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Design and Development of an Electro-Mechanical Robo Mop for Efficient Floor Cleaning

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ABSTRACT:

The objective of this project is to design and develop an Electro-Mechanical Robo mop capable of cleaning floors by mopping, controlled via the Blynk app. The Robo mop employs components such as a Node MCU ESP8266 for Wi-Fi control, a Motor Driver L298N for motor operations, and a 2channel relay module to operate both the mop motor and water pump. The system also includes 100 RPM geared motors, a DC mini water pump, and a 12V sealed AGM battery. The Robo mop is manually controlled through a smartphone, enabling users to direct its movement and cleaning functions. The Node MCU ESP8266 receives user inputs from the Blynk app to control the Robo mop's motion. The Motor Driver L298N ensures precise navigation, while the 2-channel relay module synchronizes the cleaning mechanism and water dispensing. Experimental results demonstrate the Robo mop's effectiveness in reducing manual labor and enhancing cleaning efficiency. This project showcases the potential of combining electromechanical systems with microcontroller technology for smart home automation. The Robo mop is ideal for residential use, maintaining clean floors in homes with children or pets, and is beneficial in commercial environments such as offices and healthcare facilities, promoting hygiene and safety

Keywords: Smart home technology, Electro-mechanical robot, cleaning technology, Intelligent systems, floor mainatinance

Introduction:

From the very beginning of human era, cleaning was one of the tedious tasks. There were many methods for cleaning the premises. But those methods were tedious and needed high effort. It has become difficult for the working population to find time for room cleaning. Moreover sometimes it becomes difficult to clean at human hazardous places which can make a man sick or even die. Because of the difficulties, the existed system was not considered as an efficient method. As the technology has advanced, with the help of automation, cleaning task was made much more efficient. The burden of cleaning can drastically be reduced by means of using an automatic floor cleaner capable of accepting user commands via mobile. Main objective of this project is to design and implement a robot by using Node MCU and blynk, and thereby controlling the robot through user commands by means of GSM. Among various vacuum cleaning robots present in the world only some robots can be used especially for doing the household chores of man. Among those robots, one special kind of robot that is very useful for everyone is cleaning and mopping robot. Prefixed algorithms and programs to clean the specified area is called a cleaning robot. The main use of this robot is to reduce the human interaction in the cleaning process which can be a time taking process and avoid human working at hazardous places like nuclear plants and chemical industries. These robots can be used anywhere i.e., in offices, houses, industries etc. These robots can be activated with the press of a single button or can be pre-set to activate at a particular time. There are many successful products in the market. The leading products are IRobot Roomba, Rrimin Smart Vacuum Cleaners Intelligent Automatic Sweeping Clean Robots, Exilient Ready Maid Robotic vacuum cleaner and many more. Every product has its own pros and cons. The main problem with these products is they are costly and not much compatible for Indian users. These products are much effective for wooden floor than the tiles. Some products do work for the tiles but this is available in high-end versions only.

What is the Floor Cleaning Robot?

A floor cleaning robot is an advanced, automated device designed to clean floors efficiently with minimal human intervention. These robots are equipped with a variety of sensors, motors, and cleaning mechanisms, allowing them to navigate and clean different types of flooring, such as hardwood, tile, and carpet. The primary components include ultrasonic or infrared sensors, which detect obstacles and help the robot navigate around them, and cliff sensors that prevent the robot from falling down stairs or ledges. Dirt sensors enable the robot to identify areas with more dirt and focus its cleaning efforts there, ensuring thorough and efficient cleaning.

The robot's movement is powered by drive motors, which allow it to navigate across different surfaces, and brush motors, which operate the brushes that sweep and scrub the floors. The vacuum motor creates suction to collect dust and debris, while the water tank and mop mechanism enable wet cleaning and mopping of floors. The microcontroller acts as the brain of the robot, coordinating all its operations and responding to sensor inputs. Modern floor

cleaning robots often feature connectivity options such as Wi-Fi or Bluetooth, allowing users to control and schedule cleaning sessions remotely via smartphone apps or voice assistants. Floor cleaning robots are widely used in residential settings for daily maintenance and deep cleaning of home floors. They are also employed in commercial spaces such as offices and stores to maintain cleanliness and hygiene. In industrial settings, they are used in factories and warehouses for automated floor cleaning, contributing to a cleaner and safer working environment. Overall, floor cleaning robots represent a significant advancement in home and commercial automation, combining technology and convenience to improve cleanliness and hygiene in various environments.

Methodology:

To program the Arduino for the floor cleaning robot, we will use the Arduino IDE to write code that controls the motors, reads the sensors, and communicates with the Blynk app. Start by defining functions to move the robot in different directions: forward, backward, left, and right, by setting the appropriate pins high or low to control the motor driver. Next, implementing obstacle detection using ultrasonic sensors. The sensors will measure the distance to nearby objects, and if an obstacle is detected within a certain range, the robot will stop, move backward, and then turn to avoid it. For integrating Blynk, we need to include the Blynk library in our code, and set up the Wi-Fi connection by providing our network credentials and the Blynk authentication token. This will enable your Arduino to communicate with the Blynk app, allowing you to remotely control the robot's movements and monitor its status in real-time. By combining these elements motor control functions, obstacle detection, and Blynk integration you create a functional and remotely controllable floor cleaning robot.

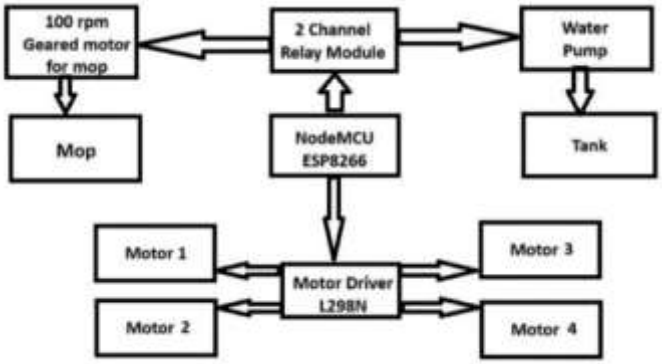

Fig 1 Block Diagram

The Node MCU ESP8266 circuit with the relay module is essential for the manual control of the floor cleaning robot prototype. The Node MCU ESP8266, equipped with Wi-Fi capabilities, acts as the central controller, receiving commands from the user via the Blynk IoT platform. It processes these commands to control the robot's movements and functions. The relay module serves as a switch, enabling the Node MCU to safely interface with high-power components such as the water pump and DC motors. The water pump, controlled by the relay module, dispenses water for mopping purposes, while the DC motors move the mop mechanism. The LM2596 motor driver and L298N step-down converter regulate power distribution to the motors and other components, ensuring smooth operation. A battery provides power to the entire system, managed carefully to avoid overloading. Together, these components and the Blynk IoT platform enable precise control over the cleaning process, making the floor cleaning robot versatile and efficient in manual operation.

The Node MCU ESP8266 circuit with motor drivers is integral to the manual control system of the floor cleaning robot prototype. The Node MCU ESP8266, with its Wi-Fi capabilities, acts as the central controller receiving commands from users via the Blynk IoT platform, allowing remote manual control over the robot's movements and functions. The LM2596 motor driver regulates voltage to the DC motors, ensuring smooth and controlled motion by converting higher voltage to stable outputs suitable for motor operation. Meanwhile, the L298N motor driver acts as an H-bridge, enabling the Node MCU to control the direction and speed of the DC motors, facilitating precise movements and operational flexibility. Powered by a battery, the system ensures consistent power supply to the Node MCU and motor drivers, optimizing performance during cleaning operations. Integrated with the Blynk IoT platform, this setup offers comprehensive control and monitoring capabilities, making the floor cleaning robot efficient and adaptable for manual operation scenarios

How Does Floor Cleaning Robot work?

In this project, we're building a floor-cleaning robot that operates under the control of a Node MCU microcontroller. This microcontroller interfaces with the Blynk app, allowing for remote control over the robot's movements and cleaning functions. The robot is powered by a 12V AGM sealed battery, ensuring that it has the necessary energy to operate both the locomotion and cleaning components. The Node MCU connects to a WiFi network to receive commands from the Blynk app, enabling seamless remote control

Components and Connections: The heart of this project is the Node MCU, a versatile microcontroller known for its Wi-Fi capabilities, which allows it to connect to the internet and communicate with the Blynk app. The L298N motor driver is used to control the DC motors responsible for the robot's

movement. This motor driver interfaces directly with the Node MCU to receive direction commands. A 12V AGM sealed battery powers the entire setup, providing sufficient energy for the Node MCU, the motor driver, the motors, the mop mechanism, and the water pump

Setup and Operation: To begin, power on the robot by flipping the toggle switch, which connects the 12V battery to the Node MCU and other components. Next, the Node MCU connects to the specified Wi-Fi network, allowing it to communicate with the Blynk app. In the Blynk app, you need to create a new project and link it to your Node MCU using the authentication token provided by Blynk. This setup in These virtual pins (V0 to V5) are mapped to digital pins on the Node MCU. For instance, V2 controls the forward movement by signaling the Node MCU to activate specific pins (D1 and D3) on the motor driver, which in turn powers the motors to move the robot forward. Similarly, V3 controls reverse movement, V4 turns the robot to the right, and V5 turns it to the left. The cleaning functions are controlled by V0 and V1, where V0 activates the mop, and V1 activates the water pump.

Detailed Pin Control: The Node MCU uses its digital pins (D1 to D4, D7, and D8) to control various aspects of the robot's functionality. Pins D1 to D4 are connected to the L298N motor driver's input pins (in1 to in4). These pins are crucial for controlling the direction and movement of the robot. For example, setting D1 and D3 to HIGH and D2 and D4 to LOW makes the robot move forward. Conversely, reversing these signals moves the robot backward. To turn right or left, the signals to these pins are adjusted to change the direction of the wheels accordingly. Pins D7 and D8 control the mop and water pump, respectively. When V0 (mapped to D7) is activated via the Blynk app, the mop starts operating to clean the floor. Similarly, when V1 (mapped to D8) is turned on, the water pump dispenses water onto the floor for mopping. This precise control of each component through digital pins allows the robot to perform its cleaning tasks effectively under remote commands defining six virtual pins in the app, each controlling a specific function of the robot.

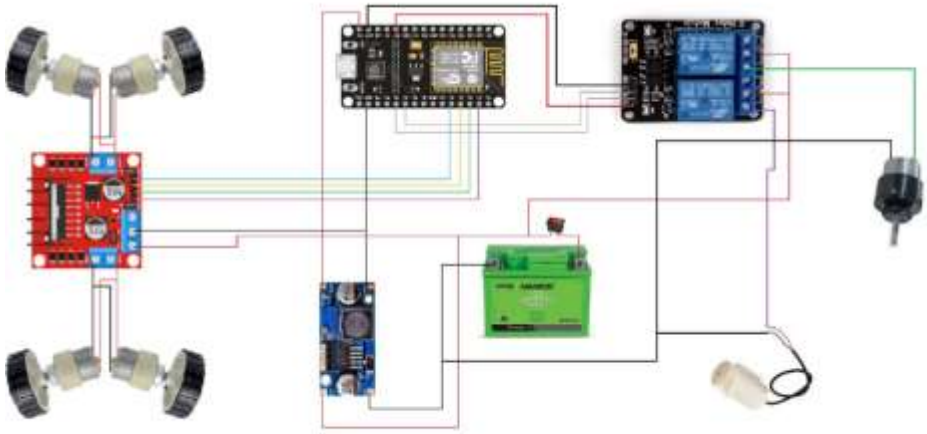

Fig 2 CIRCUIT DIAGRAM

OBJECTIVES:

1. Enhanced Cleaning Efficiency
2. User-Friendly Remote Control.
3. Obstacle Detection and Navigation.

RESULTS

The manually controlled floor cleaning robot, operated via the Blynk IoT app, demonstrated effective and reliable performance throughout the testing phase. The integration of Node MCU ESP8266, motor drivers (LM2596 and L298N), relay module, and ultrasonic sensors proved to be successful in creating a responsive and efficient cleaning solution..

Using the Blynk IoT app, users were able to control the robot's movements with precision. The app's user-friendly interface allowed for seamless operation, enabling commands to be sent to the robot in real-time. The robot responded accurately to directional inputs, showcasing smooth transitions and consistent speed control. The remote control capability facilitated cleaning in hard-to-reach areas and provided flexibility in navigating around obstacles.

Fig 3 OUTPUT OF THE PROJECT

The robot was equipped with a water pump and mop mechanism, activated through the relay module. The ability to manually control the water dispensing ensured that the right amount of water was used, preventing over-saturation of the floor. The mop mechanism, driven by the DC motors, effectively cleaned the floor surface, leaving it free of dirt and stains. The combination of precise water control and efficient mopping contributed to the overall cleaning effectiveness of the robot.

The battery life was sufficient for extended cleaning sessions, and the connection between the NodeMCU ESP8266 and the Blynk app remained stable throughout the tests. This reliable connectivity ensured uninterrupted control and monitoring, allowing users to focus on the cleaning tasks without worrying about disconnections or delays.

Conclusion

We have successfully built the project floor cleaning robot! By combining components like the Node MCU ESP8266, relay module, motor driver, and other essential parts, we've created a versatile and efficient cleaning solution. With its ability to navigate and clean autonomously, our robot offers both convenience and effectiveness. This project not only showcases our technical skills but also contributes to the advancement of automation in household chores. With further refinements and enhancements, our floor cleaning robot has the potential to revolutionize home cleaning routines. The utilization of the Node MCU ESP8266, coupled with the Blynk IoT application, empowers seamless remote control and monitoring, granting users unprecedented flexibility in operation. The integration of the 2-channel relay module ensures smooth coordination of the various components, enhancing the robot's functionality and reliability. Equipped with robust wheels for mobility and a mop for cleaning, the robot efficiently traverses surfaces, diligently mopping away dirt and grime. The LM2596 step-down converter and L298N motor driver optimize power distribution and motor control, respectively, facilitating a smooth and effective cleaning process. By harnessing the power of the Blynk IoT application, users can effortlessly command the robot to initiate cleaning sessions at their convenience. This intuitive interface simplifies the user experience, making home cleaning tasks more accessible and enjoyable. The manual floor cleaning robot represents a practical solution to household cleaning challenges, offering users a convenient and efficient way to maintain cleanliness in their living spaces. Its versatility and ease of operation make it a valuable asset in any home environment.

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