

# IoT-Powered Surveillance Robot for Border Security Assistance

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**Abstract**—At present the surveillance of International border areas is a difficult task. The border guarding forces are patrolling the border seriously, but it is not possible to watch the border at each and every moment. An essential requirement of this situation is a robot which automatically detects trespasser in the border and report nearby board security control unit. Many of the military departments now utilize the robots to carry out risky jobs that cannot be done by the soldiers. In this present work, a Raspbian operating system-based spy robot platform with remote monitoring and control algorithm through Internet of Things (IoT) has been developed which will save human live, reduces manual error and protect the country from enemies. The spy robot system comprises the Raspberry Pi (small single-board computer), night vision pi camera and sensors. The information regarding the detection of living objects by PIR sensor is sent to the users through the web server and pi camera capture the moving object which is posted inside the webpage simultaneously. The user in control room able to access the robot with wheel drive control buttons on the webpage. The movement of a robot is also controlled automatically through obstacle detecting sensors to avoiding the collision.

**Keywords**—Border security, Raspbian OS, IoT, Spy Robot, Raspberry Pi, PIR sensor, Obstacle Detecting Sensor.

## I. INTRODUCTION

In today's world the robotics field is growing exponentially and some of the popular robotic products are used largely by the industries, defense, academic and research communities. The design and implementation cost of a robot is very less than hiring a human caregiver. The robots can here program faster and more efficient. The robot has sufficient intelligence to cover the largest area to provide a secured space. The intelligent robots can perform preferred tasks in unstructured environments with or without human direction. The real time object detection is required because safety and security are essential in the remote monitoring and control systems such as intelligent home environments, consumer surveillance system, etc. This system is very flexible to monitor any living object with the help of the PIR sensor and it is more suitable for surveillance systems. A robot can be controlled in two methods by hardwired control or wireless control. The wireless control provides additional benefits including increased flexibility and reduced installation cost. In latest the internet technology is used for movement control and all other purposes like image or videos capture by the robot and shared via internet.

## II. RELATED WORK

The related work for an IoT-powered surveillance robot for border security assistance includes the development of robot dogs and AI-powered border inspectors. The U.S. Customs and Border Protection (CBP) has been exploring the use of robot dogs and AI technology to enhance border security. Additionally, research and development initiatives have been focused on leveraging technology, such as Automated Ground Surveillance Vehicles (AGSVs) or robot dogs, to augment CBP personnel's capabilities and reduce their exposure to life-threatening hazards. Furthermore, academic research has also been conducted on border security using IoT and embedded systems, as well as the development of intelligent surveillance robots for monitoring international border security. These sources provide insights into the ongoing efforts and developments in the field of IoT-powered surveillance for border security assistance.

### III.SYSTEM COMPONENTS

An IoT-powered Surveillance Robot for Border Security Assistance consists of various system components that work together to provide efficient and effective border security. Based on the search results, the following components can be identified:

#### A. Robotic Vehicle:

The robot serves as the platform for the surveillance system. It is equipped with sensors and cameras to monitor the surrounding area continuously. Mechanical Control: Robotic vehicles can be controlled using joysticks or servo motors from remote and hazardous places. This allows users to operate the vehicle safely and efficiently. Continuous Monitoring: The robotic vehicle is designed to monitor the surrounding area continuously, providing a constant presence along the border. Remote Control: The movement of the robot can be controlled using an application with Bluetooth or Wi-Fi connectivity. This allows users to operate the vehicle from a safe distance. Autonomous Operation: Some robotic vehicles, like ELTA's Guardium border patrol robot, autonomously perform reconnaissance and surveillance of borders and critical facilities, providing 24/7 intelligence. Integration with Other Technologies: Robotic vehicles can be combined with various technologies, such as IoT and embedded systems, to create an integrated surveillance system. The interaction of data output from different technologies is essential for effective border security.

#### B. Remote control:

The movement of the robot can be controlled using an application with Bluetooth or Wi-Fi connectivity. This allows users to operate the vehicle from a safe distance. Remote control is an essential feature of an IoT-powered Surveillance Robot for Border Security Assistance. The robot can be controlled remotely using an application with Bluetooth or Wi-Fi connectivity. This allows users to operate the robot from a safe distance and navigate it to the target region. The remote-control mode can be accessed by the users through an Android-based application. The live feed captured by the robot's camera can be viewed on a connected local device, such as a smartphone or tablet. The robot's movement can be controlled manually or in automated mode using an Arduino microcontroller. The remote-control feature enables users to operate the robot safely and efficiently, making it an effective tool for border security assistance. The live feed captured by the robot's camera can be viewed on a connected local device, such as a smartphone or tablet. Additionally, IoT technology can be used to control the robot remotely, allowing users to access and control the robot through an internet connection. The remote-control feature enables users to operate the robot safely and efficiently, making it an effective tool for border security assistance.

#### C. Camera Modules

High-resolution cameras are installed on the robot to capture live video feeds of the surrounding environment. These cameras can provide a 180-degree visual feed and allow users to control the camera angle remotely. Camera modules for IoT-powered surveillance robots play a crucial

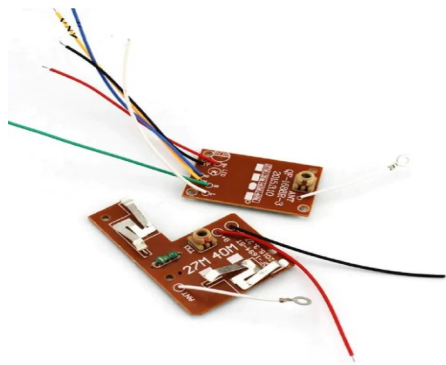


Fig. 1. Remote control

role in providing clear and detailed visuals for various applications, such as surveillance, home automation, industrial monitoring, and healthcare. Some key features of camera modules for IoT-powered surveillance robots include: High-Resolution Imaging: These modules can offer high-resolution image or video capture, ensuring clear visuals. Connectivity Options: IoT camera modules support various communication protocols like Wi-Fi, Bluetooth, Zigbee, or cellular networks, enabling seamless data transfer to cloud servers or other connected devices. Power Efficiency: Designed to be energy-efficient, these modules optimize power consumption for battery-powered IoT applications

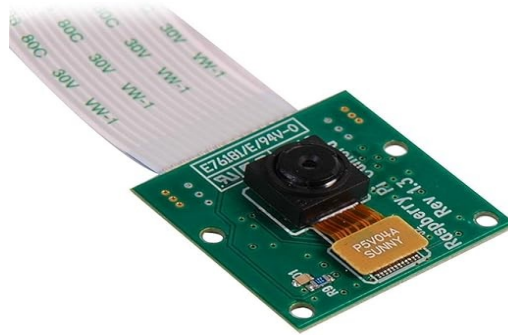


Fig. 2. Camera modules

#### D. Power Supply

A power supply is an electrical device that stores and transmits electrical energy in order to convert it into a various form of energy. A power supply or battery delivers the necessary electric energy to power the load at the needed voltage, current, and frequency.



Fig. 3. 5 V 1500 mAh Battery

#### IV.METHODOLOGY

Based on the search results, the methodology of an IoT-powered Surveillance Robot for Border Security Assistance involves the following: **Wireless Sensor Network Architecture:** A wireless sensor network architecture is used for border patrol systems, which is introduced via the internet using Node Mcu 1. This architecture enables the robot to communicate with other devices and sensors in the network. **Autonomous and Intelligent Robot:** An autonomous and intelligent robot is used to monitor every single movement along the border. The robot is equipped with sensors, such as PIR sensors and metal detectors, to detect human intruders and explosives weapons. **Remote Control:** The robot can be controlled remotely using an Android-based application with Bluetooth or Wi-Fi connectivity. This allows users to operate the robot from a safe distance and navigate it to the target region. **Continuous Monitoring:** The robot is designed to monitor the border area continuously, providing a constant presence along the border. **Real-time Video Streaming:** The robot's camera captures live video feeds of the surrounding environment, which can be viewed in real-time on a connected local device, such as a smartphone or tablet.

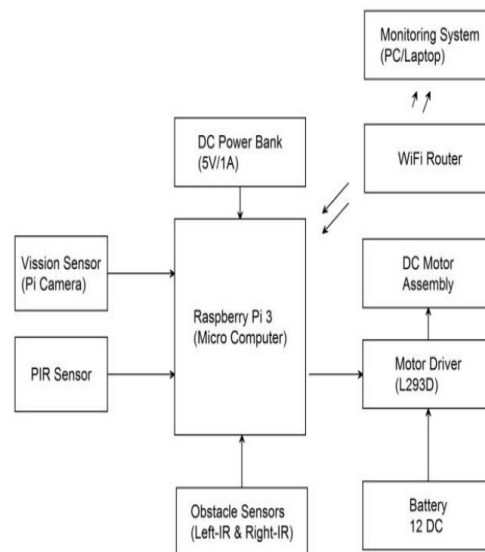
#### V.DETAILED DESIGN

A detailed design of an IoT-Powered Surveillance Robot for Border Security Assistance can be divided into several components and aspects: **Robotic Vehicle:** The robot serves as the platform for the surveillance system. It is designed to navigate and monitor the border area, providing a constant presence along the border. The movement of the robot can be controlled using an application with Bluetooth or Wi-Fi connectivity. **Camera Modules:** High-resolution cameras are installed on the robot to capture live video feeds of the surrounding environment. These cameras can provide a 180-degree visual feed and allow users to control the camera angle remotely. **User Authentication System:** A user authentication system ensures that only authorized users can access and control the robot. This adds an extra layer of security to the system. **Data Transmission:** The robot sends the captured video feed to a local device, such as a smartphone or tablet, allowing users to view the live feed on their devices. **Power Source:** The robot is typically powered by batteries, which provide the necessary energy for its operation. **Integration with IoT and Embedded Systems:** The robot can be integrated with various technologies, such as IoT and embedded systems, to create an integrated surveillance system. The interaction of

data output from different technologies is essential for effective border security. Wireless Sensor Network Architecture: A wireless sensor network architecture is used for border patrol systems, which is introduced via the internet using Node Mcu. This architecture enables the robot to communicate with other devices and sensors in the network.

## VI. CONCEPTUAL DESIGN

Basically, two gear motors are sufficient to produce the movement of spy robot and the motor driver module is used to supply enough current to drive two gear motors which protects the Raspberry-pi module from the damage. The major advantage of using the minimum number of gear motor is minimizing the power consumption. Robot has two infrared sensors which are used to sense the obstacles coming on both sides of robot path. It will move in a particular direction and when the obstacle coming in its path, it will turn to the opposite direction. Besides, the PIR sensor is used to detect the presence of living object in the robotic environment, which in turn triggers the visual sensor (pi camera) then capture the image or video and store it in the web server. An autonomous platform for the spy robot is a machine that can be operated from human-made environment by using control buttons available on client web page. Now-a-days the Raspberry-pi has been widely used to make projects in various fields like medical, defense, agriculture and industries. The spy robot is designed with Raspberry-pi 3 module which having an inbuilt wireless controller, Bluetooth controller



and pi camera support.

Fig. 4. The block diagram of the spy robot for a surveillance system

The entire proposed system consists of a Raspberry pi Model 3 board, PIR and IRs sensors, L298N motor driver, and robot chassis. The Raspberry pi is a credit card size single board small, inexpensive computer developed in the United Kingdom by the educational charity Raspberry pi Foundation. Raspberry pi has included software such as Python, Java, Scratch, Mathematica, Sonic Pi and more which enables users to teach programming and design animation, game, interesting video, etc. In addition, programmers can also develop scripts or program using the Python language and it is the main core language in the Raspbian operating system. Python language has been used in this project to write the script for client/server communication. The Raspberry pi 3 Model-B is the 3rd generation Raspberry pi minicomputer with a 64-bit 1.2GHz quad-core processor, 1GB RAM, WIFI and Bluetooth 4.1 controllers. It also has 4 x USB 2.0 ports, 10/100 Ethernet, 40 GPIO pins, Full-size HDMI 1.3a port, Camera interface (CSI), Combined 3.5mm analog audio and composite video jack, a Display interface (DSI), MicroSD slot and Video Core IV multimedia/3D graphics core @ 400MHz/300MHz. The GPIO18 (Physical pin 12) of Raspberry Pi is connected to the PIR motion sensor. The GPIO23 (Physical pin 16) and the GPIO24 (Physical pin 18) are connected to the Left IR sensor, and Right IR sensor respectively.

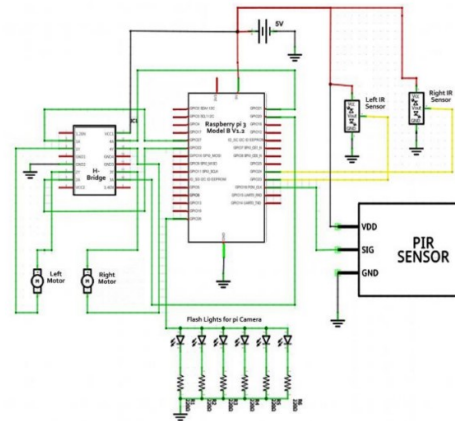


Fig. 4. The circuit diagram of the spy robot for a surveillance system

## VII.APPLICATIONS

The application of IoT-Powered Surveillance Robots for Border Security Assistance is significant for monitoring remote and border areas, enhancing national security, and reducing the need for human presence in potentially hazardous locations. The use of autonomous and intelligent Border Security Robots equipped with sensors for human intruder detection and the presence of explosive weapons, along with continuous monitoring through wireless cameras, provides a cost-effective and efficient solution for border surveillance. These robots can be controlled remotely using various technologies, such as Bluetooth, Wi-Fi, and Android-based applications, allowing for real-time monitoring and accurate border surveillance.

## VIII.CONCLUSION

The Spy Robot used for this secure purpose can operate effectively in order to collect various types of information that required by users. For instance, the presence or absence of the unwanted folks in war areas whose are not allowed in such areas can be determined by the PIR sensor which sends a signal to the Raspberry Pi when a human - being is in the ambient of the Robot.

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