Floor Cleaning Robot Using Node-MCU

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Abstract: This project focuses on creating an affordable Node-MCU base robot cleaner that utilizes mapping algorithms to efficiently clean floor spaces in residential or office settings. Equipped with sensors to detect obstacles, the robot transmits this data to a microcontroller that directs its movements. With the ability to conduct both dry and wet cleaning tasks accurately, the robot benefits from a sophisticated electronic and mechanical control system. Operating in manual and automatic modes, all functions, both hardware and software, are overseen by the Node-MCU microcontroller, enabling wireless communication through IoT technology.

This innovative system offers a cost-effective and highly automated solution, surpassing traditional vacuum cleaners. The robot can be remotely controlled from any location via its Wi-Fi module, providing convenience and flexibility. In today's context, robots play a crucial role in simplifying tasks for humans, saving time and effort. This research introduces a floor cleaning robot that not only handles dry and wet cleaning tasks but also allows control through an Android device. By incorporating a wireless system, the robot enhances cleaning efficiency, featuring a dry cleaning brush and a water storage cleaning pad for wet cleaning purposes.

Keywords: Node-MCU, Motor Driver, DC Motor, Ultrasonic sensor, etc.

I. INTRODUCTION

The Automatic Floor Cleaning Robot represents a cutting-edge advancement in the realm of robotics and IoT technology, revolutionizing the way floor cleaning tasks are approached, by harnessing the power of the Node-MCU, an open-source IoT platform built on the ESP8266 Wi-Fi module, this robot achieves a seamless integration of hardware and software for efficient and autonomous floor cleaning operations.

At the core of this innovative system lies the Node-MCU, functioning as the central processing unit that enables communication, control, and automation through its Wi-Fi capabilities. This pivotal feature allows users to remotely manage and monitor the robot's activities from a smartphone or computer, enhancing convenience and accessibility in the cleaning process.

The primary goal of this project is to develop a cost-effective and highly efficient floor cleaning solution capable of autonomously navigating and cleaning diverse floor surfaces. Through the strategic incorporation of sensors, motors, and the computational prowess of the Node-MCU, the robot can adeptly detect obstacles, chart optimal cleaning paths, and dynamically adapt to varying environmental conditions in real-time.

In terms of functionality, the robot is equipped with dual vacuum compressors for dry cleaning tasks and a specialized cleaning pad with water storage for wet cleaning operations. Operational control is facilitated through an android device utilizing the Blynk app, which acts as a transmitter, issuing commands to the receiving Node-MCU. This setup enables seamless execution of dry cleaning functions and precise movement control, while an ultrasonic sensor enhances collision avoidance capabilities by providing real-time path visualization on the android device.

The Automatic Floor Cleaning Robot not only showcases the seamless integration of hardware and software components but also underscores the sophisticated programming logic behind its autonomous navigation system. Furthermore, the practical applications and benefits of this robotic cleaning solution extend beyond individual households to encompass commercial environments, where efficiency and productivity are paramount. By automating floor cleaning tasks, this robot exemplifies the evolving landscape of home automation and smart living, offering a glimpse into the future of intelligent cleaning solutions.

II. SYSTEM MODEL

The proposed model "Floor Cleaning robot based on IOT" is designed for both dry and wet floor cleaning process. It consists of Node-MCU, motor driver, 12V DC motor, and an external wet floor cleaning mechanism. The wet floor cleaning mechanism includes a cleaning pad placed behind the robot and a water storage unit. To power the system, an external battery is used. The robot can be controlled and monitored through Wi-Fi module which is inbuilt in Node-MCU The robot is capable of cleaning both dry and wet dust, making it suitable for both office and home environments. It is cost-effective as compared to the cost of labor and is capable of cleaning remote areas which are not easily accessible.

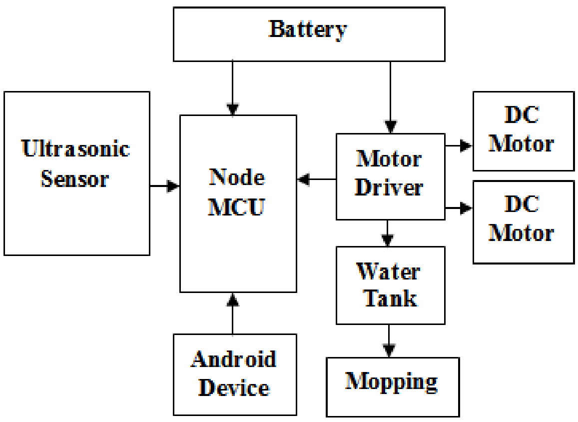

Fig.1: Block Diagram

a) Node-MCU:

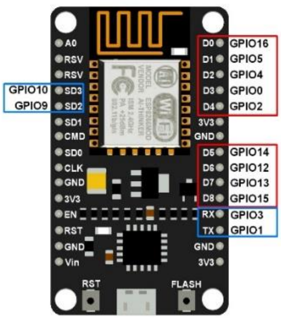

Fig. 2: Node-MCU

The microcontroller utilized in the proposed model is the Node-MCU, an open-source platform for electronic projects. It employs the ESP8266-12E as the main controller, which is a wireless SOC with high integration. This microcontroller can embed Wi-Fi capabilities into systems or operate as a standalone application. It operates at 3.3V with a recommended input voltage range of 4.5-10V.

The Node MCU features 11 digital input/output pins, 1 analog pin, a compact size of 49mm*26mm, and a clock speed of 80MHz. It can function within a temperature range of -45° C to -125° C. The Node MCU supports a simplified programming language called "Lua Script" and can also be programmed using Arduino IDE in C or C++. This microcontroller offers a cost-effective solution for developing IoT applications as it eliminates the need for a separate Wi-Fi module.

b) Motor Driver:

Fig.3: Motor Driver

A L298N dual full bridge driver module, which is a high voltage, high current driver designed to drive two DC motors or a stepper motor. The module has a compact size of 4.2 x 4.2 cm and features 15 input/output pins, including 5V and ground pins, input pins for motor control, and output pins for connecting the DC motors. The module can handle a high operating voltage of up to 40V and a peak current of up to 3A, making it suitable for driving high-power motors. The L298N driver is controlled by logic signals from a microcontroller or other digital circuit, allowing for precise control of motor speed and direction. The module also includes a built-in stabilivolt tube to provide a stable 5V supply for the logic circuitry. Overall, the L298N module is a versatile and powerful solution for driving DC motors in various applications, including robotics, automation, and mechatronics.

c) DC motor :

Fig.4: DC Motor

A DC motor is a type of motor that converts direct current (DC) electrical power into mechanical power. It is commonly used in robotics due to its ability to generate high torque at low speeds, making it suitable for various applications.

A 12V DC motor is a popular choice due to its small size, low cost, and high power output. In the proposed robot design, four DC motors are used to enable forward and backward movement. DC motors are ideal for robotic applications due to their precise control, high efficiency, and adaptability.

d) Ultrasonic Sensor:

Fig.5: Ultrasonic Sensor

Integrating an ultrasonic sensor into an automatic floor cleaning robot help in obstacle detection and navigation. The ultrasonic sensor is used to measure the distance to obstacles in front of the robot, allowing the robot to avoid collisions and navigate around objects. The distance value on the sensor has been determined, that is, when the distance read by the ultrasonic sensor is below 40 cm.

Distance in cm = (Echo pulse width high time (in us))/58

OR

Distance = (Echo pulse width high time * Velocity Sound (340m/s))/2

e) Lithium Battery:

Fig.6: Lithium Battery

Lithium cells, also known as lithium-ion cells or lithium batteries, are commonly used in various electronic devices due to their high energy density and long-lasting power. They power everything from smartphones and laptops to electric vehicles and renewable energy storage systems. Their widespread use is attributed to their ability to provide a reliable and rechargeable power source, making them essential in today's technology-driven world.

f) DC Pump Motor:

Fig.7: DC Pump Motor

This is a low cost, small size submersible pump motor which can be operated from a 2.5V to 6V Power Supply. It can take up to 120 litters per hour with very low current consumption of 220 mA. It uses centrifugal force to pressurize, transfer or circulating water or other liquids.

III. METHODOLOGY

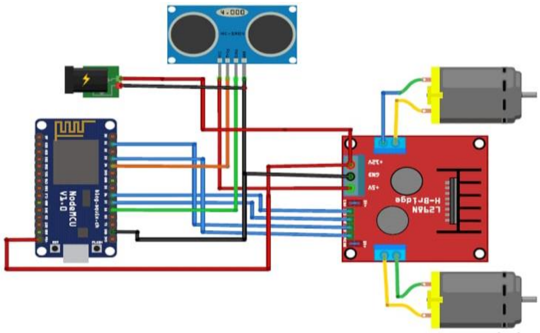

Fig.8: Connection Diagram of the System

The automatic floor cleaning robot offers users the choice between two distinct algorithms: random walk and wall follow. The selection of the appropriate algorithm significantly impacts the robot's behavior when navigating obstacles. When the user chooses the random walk algorithm, the robot is programmed to follow a random path, making decisions based on the immediate environment. This algorithm enables the robot to explore its surroundings more thoroughly, making it suitable for cleaning large, open spaces with few obstacles.

When the robot encounters an obstacle in the random walk mode, it first checks the distance to the barrier directly in front of it. If an obstacle is detected, the robot halts momentarily to engage the DC motor. It then reverses slightly and turns left by reversing the left wheel and moving the right wheel forward. This maneuver allows the robot to navigate around the obstacle and continue its cleaning path. If no obstacle is present in front of the robot, it assesses whether the barrier is located to the left or right, adjusting its direction accordingly. The robot can continue moving forward as long as no obstacles obstruct its path.

Conversely, when the user selects the wall follow algorithm, the robot is programmed to maintain a consistent distance from walls and corners. This algorithm is more suitable for cleaning along edges, corners, and narrow spaces. The robot first checks for obstacles directly in front of it or if it is approaching a corner. If an obstacle is detected, the robot pauses briefly to activate the DC motor. It then reverses slightly before turning right by reversing the right wheel and moving the left wheel forward. This maneuver allows the robot to navigate around the obstacle and maintain its distance from the wall.

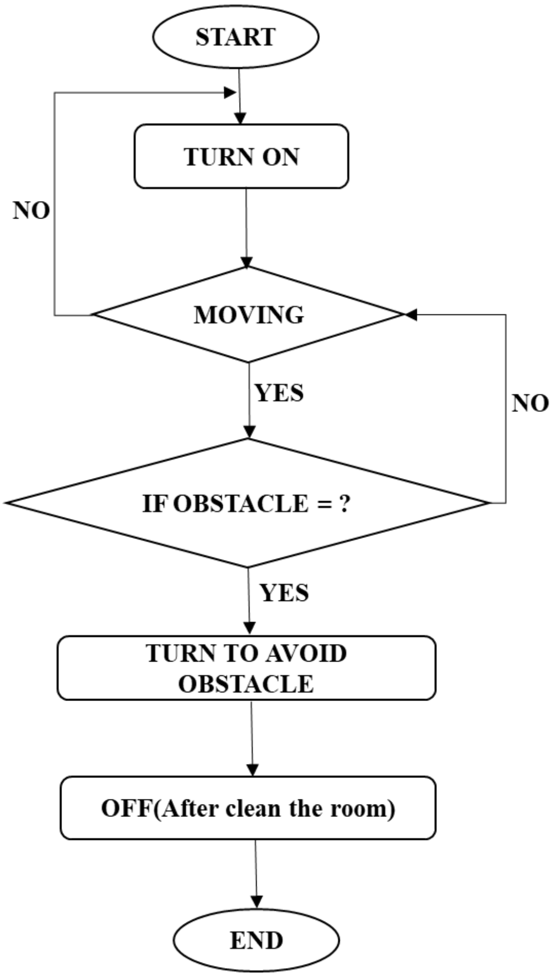

Fig.9: Flow Chart of the System

If no obstacle is present, the robot determines if it is nearing an edge. In such a scenario, the robot briefly pauses before proceeding and turning left. This behavior ensures the robot maintains a consistent distance from the edge while continuing to clean. Furthermore, the ultrasonic sensor on the left ensures the robot maintains a steady pace along the wall, adjusting its speed as necessary to avoid collisions. The sensor is linked to the microcontroller, which controls the actuator to execute specific functions under predefined conditions.

In summary, the automatic floor cleaning robot offers users the flexibility to choose between two distinct algorithms, each with its unique advantages. The random walk algorithm is ideal for cleaning large, open spaces with few obstacles, while the wall follow algorithm is more suitable for cleaning along edges, corners, and narrow spaces. The robot's ability to navigate obstacles and maintain a consistent distance from walls and edges is made possible through the use of ultrasonic sensors, motor drivers, and microcontrollers, ensuring efficient and effective cleaning operations.

IV. RESULTS

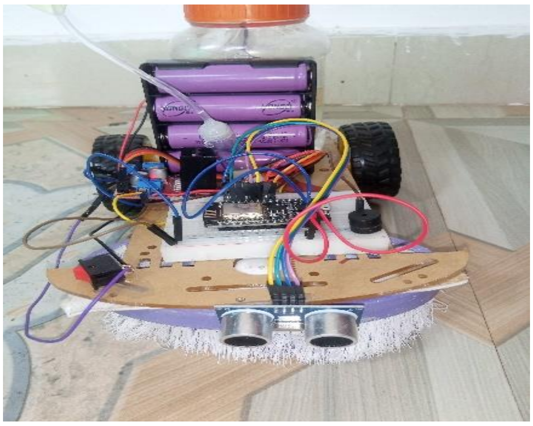

Fig.10: Front View of Robot

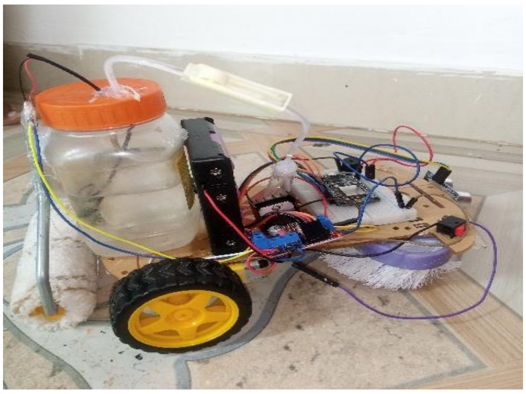

Fig.11: Side View of Robot

V. CONCLUSION

In this project or prototype automatic floor cleaner is a cutting-edge model designed to facilitate floor cleaning through a highly stabilized electronic system. This innovative system is suitable for both office and home environments and is capable of cleaning both dry and wet dust. Unlike many floor cleaning robots currently available in the market, which often struggle to clean remote or hard-to-reach areas, this robot is purely based on Internet of Things (IoT) technology. This means it can be operated from any location with an internet connection, ensuring that surrounding areas are consistently maintained in a hygienic condition.

In both industrial and domestic applications, this robot offers a cost-effective solution compared to the cost of labor. Its cost-effectiveness and flexibility make it a superior choice for floor cleaning tasks. These features of the robot make the device user-friendly. It also reduces human efforts. Also, the implementation cost of the robot is less as compared to the other cleaning robots. So it can be affordable to everyone.

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