IOT Based Smart Multi Apllication Surveillance Robot

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Abstract
The goal of this project is to devlop a survillence robot for domestic use.With technology advancing rapidl, robots are becoming essential part of our daily lives, helping to reduce human efforts and minimize errors.This survillence is designed to move around an area, capturing and transmiting live video and audio to the user. It can be controlled remotely via a mobile phone or a laptop using the Internet of Things (IOT). The built-in wireless camera allows for real-time video streaming both during the day and at night. The robots oprates in manual mode, thanks to an ardino microcontroller that process data from various sensors, Aditionally it is equipped with a metal detector to identify potential threats like hidden metal objects or bomb. This project lays the foundation for smarter and more efficient home survillence. With further development, the robot could also be adapted for defence and security applications. The combination of robotics,Iot and artificial intelligence has the potential to revolutionize the way we approach survillence ensuring a safer and more secure environment with minimal human intervention.

Keywords: Surveillance Robot, IoT, Real-time Monitoring, Wireless Camera, Arduino, Metal Detector , Remote Control, Embedded Systems, Automation, Security.

I. INTRODUCTION

Technology has revolutionized the way we interact with the world, especially through robotics and automation. From AI-driven assistants to self-driving cars, robots are transforming industries and daily life. Automation is not just about efficiency—it’s reshaping the future. From industrial machines to connected home technology, robots are becoming an essential integrated to our daily routines. One of the most important applications of this technology is surveillance—the act of closely monitoring people, places, or activities to ensure safety and security. Traditionally, surveillance has relied on human personnel, but with advancements in automation, robots are now employed to handle these tasks more efficiently. Surveillance is necessary in a variety of settings, including borders, public areas, offices, and industrial sites**.** Whether it's keeping an eye on suspicious activity, monitoring restricted areas, or simply ensuring the smooth operation of a facility, surveillance plays a crucial role in maintaining security.

This endeavor aims to developing a smart surveillance robot that can operate in both indoor and outdoor environments. The robot is engineered to navigate its surroundings, detect obstacles, and send real-time video feedback to a user. At the core of the system is an Arduino Uno microcontroller, which acts as the brain of the robot, controlling all its movements and functions. To move around, the robot is equipped with DC motors and a wheel chassis, allowing it to travel smoothly across different surfaces. A rechargeable battery powers the entire system, ensuring continuous operation. For communication and remote control, the robot is equipped with a Wi- Fi module (ESP8266 12e), enabling it to be operated via a mobile phone or computer using the Internet of Things (IoT). This means the robot is user-controlled from anywhere.

1. OBJECTIVES

1. Build a surveillance robot that can operate in both indoor and outdoor environments.
2. Incorporate a Wi-Fi-enabled communication system to enable remote access and control.
3. Implement live video streaming capabilities to provide real- time monitoring.
4. Use ultrasonic sensors for obstacle detection to prevent collisions during navigation.
5. Integrate a metal detection system to identify potential security threats.
6. Equip the robot with fire detection sensors to enhance safety measures.

II. PROBLEM STATEMENT

Existing surveillance systems often suffer from limited coverage, lack of real time monitoring and high dependency on intervention. Traditional security solutions, such as CCTV cameras and manual patrolling, high significant drawbacks including fixed view point, blind spots and delayed threat detection. These limitations make security monitoring less effective, especially in dynamic or high-risk environment.

The robot should be equipped with advanced sensors, communication systems, and the ability to navigate diverse terrains, providing enhanced situational awareness for military operations. Additionally, it should possess deployable features for operations including reconnaissance, target identification, and logistical support, enhancing the efficiency and safety of military personnel in various scenarios.

III. PROPOSED FRAMEWORK

A. Hardware components used

1. Arduino mega
2. Ultrasonic sensor
3. DC motor
4. Metal sensor
5. Gas sensor
6. Power supply
7. Fire sensor
8. DC Motors
9. Node MCU

B. Software tools used

1. Arduino IDE
2. Embedded C
3. Blynk IoT Platform

C. System Architecture

The IoT-based smart multi-application surveillance robot which is designed to perform real-time monitoring and detection tasks using an integration of sensors, communication modules, and a microcontroller. At the core of the system is the Arduino Uno, which is based on the AT mega328P microcontroller. This microcontroller acts as the brain of the robot, processing data signals from multiple sensors and sending control signals to the actuators. The entire system is powered by a battery-based power supply, which ensures continuous operation. The Wi-Fi module (ESP8266) facilitates remote communication, allowing users to control and monitor the robot using an IoT-based mobile application. Through this setup, the robot can be manually controlled or operate Incorporation of Wi-Fi- Enabled Remote Connectivity Platform Control autonomously, making it highly versatile for security and surveillance applications. The movement of the robotics achieve during DC motors, which are controlled by a motor driver module. The Arduino Uno sends PWM (Pulse Width Modulation) signals to the motor driver to adjust the speed and direction of movement. To ensure obstacle avoidance, an ultra-sonic sensor is mounted at the front of the robot, continuously scanning for objects in its path. When an obstacle is detected, the sensor sends a signal to the microcontroller, which then halts the motors or redirects the robot's movement accordingly.

D. Implementation

The implementation of a Wi-Fi-enabled communication system in the IoT-based surveillance robot involves integrating a Wi-Fi module (ESP8266/ESP32) with the Arduino Uno (ATmega328P) to facilitate real-time data transmission and remote control. The ESP8266 is programmed to connect to a wireless network, enabling communication between the robot and a cloud-based platform like Blynk or Firebase. The Wi-Fi camera (ESP32-CAM or IP camera) streams live video over the internet, allowing users to monitor the robot's surroundings remotely via a mobile application or web interface. The microcontroller processes sensor data, such as obstacle detection (ultrasonic sensor), fire detection, and metal detection, and transmits alerts to the user when anomalies are detected. Through this implementation, the surveillance robot can be controlled from anywhere, enhancing security, automation, and efficiency in monitoring applications.

OBJECTIVE 1

Develop a surveillance robot that can operate in both indoor and outdoor environments.

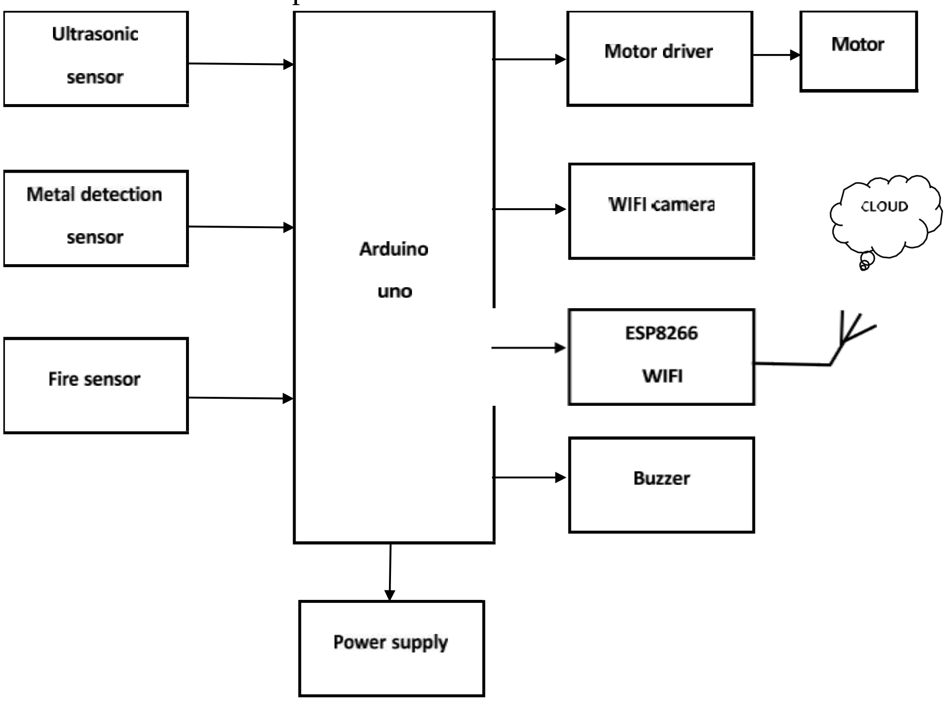


Fig 1: Block diagram of the IoT based multi-application Robot

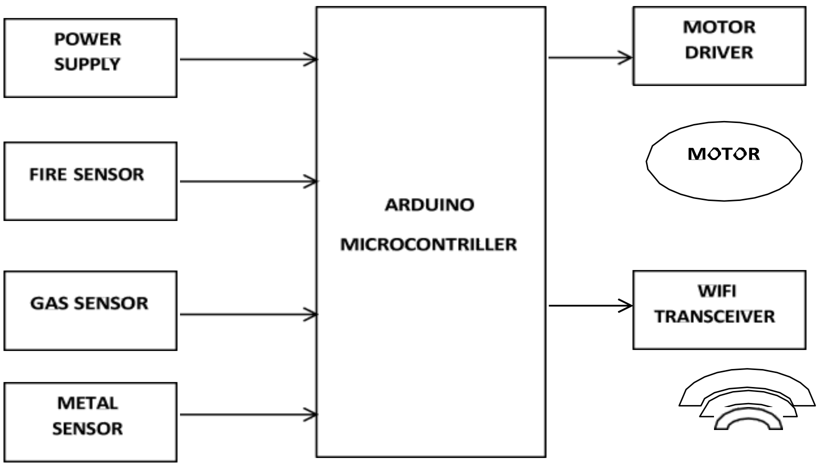
Fig 1 depicts the block diagram of the IoT based multi- application Robot, The Arduino UNO microcontroller forms the heart of the Project. All the other elements are integrated with it to provide the desired output. The Arduino receives the power from the 12.3-amp battery power supply and starts the execution of the code in it. The user commands the robot with the help of the smart phone form the webpage. The commands from the user is sent to the Arduino UNO microcontroller. The ultrasonic sensor interfaced with the Arduino is responsible for object detection. The movement of the vehicle is automatically stopped when the ultrasonic sensor detects any obstacle. Therefore, the user will be able to control the robot accordingly. Fire sensor detect the fire, if fire detected on that time robot will stop and buzzer will ON. The metal detector sensor is turned and during the robot's motion it will keep detecting the objects at ground level and when any metal object is detected the Arduino sends the signal and the buzzer present on the Metal detector senor will beep. The camera module is also interfaced with a LED indicator that can be utilized during the night or in dark places. The operator is able to turn it off and coming from the mobile. Take the command from the smart phone and move accordingly. If pressed forward, move forward, if backward then backward accordingly left and right. 2. Start the camera and send the live feed on the phone through web server. The user can see the video and control the vehicle. 3. Keep moving as per the commands until any obstacle is detected on the ultrasonic sensor. When a obstacle is detected it will stop moving forward.4. Keep detecting and looking forward for any metal objects, if detected send signal to the buzzer. The buzzer will beep.In this manner surveillance robot is built to using different sensors to achieve the security required.

OBJECTIVE 2

Incorporate a Wi-Fi-enabled communication system to enable remote access and control.

Fig2 shows the block diagram of Wi-Fi enabled Communication System for Remote Access Control. To enable remote access control in the IoT-based smart surveillance robot,a Wi-Fi enabled communication system is incorporated, allowing users to monitor and control the robot from anywhere with an internet connection. This is achieved by integrating the ESP8266 Wi-Fi module, which acts as a communication bridge between the robot’s microcontroller (Arduino Uno with ATmega328P) and a cloud-based IoT platform.

The Wi-Fi module connects the the robot via a wireless network, enabling real-time data transmission linking the robot and the user’s mobile application. This system eliminates the range limitations of traditional RF or Bluetooth-based control, making it ideal for long- distance surveillance and security applications.



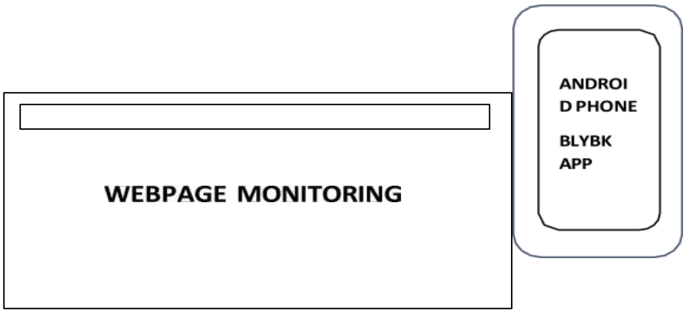


Fig 2: Block Diagram of Wi-Fi-Enabled Communication System for Remote Access Control

OBJECTIVE 3

Implement Live Video Streaming capabilities to provide real time monitoring.

Fig 3 : Live Video Streaming for Real Time Monitoring

Fig.3 shows the Live Video Streaming for Real-Time Monitoring. Implementing live video streaming in an IoT-based smart surveillance robot enhances its real-time monitoring capabilities, allowing users to visually inspect remote locations. This is achieved using a Wi-Fi-enabled camera module, which captures video footage and transmits it over the internet to a mobile application or web interface. The camera continuously streams video, granting users access to observe the robot's surroundings in real time. This feature is particularly useful for security surveillance, military applications, and industrial monitoring, where remote visibility is crucial for decision- making. The hardware setup for live video streaming includes a Wi-Fi camera (such as ESP32-CAM, Raspberry Pi Camera Module, or an IP camera), which is mounted on the robot. The camera is powered by the robot's battery supply and is integrated with a Wi-Fi network, enabling it to send video transmission to a cloud server or seamlessly to the user's mobile device. The ESP8266 Wi- Fi module, which facilitates robot control, can also be used to transmit camera feed via a web server. In cases where higher resolution and additional processing power are needed, a Raspberry Pi with a camera module can be embedded in the system, supporting more advanced video processing features.

OBJECTIVE 4

Use ultrasonic sensors for obstacle detection to prevent collisions during navigation.

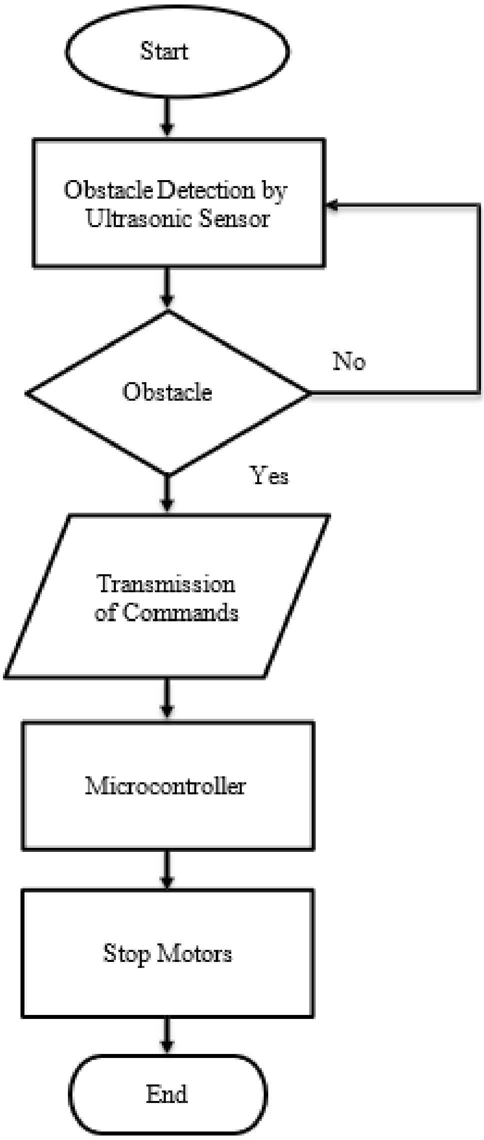


Fig 4: Flowchart for the operation of ultrasonic sensor

Fig..4 shows the Flowchart for the operation of ultrasonic sensor. As the robot moves, the ultrasonic sensor continuously emits pulses. If an obstacle is within range, the sensor detects the reflected wave and calculates the distance. The Arduino processes this data and decides the next action neither stopping, slowing down, nor changing direction. In an IoT-enabled setup, this information may also be relayed to the user's mobile app, allowing for remote monitoring of obstacle encounters.

Using ultrasonic sensors for collision prevention significantly enhances the autonomous capabilities of the robot. It allows safe navigation in dynamic environments, preventing damage to the robot and surrounding objects. The sensor works efficiently in various lighting conditions, making it reliable for both day and night operations. Additionally, integrating AI-based obstacle avoidance algorithms can further improve navigation efficiency. Overall, ultrasonic sensors are an essential component for ensuring safe and intelligent movement in smart surveillance robots.

OBJECTIVE 5

Integrate a metal detection system to identify potential security threats.

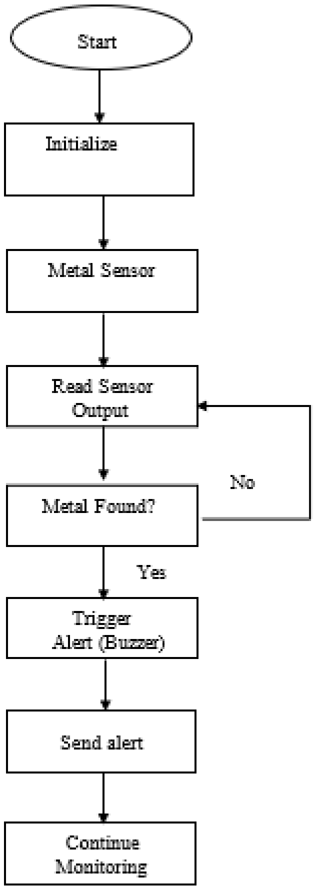


Fig5: Flow chart of Metal detection sensor operation

Fig5 shows the Flowchart for operation of Metal Detection Sensor. Integrating a metal detection system into an IoT-based smart surveillance robot enhances security and safety byidentifying metallic objects such as weapons, explosives, or hazardous materials. This feature is particularly useful in applications like military surveillance, landmine detection, airport security, and industrial monitoring, where detecting hidden metal objects is critical for preventing potential threats. The metal detector sensor continuously scans the ground as the robot moves, ensuring real-time monitoring of its environment.

The hardware setup consists of a metal detector sensor, such as an inductive proximity sensor, which operates based on electromagnetic field disturbances. When a metallic object is within range, it disrupts the sensor's electromagnetic field, generating a detection signal. This signal is sent to the microcontroller (Arduino Uno with ATmega328P), which then processes the data and takes necessary action. A buzzer is activated to provide an audible alert, and a Wi-Fi module (ESP8266) transmits a notification to the Blynk mobile app or cloud platform, allowing users to receive real-time alerts remotely.

OBJECTIVE 6

Equip the robot with fire detection sensors to enhance safety measures.

Integrating a fire detection system into an IoT-based smart surveillance robot enhances its ability to detect and respond to fire hazards, making it highly useful for applications in industrial monitoring, military and disaster management. By incorporating fire sensors, the robot can continuously scan its surroundings for heat, flames, or smoke, ensuring early detection and quick response to potential fire threats. This feature improves workplace safety, prevents fire-related damages, and enables remote fire monitoring in hazardous areas.The hardware setup includes a fire sensor, such as a Flame Sensor (IR-based)

Temperature Sensor (DHT11/MLX90614), which detects infrared radiation or temperature changes associated with fire. When a fire is detected, the sensor sends a signal to the Arduino Uno (ATmega328P), which then triggers an alarm. A buzzer is activated, and the ESP8266 Wi-Fi module sends real-time alerts to a cloud-based IoT platform like Blynk, allowing users to receive immediate notifications on their mobile devices. This ensures quick response and preventive action before the fire spreads. For software implementation, the Arduino is programmed to monitor sensor readings continuously.

IV. RESULTS

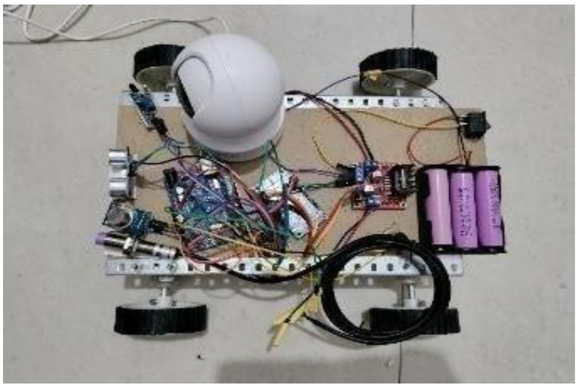


Fig.6: Model of IOT Based smart Surveillance Robot

Fig.6 shows the model of IOT Based Surveillance Robot with all the sensors interfaced.The Arduino UNO microcontroller forms the heart of the Project. All the other components are Associated with it to provide the desired output. The Arduino receives the power from the 12.3-amp battery power supply and starts the execution of the code in it. The user operates the robot with the help of the smart phone form the webpage. The commands from the user are sent to the Arduino UNO microcontroller. The ultrasonic sensor interfaced with the Arduino is responsible for object detection. The movement of the vehicle is automatically stopped when the ultrasonic sensor detects any obstacle. Therefore, the user will be empowered to operate the robot accordingly. Fire sensor detect the fire, if fire detected on that time robot will stop and buzzer will ON. The metal detector sensor is turned and during the robot's navigation it will keep detecting the objects at terrain level and when any metal object is detected the Arduino sends the signal and the buzzer present on the Metal detector senor will beep. The camera module is also interfaced with a LED indicator that can be leveraged during the night or in dark places. The individual can turn it off and following the mobile. Take the command from the smart phone and move accordingly. If pressed forward, move forward, if backward then backward accordingly left and right.

2. Start the camera and send the live feed on the phone through web server. The user can see the video and control the vehicle.

3. Keep moving as per the commands until any obstacle is detected on the ultrasonic sensor. When an

obstacle is detected, it will stop moving forward.

Fig7: Remote controlling of Surveillance Robot using Blynk app .

Fig7 shows the remote controlling of robot and detecting and looking forward for any metal objects, if detected send signal to the buzzer. The buzzer will beep.

CONCLUSION

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced ICs with the help of growing technology, the project has been successfully implemented. Therefore, the project has been effectively designed and validated.

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