MODELING, ANALYSIS AND FABRICATION OF HOTEL SERVICING ROBOT

Abstract

The research intends to provide a framework for long-term growth in the hospitality sector, which is now experiencing a severe scarcity of workers. The study establishes causal links between the features of a serving robot, customer satisfaction, risk aversion, perceived value, and the likelihood of a return visit. Furthermore, it is crucial that contentment has a positive impact. Several significant theoretical and practical implications that can contribute to the sustainability of restaurants are offered in light of these findings. Rapid developments in AI, smart sensors, big data analytics, and robotics have led to their widespread use in the service industry, where they are used to perform a variety of activities. The main goal of putting robots to work has been to increase output, but the COVID-19 pandemic has made a more urgent goal: providing contactless services to keep people from being alone. Data from actual hotel guests is used in this investigation of how well robots can serve customers. The objective of this project is to build a robot waitress capable of taking and fulfilling guest orders in a hotel.

Keywords: Serving Robots, Workforce Scarcity, Risk Aversion, Perceived Value, Sustainability, AI and Robotics, Contactless Services, Emerging Technologies, CATIA, ANSYS

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I. INTRODUCTION

Humans have always been the ones to supply services in the past. Smart robots are progressively taking the place of employees in the provision of contactless services as a result of the introduction of advanced digital technologies, particularly artificial intelligence (AI) and Internet of Things (IoT), as well as the present pandemic crisis. For instance, intelligent robots have been used at a few hotels, shops, airports, and meal delivery services[1, 2]. Service robots can make it easier for first responders to do their jobs in hospitals without exposing them to viruses. They can also do things for people so they don't have to be alone and do delicate remedies that not medical professionals have the skills or energy to do[3].

In a variety of capacities, including memory, computing power, physical strength, and the ability to perform unpleasant or dangerous tasks, service robots have progressively surpassed human care providers. Although their employment has skyrocketed during the current pandemic, modern service robots are most efficient and widely deployed at the first two levels of intelligence since they are still incapable of performing at the two highest order intelligence. To choose the optimal approach for building and integrating service robots in customer support procedures, businesses must be aware of the advantages and disadvantages of currently available service robots[4, 5].

To investigate customer service performance Robot employed real-world discoveries of expected to contribute to the service robot and offer beneficial new information to service organisations in their strategies to successfully deploy service robots for a great customer experience. For their algorithm, Prejitha et al. [6] used sensors like LDR, LED, and sensors resistance and voltage divider setup. They created a straightforward, inexpensive line-following robot without the use of a microcontroller. Robots for taking orders and delivering meals to tables were being developed by Eksiri et al. [7]. Their robot was modelled after the ABU Robocon competition. One robot is used for ordering, and the other one serves the food. They have utilised two different robots. In order to greet people, they added sounds to their line-following technique. People stopped the robot for selfies because of its lifelike shape, and they included an emergency pause option for this purpose.

The concept of an E restaurant, where food is served by robots, was put forth by Kaushal et al[8]. They put forth a suggestion for how using robots could cut down on the cost of hiring waiters. They clarified that this robot can fulfil one or more orders in a single cycle. Additionally, they have leveraged the concept of a line follower to create a distributed Sensing and Control Framework for Mobile Robot on a local server and website (XAMPP). This actually completes a task on this system and is related to mechanical and aerospace engineering. Transporting a package from a pickup site to a drop-off location is the project's main task. A wheeled mobile robot (WMR) that acts as a lifting device and has a gripper structure in front of it completes the bundle transportation. Pushing a button on the station's floor completes the package accessibility at the pickup station. At the drop-off location, a second push catch has been set up to verify that the bundle was delivered successfully.

Figure 1: Portable Robot Servicing in Hotel

Evidence from Bicci and Kumar Robots using vacuum grippers can pick up packages of goods or objects with ease[8]. As may be seen in Figure 1, vacuum cups (also known as suction cups) are used as the mechanism for grabbing. If the things are smooth, flat, clean, and stored in cartoons, this form of grippers will offer good handling. It just has one surface that can be used to hold stuff. It might not be appropriate for handling the nearby objects that are porous.

II. MODELING

1. **3D Modeling:** Catia V5 has a number of tools for creating a complete digital depiction of the object being designed [9, 10]. The general geometry tools can also build industrial and standard pipe geometry and entire wiring descriptions. Collaborative development tools are also accessible. Several concept design tools can be used to generate initial ideas for Industrial Design, which can later be implemented during the product's engineering phase[11, 12]. Industrial design sketches, point cloud data for reverse engineering, and full-featured freeform surface tools are just a few examples. Figures 2–5 depict the Hotel Servicing Robot's 3D model with all the drawing elements presented, and Figure 6 shows the robot system assembled.

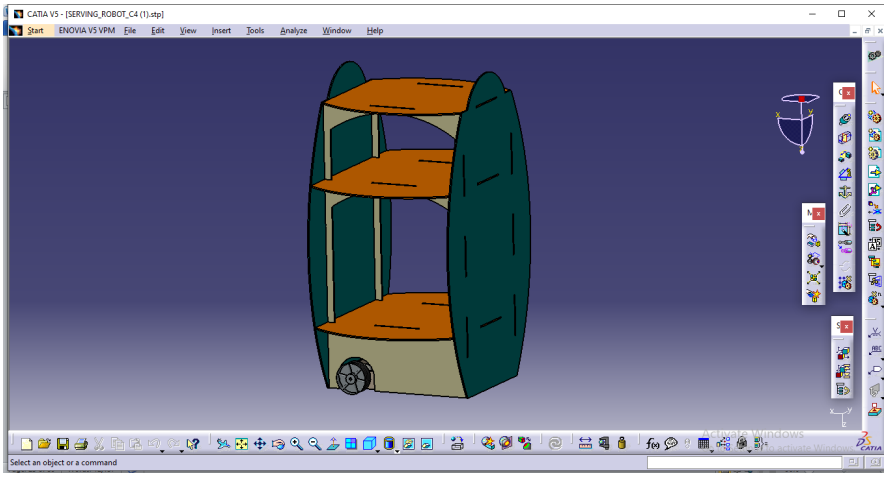

Figure 2: Indicative 3D Design

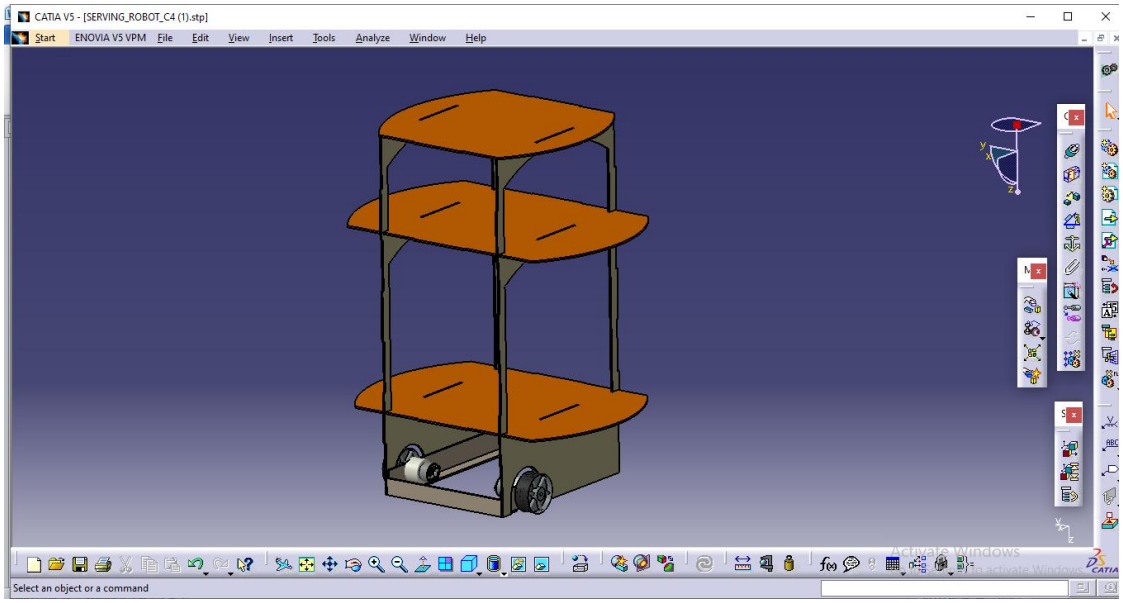

Figure 3: Frame Structure

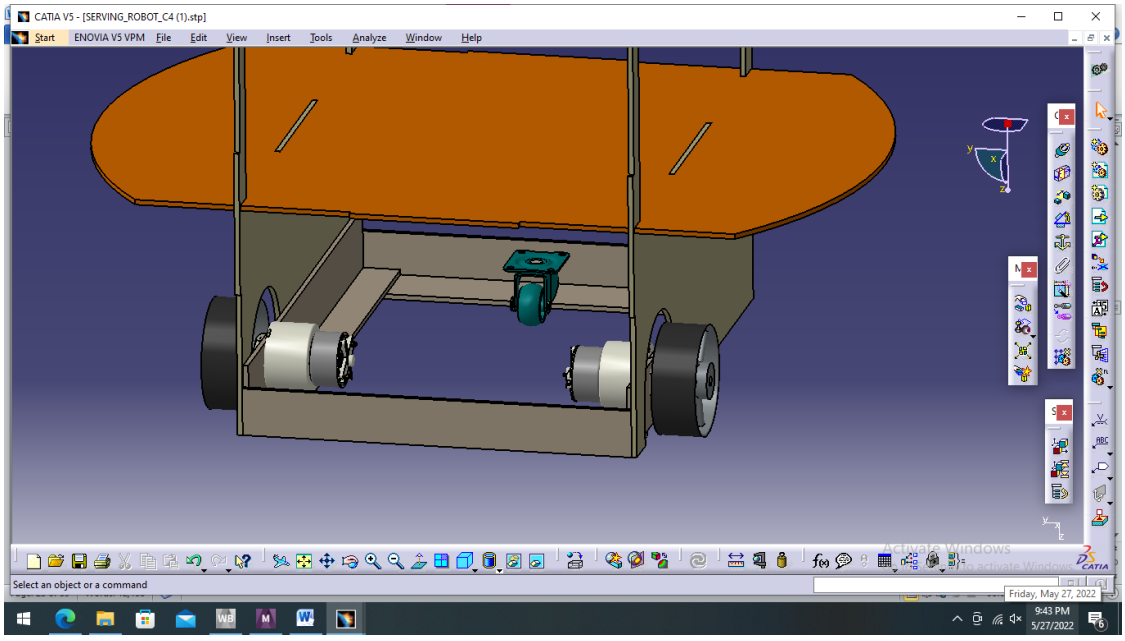

Figure 4: Wheels Assembly

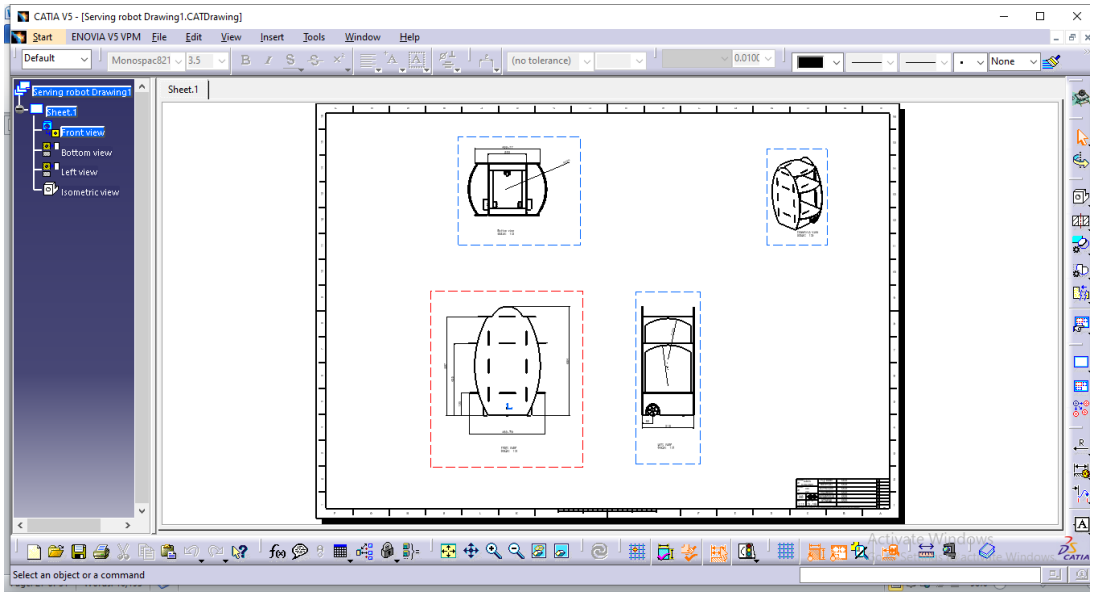

Figure 5: Assembly Drawing

2. **Analysis:** ANSYS has evolved into a powerful design analysis tool, recognised around the world for its many useful capabilities. The updated software is both straightforward and potent in its capabilities. The program's flexibility, usefulness, and speed are all enhanced with each subsequent release. Ansys assists engineers in this way to meet the expectations and challenges of the contemporary product development environment [9, 13, 14]. The robot structure is depicted in the photographs below.

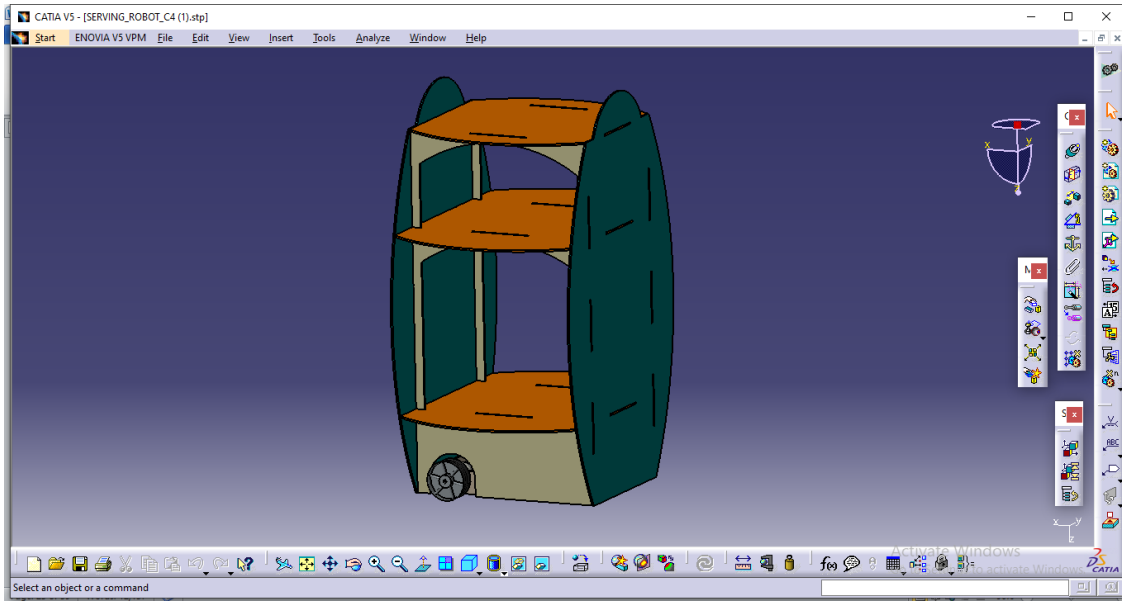

Figure 6: Assembly

The various parts considered for assembly are:

- DC Geared motors 100 RPM 2
- Caster wheel ½ inch

- 70mm dia wheels
- Aluminum channels
- Acrylic sheets
- Arduino UNO – controller
- Motor Driver L2 98D
- SR08 line following sensor
- 12V & 5V regulator 2 amps.
- 4 Channel remote
- DC jacks

The entire robot is designed in such a way that it is compatible so that it can move freely in the restaurant. The electronic parts include sensors, speakers, buzzer, battery and motors. Considering the situations and demand of contact less delivery the design has been made[15]. Unlike regular humanoid restaurant robot this design is unique and serves better for the purpose. It has more space for the food and also can accommodate well and is handy. Industrial aluminum is chosen for the Base frame because it has the strength to carry the load and the finish of it will be an added advantage.

3. **Working:** Food is delivered to the table by the robot from the kitchen. The robot navigates by using a technique called line following with the aid of infrared sensors. The robot will halt if any obstructions are in its path thanks to its ultrasonic sensors. The robot has a keypad built inside it so it will know whose table to serve. Each table will have a QR code that can be scanned to be taken to the app store, where orders for meals will be placed via an app. When food is requested, the order is immediately sent with the table number to the kitchen screen. The robot is initially positioned (on the line) close to the kitchen. The chef can load the prepared food into the delivery robot when it is ready and choose the appropriate table number on the keypad. The robot will start moving along the line towards the table. The ultrasonic sensors will detect any obstructions in the path and halt the robot if necessary. A piezo-buzzer will also inform the user to move or move the obstruction when it detects the impediment. For easy operation, the robot already has the instructions for the table coded in. The underlying ideology's flowchart is depicted in Figure 7.

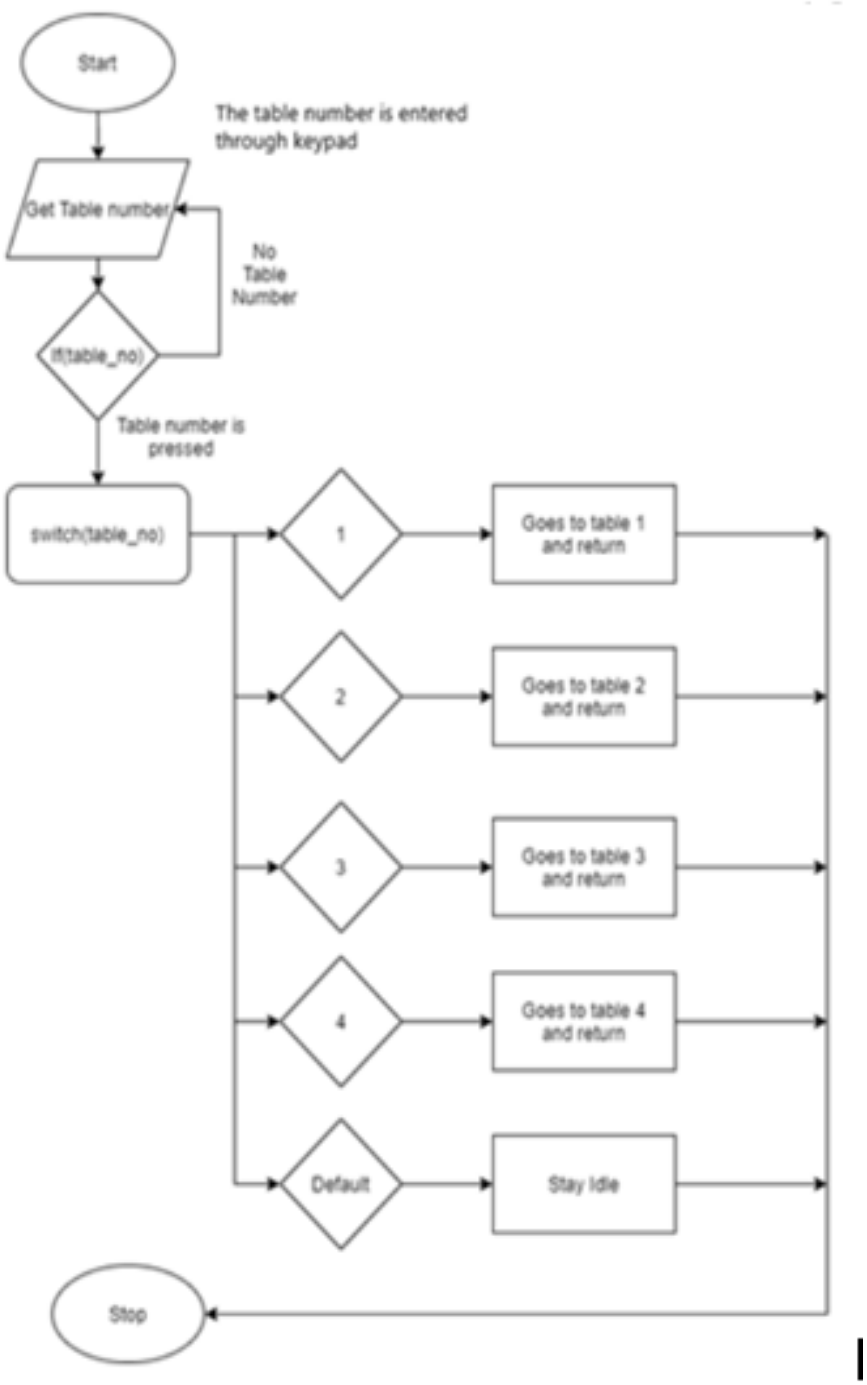

Figure 7: Flow chart of basic ideology of working

- **DC Geared motors 100 RPM:** Several applications for robotics, involving all-terrain vehicles, can utilize this 12 Volt DC Motor - 100 RPM. These motors include a 3 mm threaded drill hole in the center of their shafts for easy attachment to wheels in addition[4]. These direct current (DC) motors are basic in design and have shaft-mounted gear for optimal performance. These DC-geared motors are known as "center shaft" models because the shaft runs through the gearbox's center. A straight expansion over the straightforward DC motors in Figure 9, Figure 8 shows the

exterior design of a DC geared motor.

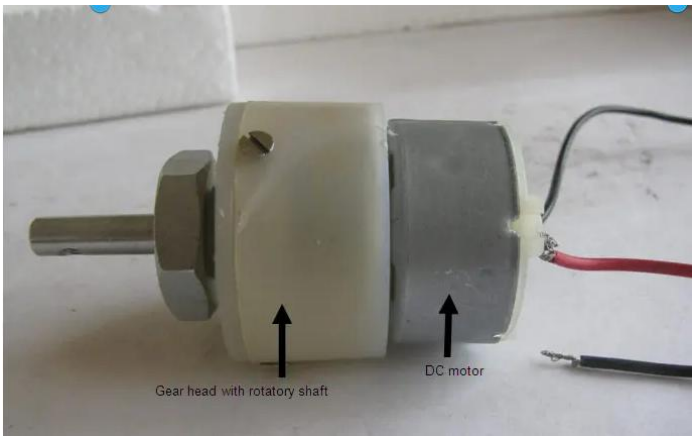

Figure 8: External Structure DC Motor

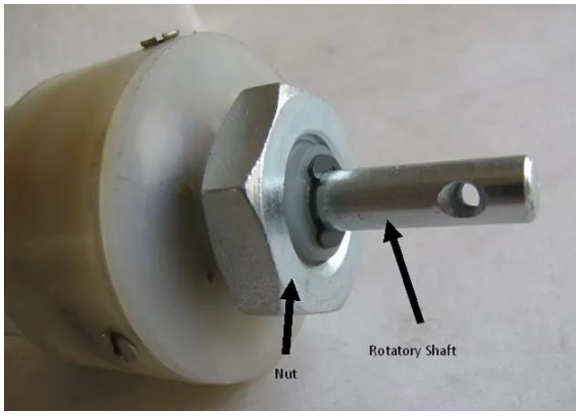

Figure 9: Lateral View DC Motor

- **The DC Geared Motor's Operation:** The DC motor operates over a respectable voltage range. The motor's RPM (rotations per minute) increases with input voltage. For instance, if the motor's operating voltage range is between 6 and 12, its RPM will be lowest at 6 V and highest at 12 V.

  RPM = K1 * V, where K1 is the induced voltage constant and V is the applied voltage, can be written as a voltage equation.

  In all DC motors, the relationship between RPM and torque is anti-clockwise. Therefore, a lower RPM might be expected from a higher torque gear, and vice versa. Geared DC motors use the concept of pulse width modulation. The smaller duplex component is turned more thoroughly by the larger gear. The smaller duplex portion transfers the torque from the bigger portion of the previous gear, but not the speed. The duplex portion of the third gear contains more teeth than the other parts, which allows it to transmit more torque to the gear that is attached to the shaft.

- **Caster wheel ½ inch**

Figure 10: Caster Wheel

Carts, racks, dollies, and other equipment are simple to move thanks to casters (see Figure 10). Another way to describe it is as a wheel-like, circular cylinder with a variable width that rotates on an axle. There are numerous mechanical uses for the wheel. A wheel is present on a caster. However, it is not just a wheel. It is an assembly that consists of a wheel and a bracket for it. This bracket, which is sometimes referred to as a "fork" or "yoke," is what distinguishes it from a typical wheel.

- **Aluminum Extrusions:** Extrusion is a manufacturing process that produces things with a consistent cross-sectional profile by forcing substances via a die with the correct cross-section[16, 17]. Advantages over traditional manufacturing methods include the ability to create intricate cross-sections and the flexibility to work with brittle materials via solely compressive and shear forces. Figure 11 shows that it also makes great surface finishes and gives designers a lot of freedom When it comes to shapes.

Figure 11: Slotted Extrusion

- **Arduino Uno – micro controller:** Microcontrollers like the Arduino UNO, which employs the ATmega328, are popular for use in electronics projects at the basic level. There are 14 digital I/O pins and 6 analogue I/O pins on the board, as well as an ICSP header, power jack, USB connector, reset button, and other components. A USB cable or the board's onboard DC power source can be used to power the charging process. The design of the board utilised by the novice in their work undergoes routine innovation and problem fixes[2, 18]. The Arduino UNO board, shown in Figure 12, has a list of hardware components for motor control, bluetooth, the internet, and other functions, and it can communicate with those devices. The Arduino UNO is a particular sort of Arduino device that is mostly utilised by novices in electronics projects and circuit design. The board is acceptable for usage and chosen over other Arduino devices because of a number of advantages. The user's requirements determine which Arduino products are best, although the Arduino UNO is a standard board when compared to other Arduino products[19].

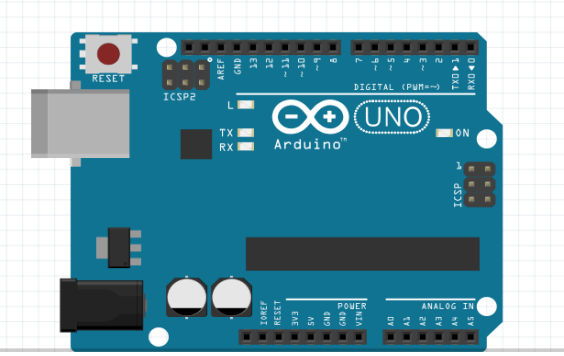

Figure 12: Arduino UNO

- **Voltage regulator:** A voltage regulator is designed to automatically regulate voltage levels. In essence, it regulates the supply voltage by lowering the source voltage to an acceptable level. This ensures the voltage won't dip under load. Electronic voltage regulators rely on the zener diode, an operational diode with a reverse breakdown voltage, as a stable voltage reference source[20, 21]. Voltage regulators are typically employed wherever there is a need to keep the dc output voltage stable. It also reduces the voltage ripple in ac current that the filter can't eliminate. A good voltage regulator may also have safety circuits that protect against short circuits, too much power, heat, and too much voltage.

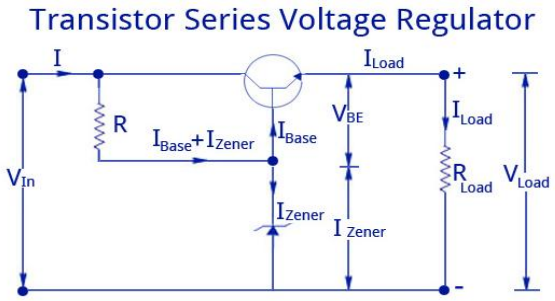

Figure 13: Voltage Regulator Circuit

As shown in Figure 13, the filtered rectifier output is passed to the input

terminals, where it is used to provide a regulated output voltage Vload across the load resistor Rload. The zener diode provides the reference voltage, and the transistor works as a variable resistor. The resistance of the transistor changes depending on how the base current, Ibase, is being used.

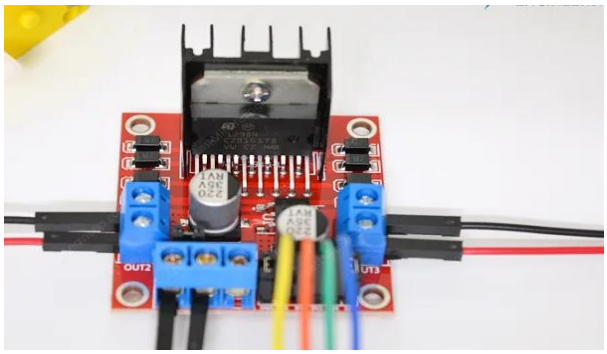

Figure 14: Motor Driver

- **Motor Driver L298D:** Connecting an L298N Motor Driver to an Arduino is one of the simplest and least expensive ways to drive DC motors[22]. The IR sensor is a three-wired device. In our circuit, the red wire is connected to the load, which is the Arduino, while the brown and black wires are utilised to connect the sensor to the power source. The L298N motor controller employs the H-bridge arrangement depicted in Figure 14 for reversing the spin of a DC motor. The ability to supply power directly to the motors is yet another benefit of using an H-bridge. This is crucial when working with an Arduino board, as its 5V output is insufficient for powering two DC motors.

- **Final Assembly:** The final assembly of Figures 15, Figure 16, Figure 17 and Figure 18-19 explained the sequence of operations such as robot bottom portion, electronics, acrylic structure assembled with bottom structure complete assembly shows and demonstrated.

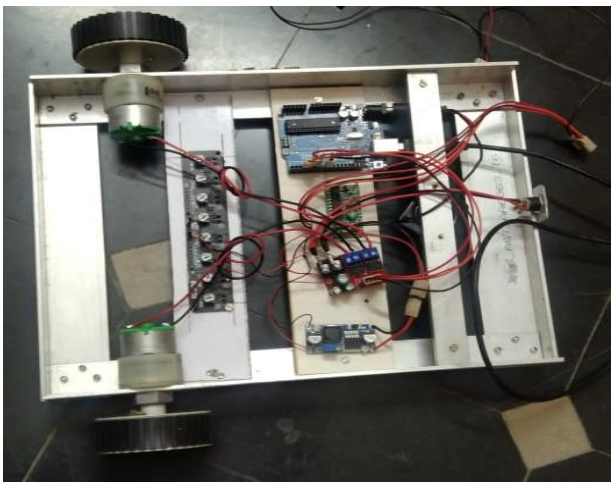

Figure 15: Robot Bottom Portion

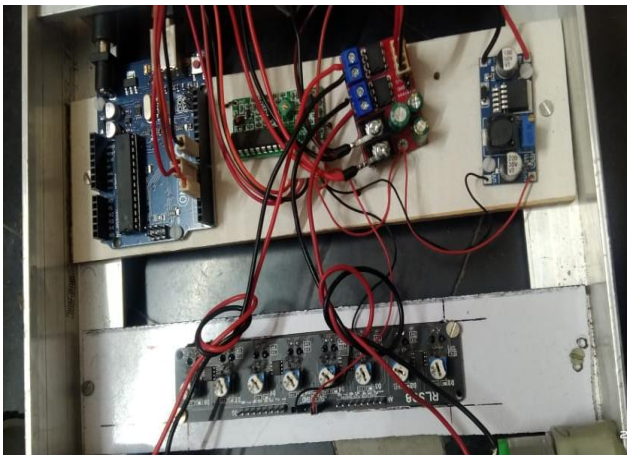

Figure 16: Electronics

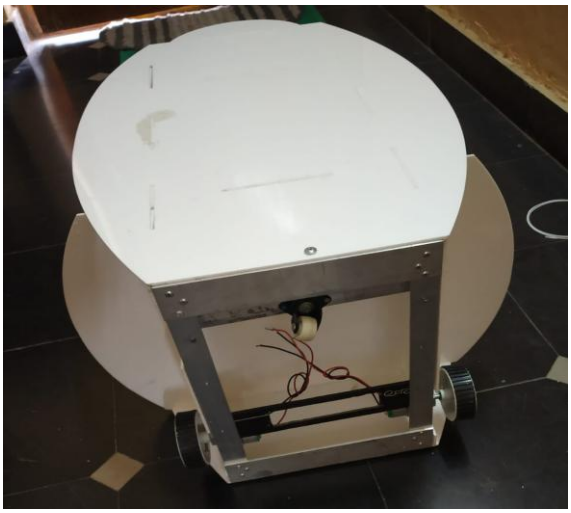

Figure 17: Acrylic Structure Assembled with Bottom Structure

Figure 18: Complete Assembly

Figure 19: Complete Assembly

III. CONCLUSION

AI and other digital technology advancements, falling hardware costs, the advent of 5G networks and the present pandemic problem will all contribute to the rapid adoption of service robots. The major goals of using robots in the past were to increase productivity and accuracy, decrease service time, and replace tedious, risky, dirty, and unsafe tasks. The robot's top structure is made of sheets of acrylic, and its bottom structure is made of aluminium. The structure is strong enough to support the plates and necessary meal items on the three specified spots. The built-in structure can be easily assembled and disassembled for cleaning as needed.

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