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Patrolling Robot

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ABSTRACT

This paper presents the implementation of an IoT-based patrolling robot, incorporating an Arduino Uno, ultrasonic sensor, motor driver, motors, IR sensor, and buzzer. The robot is designed to autonomously patrol a specified area. The ultrasonic sensor detects obstacles to prevent collisions, while the IR sensor identifies low-level objects and alerts the user. The buzzer provides an audible alarm for significant disturbances within the patrolling area. The robot navigates and changes directions using the motor driver and motors, controlled by the Arduino Uno. The ESP module offers local IoT connectivity, enabling remote monitoring and control. This system can be utilized for various applications such as surveillance and security, with the potential to enhance the efficiency and effectiveness of night patrolling operations. Developed at a low cost, the system is accessible to a wide range of users. Testing indicates that the system efficiently and effectively detects and responds to environmental stimuli. The IoT interface allows users to monitor and control the system remotely.

I. INTRODUCTION

A robot is a machine designed to perform tasks that reduce human involvement, ranging from simple toys to heavy machinery. Robots have increasingly replaced humans in tasks where physical limitations, size constraints, or extreme environments make human involvement impractical. Over the past decade, advancements in technology have led to the widespread use of sensors in various applications to enhance daily life. Sensors, which convert energy forms into electrical energy, serve as a crucial link between the environment and electronic devices. These devices, including smartphones, robots, tablets, and smart clocks, have diverse applications in industrial processes, ranging from control and protection to imaging and identification. The rapid development of technology has led to the production of numerous sensor types, such as heat, pressure, obstacle recognition, and human detection sensors. While sensors were previously used primarily for lighting purposes, they now play a significant role in simplifying daily life. The field of electronics has witnessed remarkable advancements, allowing for the constant emergence of new inventions and applications. Technologies like cloud computing, big data, and wireless sensors continue to evolve, with a particular focus on mobile robots as a key area of research. Traditional mobile robots relied on specialized processors and operating systems, which are unable to meet the demands of modern robot development. However, the evolution of embedded systems has led to the development of robots characterized by economization, miniaturization, and intellectualization.

Obstacle avoidance is essential for ensuring the safe navigation of mobile robots and remains a critical area of research. As intelligent robot technology continues to advance and its applications become more widespread, the development of intelligent home robots has emerged as a prominent research focus. This field holds significant promise as a high-technology industry with a bright future.

In today's rapidly advancing world, robotics stands out as one of the most dynamic and captivating fields. Robots are equipped with various input and output mechanisms to perceive their environment and respond accordingly. They utilize infrared sensors to detect obstacles obstructing their path, cameras to capture images of their surroundings, and actuators such as motors, grippers, and arms to execute actions. The evolution of technology and research has led to the development of military robots, revolutionizing various aspects of defense and security. Automation is increasingly replacing humans in hazardous work environments, creating safer conditions for personnel. Border patrolling and surveillance are areas where automation can significantly enhance safety and efficiency. Robotics systems equipped with sensors can monitor the surrounding area for human presence, fires, or bomb blasts, transmitting this information to a central control station in real-time. This capability greatly improves border surveillance, making it more effective and responsive to potential threats. Many countries now employ military robots to undertake dangerous tasks, leveraging their integrated systems comprising sensors, grippers, weapons, cameras, and actuators.

These robots come in various shapes and configurations, each tailored to specific purposes and operational requirements. For instance, robotic vehicles equipped with surveillance capabilities can effectively substitute for human soldiers in border areas, providing continuous monitoring and enhancing security.

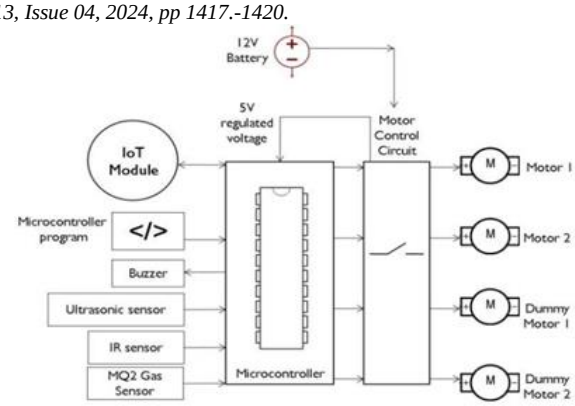
II. RELATED WORK

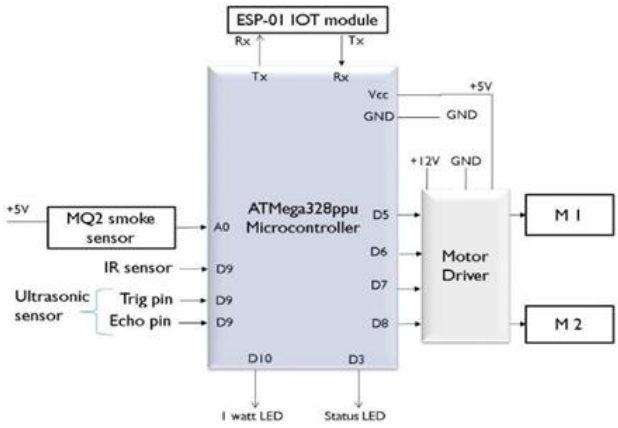
Existing surveillance systems often rely on robots with limited communication ranges, utilizing technologies such as RF, Zigbee, and Bluetooth. Some projects employ short-range wireless cameras, while others may only offer manual control modes requiring continuous human supervision. Additionally, there are robots controlled via wired connections, but they are restricted to specific ranges and are not user-friendly due to the constraints of wired communication and power supply. These traditional systems are designed to patrol designated areas, monitor for intruders, and alert authorities when suspicious activity is detected. However, they often require significant manual labor, leading to high costs and inefficiencies. The emergence of smart robots, particularly IoT-based ones, addresses these limitations by autonomously patrolling areas and responding to environmental stimuli.

The robotics field is experiencing rapid growth, with popular products widely used in industries, defense, academia, and research communities. Compared to hiring human caregivers, the design and implementation costs of robots are significantly lower. Additionally, robots can be reprogrammed quickly and efficiently, offering intelligence capable of covering large areas and providing enhanced security. Real-time object detection is crucial for safety and security in various monitoring and control systems, including intelligent home environments and consumer surveillance systems. Similarly, real-time human body detection is essential for applications such as home security, surveillance, and communication systems. In today's modern world, where crime is evolving, these advanced technologies play a vital role in enhancing security measures against incidents like robbery and theft.

III. SYSTEM DESIGN

In this project, the robotic surveillance system is designed to offer real-time monitoring capabilities and adaptability to sensor conditions. Users can input commands to control the robot's movement direction, allowing it to make decisions regarding its path based on environmental factors. Additionally, the system can monitor its surroundings and respond accordingly to detected values. Users have the convenience of accessing monitoring data remotely via phone or web interface over the network from any location. Key components of the system include the microcontroller, IoT module, motor driver, ultrasonic sensor, and IR sensor. An important feature is the integration of a buzzer that triggers upon object detection by the ultrasonic module, enhancing the system's alert capabilities.

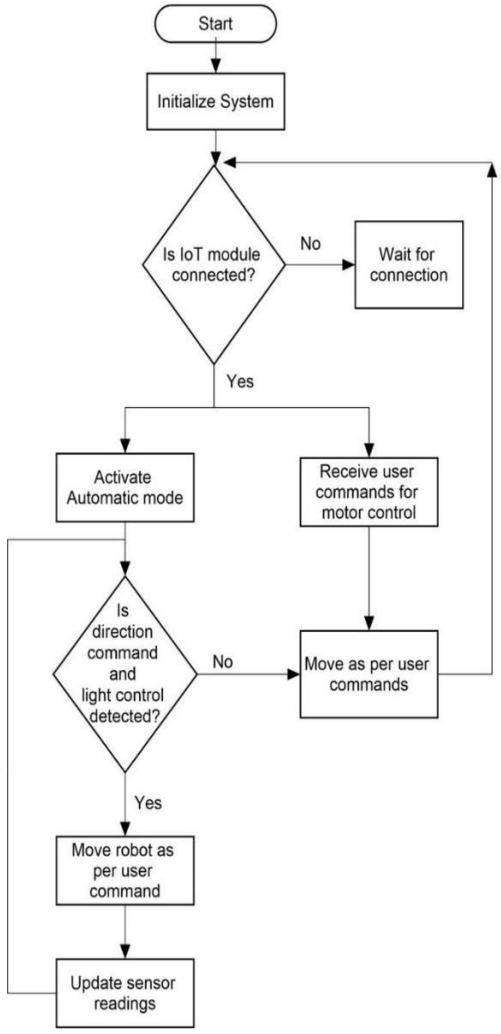


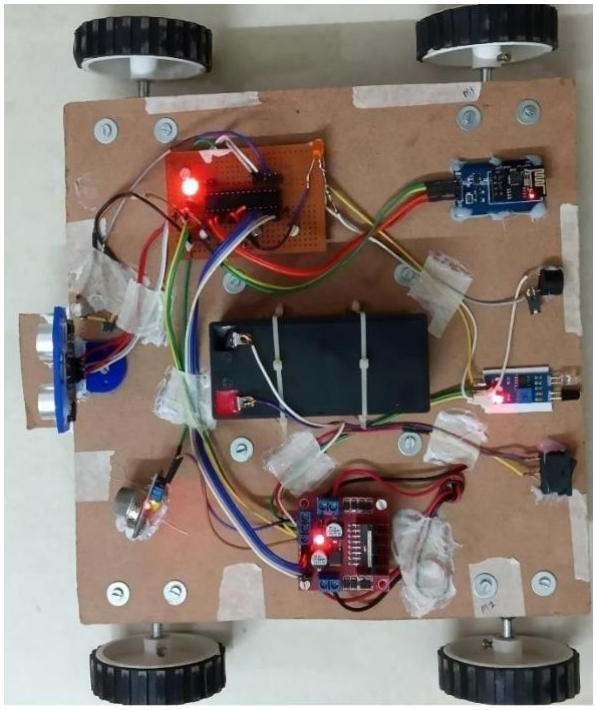


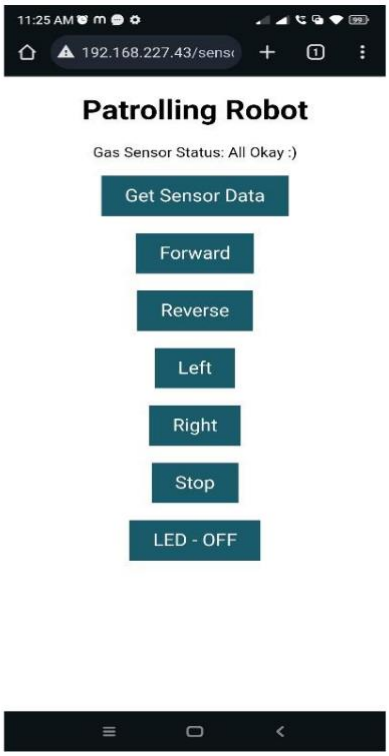
The AC mains supply is directed to the primary side of the transformer to attain the desired voltage at the secondary side. Subsequently, it is fed into the bridge rectifier, which converts the sinusoidal input into a fully rectified output. However, the rectified output contains residual ripple voltage, which necessitates the utilization of a filter circuit to mitigate it. Ripple voltage refers to the presence of a small AC component within a DC signal. The filtered output is then regulated by a voltage regulator to ensure a stable DC output despite fluctuations in the load current. Integrated circuit (IC) regulators are preferred due to their versatility and cost-effectiveness, offering features such as programmable output, current/voltage regulation, internal short circuit protection, and thermal shutdown. The 78XX series, renowned for its regulation capabilities, is commonly employed in this context. It comprises 3-terminal positive voltage regulators, while the 79XX series features 3-terminal negative voltage regulators. As implied by their names, these regulators transform voltage levels from one level to another. A step-down transformer is utilized to reduce the mains voltage from 230V to 15V, also providing isolation from the mains supply.

IV. FLOWCHART

In this research, the robotic surveillance system not only facilitates real-time monitoring but also operates in accordance with sensor conditions:







V. RESULT

The model operates using a DC battery with a capacity of 1.3Ah. Its internal electronic circuitry receives power from voltage regulators on the motor driver. Voltage and continuity tests were conducted, revealing that the fully charged battery supplies approximately 12V to the motor driver module. This module regulates the voltage to +5V DC, powering other electronic components such as the microcontroller, LEDs, and sensors.

This project incorporates a robotic surveillance system capable of real-time monitoring and responsive to sensor inputs. Users can input commands to control the robot's movement direction, and it can adapt its actions based on sensor readings and environmental conditions. Monitoring data can be accessed remotely via phone or web interface over the network. Key components of the system include the microcontroller, IoT module, motor driver, ultrasonic sensor, and IR sensor. The system is equipped with a buzzer that activates upon object detection by the ultrasonic module.

VI. CONCLUSION

In this paper, the design and implementation of a pipe inspection robot controlled with IoT are demonstrated. This robot streamlines patrolling tasks and ensures safety in hazardous environments. The utilization of a microcontroller-based control mechanism enhances cost-effectiveness and enables wireless control. Its compact size and lightweight nature allow for easy robotic movement, particularly when the entire assembly is battery powered.

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