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IoT Based Autonomous Floor Cleaner Robot

Trupti Dhudhat¹, Aditya Athawale², Mayur Takwale³, Om Davare⁴, Jeet Patil⁵, Ms. Trupti Dhudhat⁶

Diploma Student, Dept. of I.T., Vidyalkar Polytechnic, Wadala, Mumbai, Maharashtra, India¹⁻⁵

Assistant Professor, Dept. of I.T., Vidyalkar Polytechnic, Wadala, Mumbai, Maharashtra, India⁶

ABSTRACT: This project presents the design and implementation of an advanced IoT-based autonomous floor cleaner robot that combines intelligent cleaning functions with real-time surveillance. Powered by an Arduino UNO microcontroller, the system performs a multi-stage cleaning process—dry mopping, wet cleaning using a water pump, and air drying with a DC fan—to ensure spotless and hygienic surfaces with minimal human intervention. Equipped with multiple ultrasonic sensors for obstacle detection and a servo-mounted sensor for dynamic environmental scanning, the robot navigates efficiently through complex spaces. The integration of an ESP32-CAM module enables live video streaming for real-time monitoring, while IoT connectivity via cloud platforms such as ThingSpeak or Blynk allows remote control, performance analytics, and notifications through smartphones or computers. Designed for energy efficiency and high cleaning performance, the system offers an eco-friendly and cost-effective solution. By merging automation, IoT, and surveillance technologies, this project delivers a smart, reliable, and scalable cleaning robot that minimizes human effort and time while advancing the development of intelligent, multitasking service robots for residential, commercial, and industrial applications.

KEYWORDS: Internet of Things (IoT), Autonomous Cleaning Robot, Smart Floor Cleaning System, Embedded Systems, ESP32 CAM, Real-Time Monitoring, Obstacle Avoidance, Wireless Communication, Robotics Automation

I. INTRODUCTION

In recent years the rapid growth of automation and the Internet of Things has significantly transformed everyday human activities by reducing manual effort and increasing efficiency. Cleaning is one of the most repetitive and time consuming household tasks and has therefore become a major focus area for robotic innovation. Conventional cleaning methods such as sweeping and mopping often fail to provide consistent results and may cause physical fatigue or health issues due to continuous dust exposure. The IoT Based Autonomous Floor Cleaner Robot proposed in this project is designed to automate floor cleaning operations while providing real time monitoring and control through IoT technology. The system performs a multi stage cleaning process consisting of dry mopping wet cleaning and air drying to achieve effective and hygienic results. An Arduino UNO microcontroller is used as the main control unit and ultrasonic sensors are employed for obstacle detection and safe navigation. To enhance functionality the robot integrates an ESP32 CAM module that enables live video surveillance for real time monitoring of the cleaning process. IoT platforms such as ThingSpeak and Blynk are used to allow remote access performance analysis and system monitoring through smartphones or computers. The proposed system aims to minimize human intervention improve cleaning efficiency and provide a cost effective and energy efficient solution suitable for residential commercial and industrial environments.

II. HARDWARE AND SOFTWARE REQUIREMENTS

A. Hardware Requirements

The hardware components used in the development of the IoT Based Autonomous Floor Cleaner Robot include an Arduino UNO microcontroller for control operations an ESP32 CAM module for live video streaming and Wi Fi connectivity DC motors for movement and mopping mechanisms and motor driver modules for independent motor control. Ultrasonic sensors are used for obstacle detection along with a servo motor for wider environmental scanning. A DC water pump is used for wet mopping and a DC fan is employed for air drying. The system uses relay modules manual switches power supply circuitry a robot car chassis wheels jumper wires and batteries for reliable operation.



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B. Software Requirements

The software requirements include Arduino IDE for programming the microcontroller using Embedded C language. IoT platforms such as ThingSpeak or Blynk are used for data logging remote monitoring and control. A front end interface is provided through the Blynk mobile application or web dashboard for live video status monitoring and manual control. The back end consists of firmware developed for Arduino UNO and ESP32 CAM along with cloud services for command processing and remote access.

III. PROPOSED ALGORITHM

Design Considerations:

The robot is powered by a rechargeable battery and operates within indoor environments. It is equipped with ultrasonic sensors for obstacle detection, a water pump for wet cleaning, and a DC fan for air drying. The system is controlled using Arduino UNO and supports IoT-based monitoring using ESP32 CAM. The robot is designed to perform cleaning operations autonomously with minimal human intervention.

Description of the Proposed Algorithm:

The aim of the proposed algorithm is to enable efficient and autonomous floor cleaning by integrating obstacle detection, navigation, and multi-stage cleaning mechanisms. The algorithm consists of the following steps:

Step 1: Initialization

The system initializes all components including motors, sensors, water pump, and fan. The robot starts moving in a predefined direction once powered on.

Step 2: Obstacle Detection

The ultrasonic sensor continuously measures the distance between the robot and nearby objects. If an obstacle is detected within a threshold distance, the robot stops and changes its direction to avoid collision.

Step 3: Navigation Control

The robot follows a simple navigation pattern (forward, left, right) to cover the maximum floor area. The motor driver controls the movement of wheels based on sensor input.

Step 4: Cleaning Operation

The cleaning mechanism is activated during movement. The water pump sprays water for wet cleaning, followed by the DC fan which dries the surface. This ensures effective multi-stage cleaning.

Step 5: IoT Monitoring

The ESP32 CAM module provides real-time video streaming, allowing users to monitor the cleaning process remotely. Data can also be viewed using IoT platforms like Blynk or ThingSpeak.

Step 6: Termination

The robot continues operation until the cleaning cycle is completed or the battery level drops below a predefined limit.

The proposed algorithm ensures efficient navigation, obstacle avoidance, and effective cleaning, thereby reducing manual effort and improving overall performance.

IV. PSEUDO CODE

Step 1: Start the system and initialize all components (motors, sensors, water pump, fan, ESP32 CAM).

Step 2: Begin forward movement of the robot.

Step 3: Continuously read distance from ultrasonic sensor.

Step 4: If obstacle is detected within threshold distance:

 Stop the robot

 Change direction (left/right)

 Continue movement



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Else

Move forward

End if

Step 5: Activate cleaning mechanism:

Turn ON water pump for wet cleaning

Turn ON DC fan for drying

Step 6: Enable IoT monitoring using ESP32 CAM for live video streaming.

Step 7: Repeat steps 3 to 6 until cleaning cycle is complete or battery level is low.

Step 8: Stop all operations and end the process.

V. SIMULATION RESULTS

The developed IoT-based autonomous floor cleaning robot was successfully tested in different indoor environments. The robot was able to navigate autonomously and detect obstacles using ultrasonic sensors, ensuring smooth and collision-free movement. The cleaning mechanism, which includes dry mopping, wet cleaning using a water pump, and air drying using a DC fan, performed effectively and improved overall cleaning efficiency. The integration of ESP32 CAM enabled live video streaming, allowing users to monitor the cleaning process in real time. IoT platforms such as ThingSpeak and Blynk were used for remote monitoring and control, providing users with the ability to access system data and control operations through smartphones or computers. The system demonstrated energy efficiency, cost-effectiveness, and reliability, making it suitable for residential and small-scale commercial applications.



Fig.1. Robot Hardware Parts



Fig. 2. Final Design Of Robot

V. CONCLUSION AND FUTURE WORK

The developed IoT-based autonomous floor cleaning robot demonstrates an effective solution for reducing manual effort in cleaning tasks. The system successfully integrates obstacle detection, autonomous navigation, and multi-stage cleaning operations including wet mopping and air drying. The robot was able to navigate indoor environments efficiently using ultrasonic sensors for obstacle avoidance. The cleaning mechanism performed satisfactorily, ensuring proper coverage of the floor surface. Additionally, the integration of ESP32 CAM enabled real-time monitoring, enhancing user control and system usability. The proposed system is cost-effective, energy-efficient, and suitable for household and small-scale applications. It provides a practical implementation of IoT and robotics for everyday use. Future work can focus on enhancing the intelligence and efficiency of the system. Advanced path planning algorithms and artificial intelligence can be integrated for better navigation and coverage optimization. The system can be further improved by incorporating mobile application control, voice-based commands, and advanced sensors such as LIDAR for accurate mapping. Battery performance can also be optimized to increase operational time. Additionally, the robot can be scaled for larger environments and commercial applications.

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