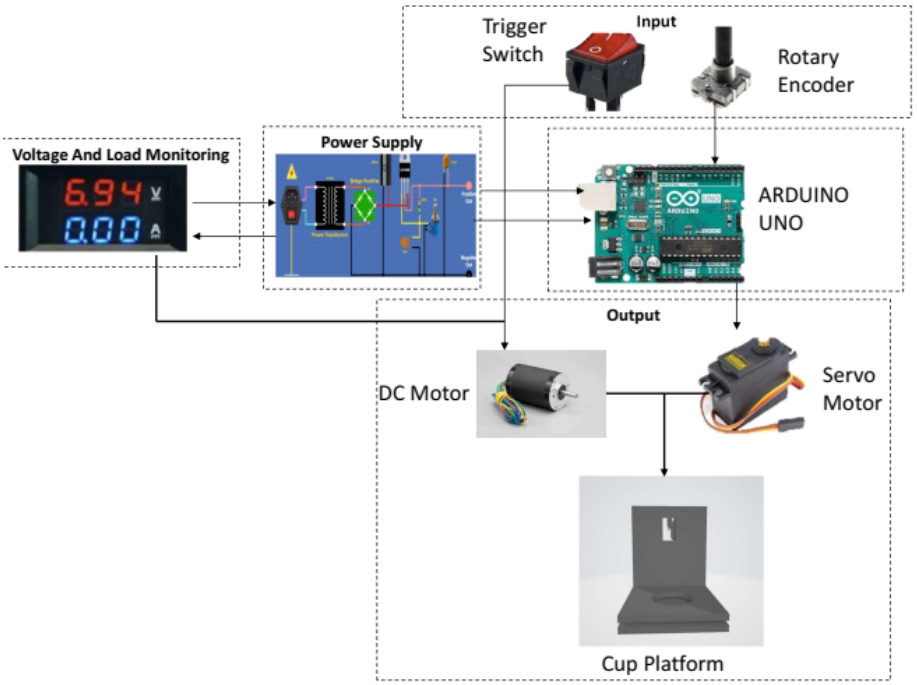

Fig. 6 *Block diagram of robotic bartender prototype*

4. Results and Discussion

The prototype of robotic bartender design is basically made from nylon material printed through ENDER 3D printer to produce 3D printed components shape. It is combined with additional material such as timing belt, linear rail pole and linear block bearing to support the 3D printed components. Fig. 7 shows the hardware design of the robotic bartender prototype. The prototype design primarily illustrates the cup platform slider base with rectifier power supply and motor controller box,

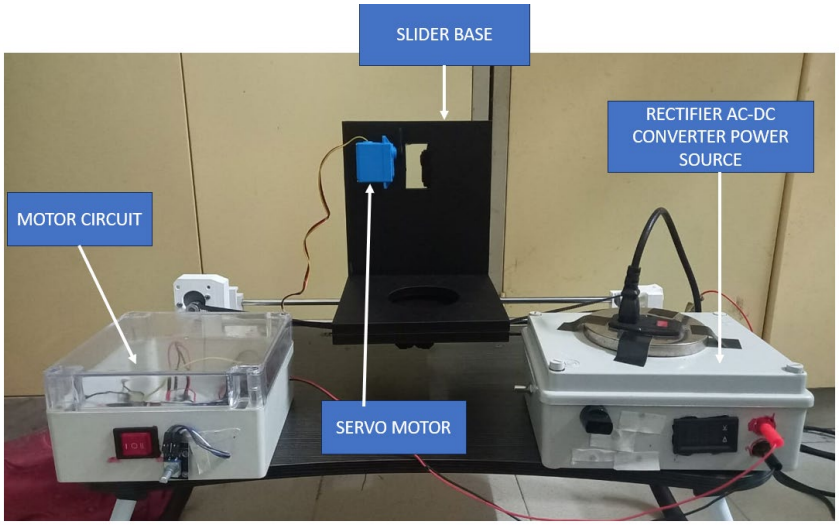

Fig. 7 Front view of developed prototype

The slider base will move left and right when trigger switch is pressed allowing the DC motor to rotate clockwise and anticlockwise direction. The Servo motor will deflect maximum up to 180-degree angle when rotary encoder is rotated precisely receiving digital and clock signal from microcontroller Arduino UNO and the Servo Motor function is to push any dispenser paddle contact with enabling feedback for the system. The rectifier power source receive AC signal as input and convert DC voltage as output enable the motor circuit to receive tremendous power in time. Fig. 8 shows the prototype shown in upper view illustrate the position of X-Axis DC Motor mount attached with DC Motor, Rod Clamp, timing belt and linear rail pole shown on the robotic bartender platform.

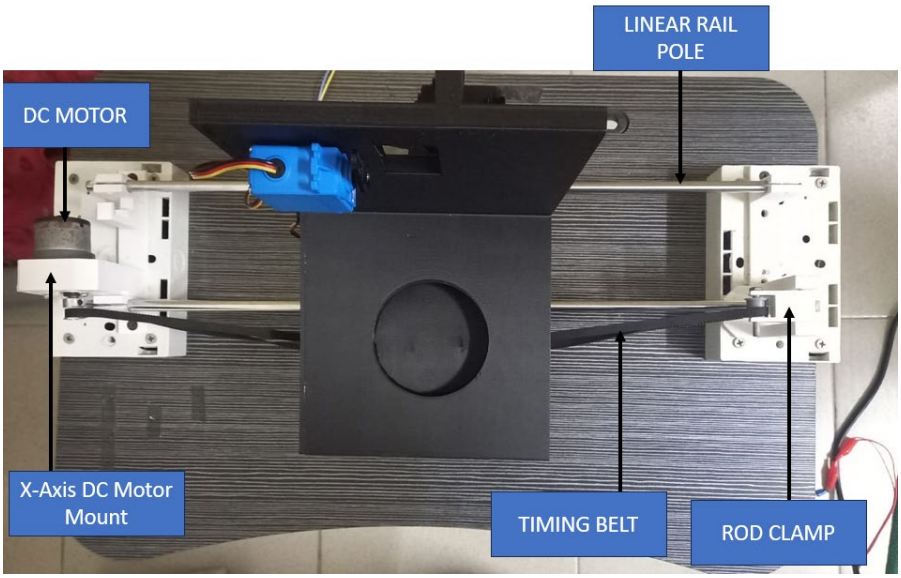

Fig. 8 Top view of developed prototype

4.1 Motor Speed vs Weight of Object

The Prototype of robotic bartender functionality is tested with DC motor speed test. The apparatus and instruments used to conduct this test are tachometer and digital weighing scale. The tachometer is used to measure the rotation speed of DC motor in revolution per minute (rpm) and digital weighing scale is used to take the mass of cup filled with water in gram measurement (g). The data shown in Table 1 represents the values obtained from the test conduct in the laboratory.

Table 1 *Motor speed vs weight of object test data*

AC Input Voltage (V)	Output DC Voltage (V)	Speed of Motor (RPM)	Weight of Object (g)
220	25	1435.1	17.5
		1434.8	19.9
		1433.4	22.5
		1432.5	25.2
		1431.2	28.5

4.2 Percentage Voltage Error Produced from Rectifier Power Source

The performance of robotic bartender prototype power source has also been analyzed by conducting the percentage voltage error produced from rectifier power source test. The purpose of this test is to ensure that the power received from the AC-DC converter output shows corresponding value from digital voltammeter embedded on the circuit box. This test is conducted by using the Fluke 87V RMS Multimeter and tapping it on the binding post of the rectifier circuit box. Equation 1 lay outs the formula employed to calculate the percentage difference within the equation “Output DC Voltage from Rectifier” signifies the value derived from the digital voltammeter embedded in the circuit box while “Measured DC voltage” denoted the value obtain from the Fluke multimeter.

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$$\frac{Measured\ DC\ Voltage - Output\ DC\ Voltage\ from\ Rectifier}{Output\ DC\ Voltage\ from\ Rectifier}\ x\ 100\% \quad (1)$$

Equation (1) shows the percentage of voltage error calculation where Measured DC voltage is from multimeter and Output DC Voltage from rectifier gain from display of digital volt-ammeter attach at the circuit box.

Table 2 *Percentage voltage error produced from source test*

Number of Potentiometer Turns (10k)	Output DC Voltage From Rectifier (V)	Measured DC Voltage (V)	% Error in Voltage Produced
1	4.3	3.5	18.6
2	9.8	9.64	1.63
4	13.0	12.94	0.46
6	13.5	13.26	1.78
9	34.62	34.29	0.95

A data graph has been plotted from Table 1 to show the relationship of DC motor speed and weight of object which is cup filled with water. The data graph in Fig. 9 shows that as the mass of object which is the cup filled with water is increased in value the speed of DC motor will decrease in time. It can be concluded that the robotic bartender are able to carry a cup filled with water because the mass in gram (g) portrays a light load for a DC motor and 3D printed component to carry the object. On the other hand, Table 2 tabulates % error of measure voltage comparison according to the potentiometer setting. All results show allowable range of % except for potentiometer of 1 kΩ. This signifies the developed rectifier is in a good condition and its operation works very well.

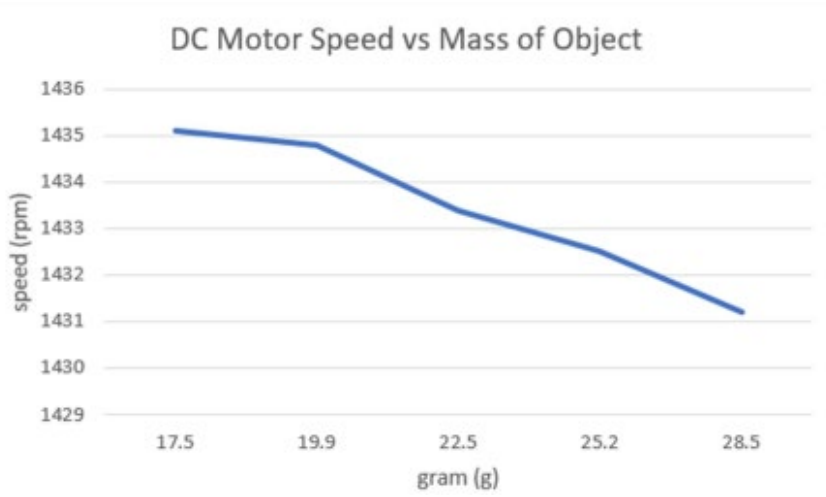

Fig. 9 *Motor speed and mass of object relationship test*

5. Conclusion

Ironically, there are two objectives that have been outlined to achieve the aim of this project, which is to propose a new model of robotic bartender compatible with DC and servo motor. The first objective of this project is to design a hardware of robotic bartender prototype using 3D printed components by implementing Sketchup software to merge and adjust measurement to fulfil the specifications of other components such as DC motor and timing belt. The second objective is to design and assemble rectifier circuit as power supply with embedded volt-amp display meter to energize the motor load. The second objective is conduct by sketching the circuit using one note diagram to determine required components in quantity to build the custom power supply then the sketched circuit is simulated inside proteus simulation software to determine its required output voltage before assembling and soldering it into stripboard. By analyzing the performance, further improvement can be implemented into the robotic bartender prototype so that the system become more reliable and convenient for the staff or food and beverage industries to utilize it.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Muhammad Haziq Mohd Noor, Mahyuzie Jenal;* ***data collection:*** *Muhammad Haziq Mohd Noor;* ***analysis and interpretation of results:*** *Muhammad Haziq Mohd Noor, Mahyuzie Jenal, Khairul Anwar Ibrahim;* ***draft manuscript preparation*** *Muhammad Haziq Mohd Noor, Mahyuzie Jenal. All authors reviewed the results and approved the final version of the manuscript.*

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