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DESIGN AND IMPLEMENTATION OF A BLUETOOTH CONTROLLED FLOOR CLEANING ROBOT

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Abstract: As technology continues to advance, there is a growing interest among researchers in creating robots that can simplify human lives. One area of focus is domestic robots, which are gradually making their way into households, although the market is still relatively new and developing. Despite this, predictions suggest that there will be significant growth in the adoption of domestic robots. The objective of this project is to design and implement a Floor Cleaning Robot through an Android Application. This robot aims to streamline the cleaning process by providing an alternative to manual vacuuming. The primary goal is to develop a prototype of a Floor Cleaning Robot using key components such as Raspberry Pi, L298N Motor Drivers, 12V DC Motors, and a 5V Submersible DC pump motor. The Raspberry Pi3 functions as the central control unit for the cleaning robot. The mopping function can be activated or halted at any given point as per user requirements. The mopping brush, powered by a dedicated DC motor, is responsible for the mopping operation, with its control signals originating from the central controller.

Keywords: Raspberry pi 3; DC motors; L298N Motor; Water Pump

I. INTRODUCTION

Basically, robotic cleaners are distinguished on their cleaning expertise like floor mopping, dryvacuum cleaning etc. Some products are based on simple obstacle avoidance using infrared sensors while some utilize laser mapping technique. Each cleaning and operating mechanism of robotic floor cleaners has its own advantages and disadvantages. The main objective of this work is to provide a substantial solution to the problem of manufacturing robotic cleaner utilizing local resources while keeping it low costs. With the aim of keeping our robot as simple as possible, while able to perform the initial goals, the following specifications were found: Navigation, Liquid Dispensing, Brushing, Mopping. These specifications will be programmed into the robot. Python language is used for programming, python is a general-purpose programming language. Hence, you can use the programming language for developing both desktop and web applications.

II. LITERATURE SURVEY

To complete the project in proper manner, a literature survey is of great help. Many techniques are being consistently proposed through various researches and are presented in many national and international conferences and published in various journals. This section presents best techniques that are taken from various research publications that are best suited for the proposed design. Floor cleaning robot by Kalamansi et al, this floor cleaner robot works automatic and manual. All hardware and software operations are controlled by PIC16F887 microcontroller. This robot can perform sweeping and mopping task.[1]. Aishwarya Pardeshi et al, present the look, developed and fabricated model of programmed cleaner robot. this type of robot performs automated function with extra features like choose and place mechanism and dirt container with air vacuum mechanism. this type of labor is straightforward and helpful in betterment of life variety of a mankind. [2]. S Monika, K Aruna Manjusha et al, worked on the paper that presents floor cleaning is worn out a neater way and efficiently by robot utilizing wireless system. This proposed robot saves the time and economy of labor. within the previous research papers like robot household appliance and automatic floor cleaner robot had some drawbacks like colliding with objects before of it and this vacuum couldn’t reach to small areas and left those areas unclean and therefore the automatic floor cleaner robot collects the dirt but the downside up here is that it doesn't clean the wet floor. Few of the drawbacks during this project paper are overcome [3]. Ajith Thomas et. al, proposed an autonomous robotic for floor cleaning program. it's able to perform sucking and cleaning, detection of obstacles, and water spraying. Furthermore, it's also able to add manual method. All hardware and software functions are manipulated by Raspberry pi3 model. [4].

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Manya et al, developed an Automatic Floor Cleaner. The project is used for domestic and industrial purpose to clean the surface automatically. When it is turned ON, it sucks in the dust by moving all around the surface. The controller is used to drive the motors and the suction unit also a couple of sensors are used to avoid the obstacles. This can be useful in improving the lifestyle of mankind [5]. Aishwarya Pardeshi et al, presents the look, developed and fabricated model of programmed cleaner robot. this type of robot performs automated function with extra features like choose and place mechanism and dirt container with air vacuum mechanism. this type of labor is straightforward and helpful in betterment of life variety of a mankind [6]. Akash Choudhary et. al, the target of this project is to form a totally automated hybrid home cleaning robot. Which is fully automated and may perform tasks like mopping and cleaning of floor. After the testing we discover that it can perform all tasks fine with none hurdle. We tested our robot on various parameters like path following, obstacle avoidance, navigation, mopping and vacuum mechanism [7]. Anju et al, have proposed and developed an autonomous and manual mode is done by the robot, the robot that capable of gulping, mopping, obstacle detection, and water spraying. The robot is mainly designed for old age people, handicapped and working women. The hardware and software operations are controlled by Raspberry Pi [8]. Priya et al, proposed an Arduino controlled model that performs the required operation of cleaning. Robot was of low maintenance, cost effective, versatile prototype robot that can perform dry as well as wet cleaning. It can operate in autonomous mode; all these features turn out to be in improving the life style of humankind [9]. Abhishek Pandey et. al, reviewed the requirement of a residence Cleaning Automatic robot. For keeping time there's a requirement of programmed system that cleans alone without person interventions. Also, they considered how precisely to help those that have physical disabilities. Because that they had to induce this done, they needed a cleaning system that may add accordance from what we are saying, thus supporting a physically someone [10].

III. METHODOLOGY

The hardware components utilized in the development of this project consists of Raspberry Pi 3, the L298N Motor Driver, 12V DC Motors, Li-ion Batteries, Robot Chassis, Wheels, Cleaning Module, Liquid Container, and Water Pumping Motor. The cleaning and mopping robot drive its operation upon activation and Bluetooth pairing. Its movement includes forward, backward, left, and right directions. Upon switching on, the robot commences simultaneous cleaning and mopping activities, effectively covering the entire designated area. Furthermore, the robot accommodates scenarios where multiple passes are necessary for thorough cleaning. The robot's navigation is facilitated through the Blue Dot application, enabling intuitive directional movement and speed control. It uses supply of 12V DC battery, the Raspberry Pi 3 serves as the central control unit, operating in tandem with an Android device connected through Bluetooth. A pivotal element in the design, the L298N motor driver circuit controls the synchronized movement of two DC motors in various directions. The Raspberry Pi 3 transmits signals to the motor driver, controlling the motion of the wheels as depicted in Fig 3.1. Upon initiation, the front-mounted brush engages in sweeping motions as per the programming instructions within the Raspberry Pi 3. The mopping feature, activated by a assigned DC motor connected to the brush, can be engaged or disengaged at the discretion, controlled by signals communicated from the controller.

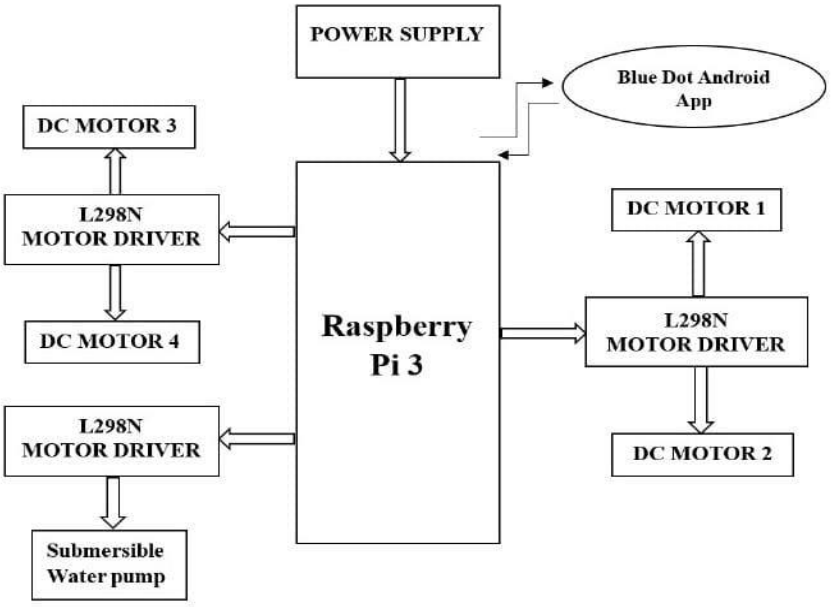

Fig 3.1 Block diagram of Bluetooth Controlled Cleaning Robot

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IV. CIRUIT DIAGRAM AND FLOWCHART

The Raspberry Pi 3 Model B requires a 5V power supply as shown in the circuit diagram. It has 40 digital I/O pins, offering substantial connectivity options. The L298N Motor driver, with its 4 I/O pins, is employed in the setup. Specifically, the GPIO26, GPIO19, GPIO13, and GPIO6 pins of the Raspberry Pi are linked to the input pins of the initial motor driver. The resultant output pins are routed to drive DC Motors 1 and 2. Notably, a 12V power supply is allocated to the motor driver, a configuration designed to concurrently control two motors. This motor driver configuration serves as the control centre for the robot's movement. Furthermore, GPIO18 PCM_CLK, GPIO23, GPIO24, and GPIO25 pins are used to interface with the input pins of the second motor driver. The outputs of this configuration are connected to Motors 3 and 4. A dedicated 12V power source powers this motor driver arrangement, effectively serving as an intermediary between the Raspberry Pi and the motors. Notably, GPIO12 and GPIO16 pins serve the purpose of controlling the water pumping mechanism. In this capacity, Motor driver 3 serves as an intermediary between the Raspberry Pi and the water pump motor, as delineated in the circuit arrangement. The water pump's operational requirements are met by a 5V power supply. Functionally, this mechanism converts rotational motion into fluid movement, rendering it pivotal for the project's objectives.

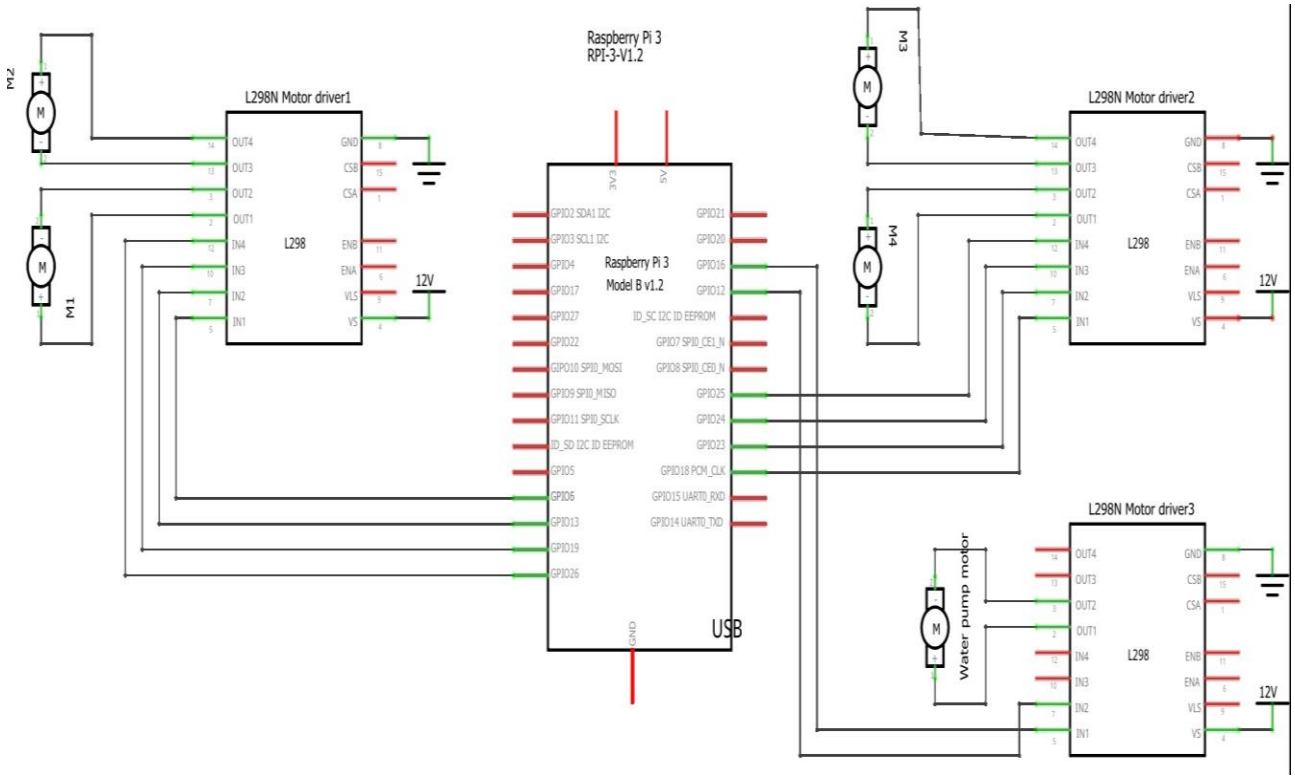

Fig 4.1 Circuit diagram of Cleaning Robot

To start the operation of the cleaning robot's by supplying power to the motor drivers and Raspberry Pi then establish a Bluetooth connection in order to initiate the Blue Dot application. Set up the cleaning module, which includes equipping the robot with rotating floor cleaning brushes and a dispenser for floor cleaner liquid.

The user is prompted to press either of the two available Blue Dots as shown in the Fig 4.2, initiating the robot's functionality. Within the first Blue Dot interface, users are presented with four directional buttons—Forward, Reverse, Right, and Left—for navigation control.

In the second Blue Dot interface, users can concurrently engage in brushing actions (Clockwise and Anticlockwise) and mopping. This is facilitated by utilizing the top, left, and right buttons to control the application of water or cleaning liquid. Upon the completion of the cleaning operation, the robot will come to a stop, concluding its tasks.

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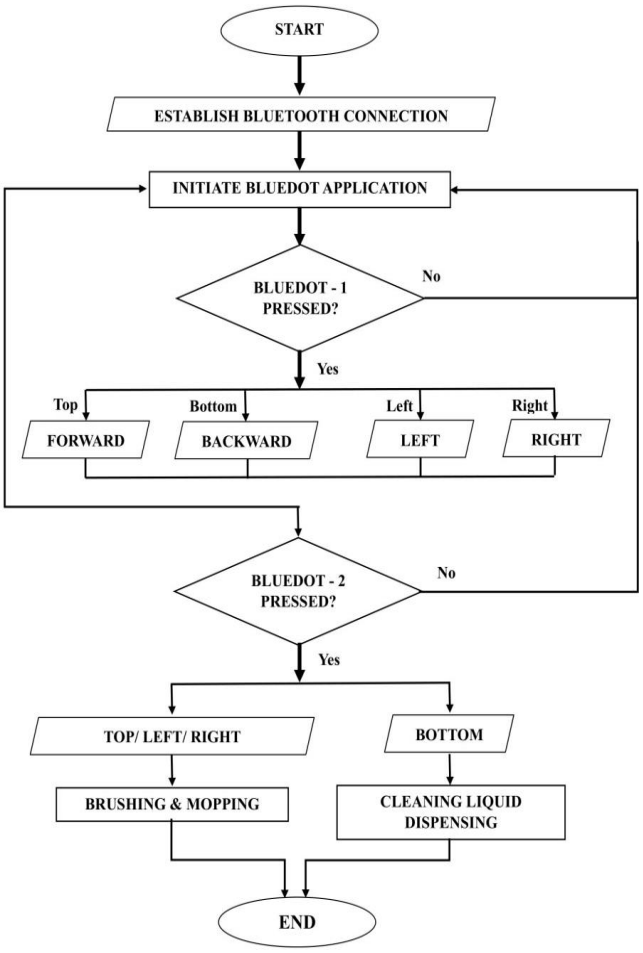

Fig 4.2 Flowchart of the Bluetooth Controlled Cleaning Robot

V. HARDWARE DESCRIPTION

The main hardware components used in this work are Raspberry Pi 3, Motor driver L298N, Li-ion batteries, Water Pumping Motor, 12V DC Motor.

A. Raspberry Pi 3

The Raspberry Pi 3 is a versatile and compact single-board computer that has garnered widespread popularity for its capabilities and affordability as shown in Fig 5.1. Powered by a 1.4GHz 64-bit quad-core processor, this ARM-based computer offers improved processing performance compared to its predecessors., the Raspberry Pi 3 facilitates convenient connectivity. Its Gigabit Ethernet over USB 2.0 ensures speedy networking, while the extended 40-pin GPIO header provides extensive options for hardware interfacing and integration Raspberry Pi 3 is energized by 12V, DC battery. Bluetooth electronics app controls cleaning robot with an android device. Raspberry Pi 3 sends the signal to the motor driver circuit that controls the wheel motion.

Fig 5.1: Raspberry Pi 3

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B. Motor driver L298N

The L298N Motor Driver Module is a high-power motor driver used for driving DC and stepper motors. It can control up to 4 DC motors or 2 DC motors with direction and speed control. The module includes the L298 motor driver IC, 78M05 voltage regulator, resistors, capacitor, power LED, and a 5V jumper. The voltage regulator is enabled when the jumper is placed, allowing the internal circuitry to be powered. However, for power supplies greater than 12V, the jumper should be removed, and a separate 5V supply should be used. The L298N module is capable of controlling the speed and direction of two DC motors using PWM and H-Bridge techniques. It can also drive a stepper motor. Fig 5.2 shows the L298N Motor driver.

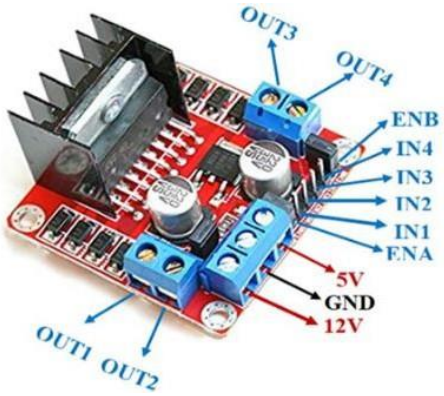

Fig 5.2 Motor driver L298N

C. Li-ion battery

A lithium-ion (Li-ion) battery is a rechargeable battery that stores energy through the reversible reduction of lithium ions which is show in the Fig 5.3. It consists of a graphite anode, a metal oxide cathode, and a lithium salt electrolyte in an organic solvent. Li-ion batteries are widely used in portable consumer electronics, electric vehicles, grid-scale energy storage, and aerospace applications. They offer high energy density, low self-discharge, and no memory effect. However, they also have disadvantages, as seen in incidents like aircraft grounding and smartphone recalls. In this project 6 Li ion batteries of 3.7V each are used. A total of 15V is used to drive the mobile robot and 5.5V for movements of the robotic arm.

Fig 5.3 Li-ion battery

D. Water Pumping Motor

Pumping motor is an essential component of a floor cleaning robot, allowing it to spray water for effective cleaning. motors are designed to operate on a 5-volt power supply, making them compatible with the robot's electrical system. The motor is typically compact and lightweight as shown in the Fig 5.4, allowing it to be integrated seamlessly into the robot's design. It features a water pump mechanism that draws water from a container and sprays it onto the floor surface. The water pumping motor provides controlled water flow, allowing the robot to distribute the optimal amount of water for cleaning purposes.

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Fig 5.4 Pumping Motor

E. Geared DC Motor

A DC motor is any motor within a class of electrical machines whereby direct current electricalpower is converted into mechanical power. Most often, this type of motor relies on forces thatmagnetic fields produce. Regardless of the type, DC motors have some kind of internal mechanism, which is electronic or electromechanical. In both cases, the direction of current flow in part of the motor is changed periodically as shown in Fig 5.5. The speed of a DC motor is controlled using a variable supply voltage or by changing the strength of the current within its field windings.

Fig 5.5 Geared DC Motor

VI. SOFTWARE REQUIREMENTS

The software requirements for the system include the use of the Raspberry Pi OS and Integrated Development and Learning Environment (Idle 3), Blue dot.

A. Raspberry Pi OS

Raspberry Pi OS serves as the official operating system tailored for Raspberry Pi single-board computers. Previously recognized as Raspbian, this OS is meticulously designed around the Debian-based Linux distribution, specifically optimized to harmonize with Raspberry Pi hardware. Its primary aim is to offer an accessible interface and an array of software tools, streamlining the setup and utilization of Raspberry Pi devices. IDLE has a very important aspect: the text editor that is we will use it throughout the book to write our programs and modules.

B. Blue Dot Android Application

Embedded within the smartphone's framework is a pre-installed Android application known as "Blue Dot" pivotal for orchestrating the movement of the Cleaning Robot as shown in the Fig 6.1. This application ingeniously employs a virtual joystick, depicted as the "Blue Dot," serving as an intuitive control interface. By interacting with the blue dot, specifically by pressing it in the top, bottom, left, and right positions within the Android application, users can command the robot's motions. The "Blue Dot" application is a versatile tool, functioning both as a Python library and an Android application. Through its seamless integration with the programming language, it empowers diverse functionalities within the robot's operation. Predominantly, it dictates the robot's directional movements—forward, backward, left, and right—corresponding to the specific positions touched on the blue dot interface. Additionally, the "Blue Dot" application introduces an element of speed control. By interacting with the blue dot's extremities, users can dictate the robot's speed. Engaging with the outermost regions prompts the robot to move at maximum velocity, while interactions with the inner region induce a slower pace. Crucially, the robot's movement comes to a halt upon the release of the "Blue Dot." In essence, the "Blue Dot" application transforms the smartphone into a dynamic control interface, facilitating precise and intuitive manual control of the Cleaning Robot's movements.

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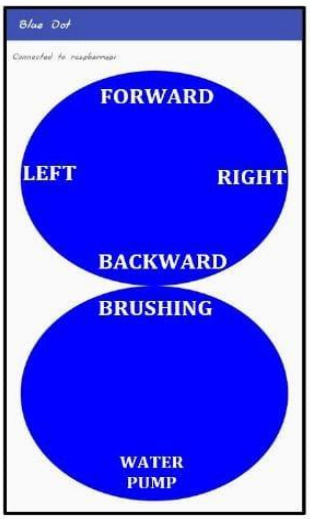

Fig 6.1 Snapshot of Robot Control Android Application

VII. RESULTS AND DISCUSSION

Extensive testing of the robot's functionalities took place within an indoor setting, aimed at evaluating its overall performance. The assessment encompassed multiple features, ensuring a comprehensive evaluation. Notably, the Raspberry Pi 3 served as the central processing unit, complemented by the integration of a dedicated DC power supply. Additionally, the water pumping motor was strategically positioned within the water container, primed to dispense water as needed. Key components, including dish washing scrubbers and a wiper mechanism, were thoughtfully affixed to both the front and back segments of the robot.

Fig 7.1(a)

Fig 7.1(b)

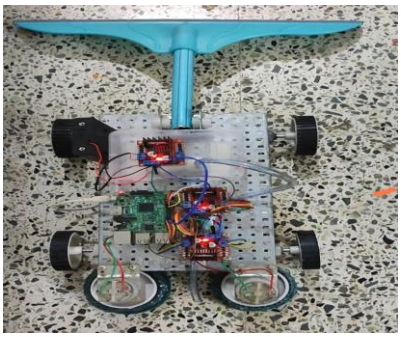

Fig 7.1(c)

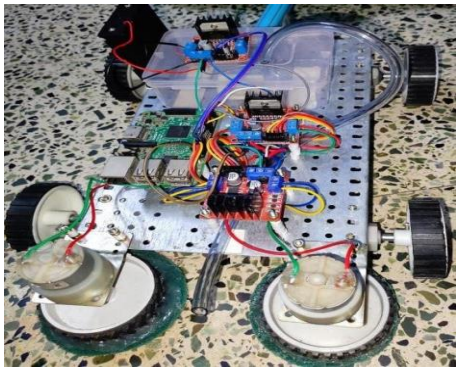

Fig 7.1(d)

Fig 7.1(e)

Fig 7.1(a): Wiper attached to wheels; Fig 7.1 (b): Scrubber pads attached to wheels; Fig 7.1(c): Top view of the Cleaning Robot; Fig 7.1(d): Components intended on chassis along with the wheels ; Fig 7.1(e): Prototype Model of the Robot

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These scrubbers, dedicated to floor cleaning, coupled with the wiper, effectively tackled the removal of liquid and smaller dust particles from the floor surface. The proficiency of the robot's Android-based control system was thoroughly validated. This encompassed successful control over various parameters such as on/off functionality, and monitoring of battery voltage. By effectively harnessing the capabilities of the Android platform, the robot's operations were seamlessly managed and monitored. It conclusively executed all planned functions, confirming the successful completion of each assigned task. The robot demonstrated its working efficiently and executed all planned function confirming the successful confirming its overall effectiveness.

VIII. CONCLUSION

This robot epitomizes modern innovation, utilizing cutting-edge technology to revolutionize floor cleaning. Operated through Bluetooth control, it offers efficient approach, minimizing labor time and costs. Its diverse functionality ranges manual control to scheduled cleaning, with potential for enhanced user-friendliness through Android app. Ideal for industries where human involvement is hazardous, this creation represents the combination of technology and ingenuity, opening the path for smarter, safer, and more flexible floor cleaning.

IX. FUTURE SCOPE

This project holds significant potential for future advancement. Integrating a PI Camera onto the robot could enable deployment in restricted human-inaccessible areas. Enhancing product durability is another avenue, while transitioning to voice-controlled locomotion could enhance operational convenience. Moreover, the inclusion of a versatile hand-like structure could expand the robot's capabilities to tasks by lifting and relocating objects, broadening its potential application.

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