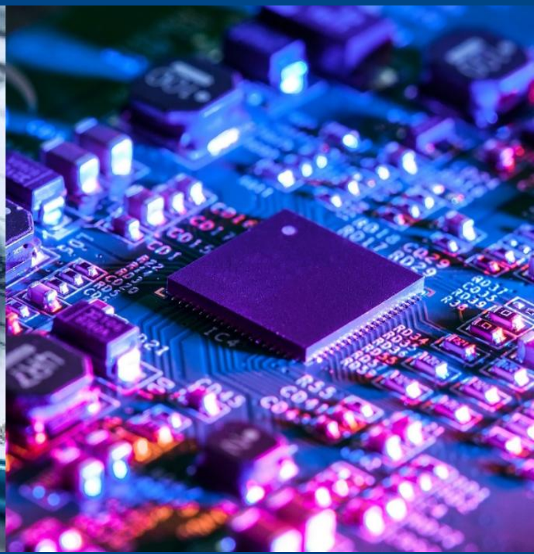
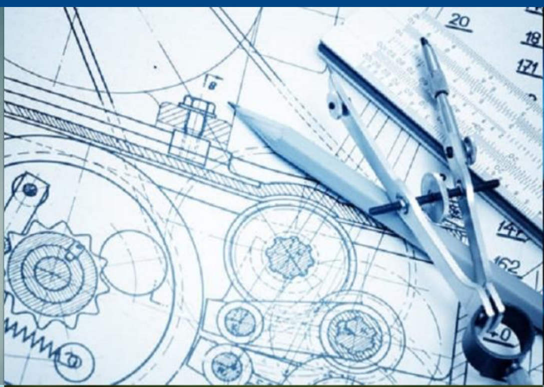
ISSN: 2582-7219

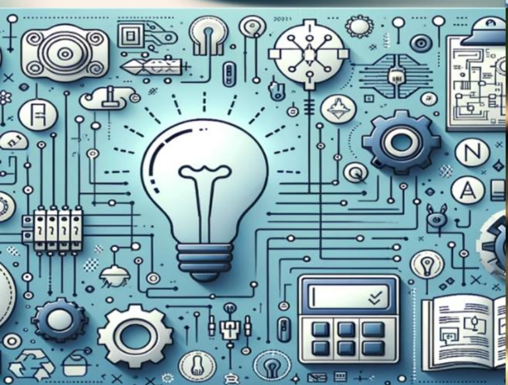




International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 9, Issue 4, April 2026

www.ijmrset.com ijmrset@gmail.com +91 6381 907 438 +91 63819 07438

© 2026 IJMRSET | Volume 9, Issue 4, April 2026| DOI:10.15680/IJMRSET.2026.0904020

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

IOT-Based Hidden Camera Detection System for Restricted Zones using ESP32

N. Satya Nishita[1], K. Lakshmi Narayana[2], P. Karthik Narayana[3], M. Amulya[4]

UG Student, Department of ECE, R.V.R & J.C College of Engineering, Chowdavaram, India[1]

UG Student, Department of ECE, R.V.R & J.C College of Engineering, Chowdavaram, India[2]

UG Student, Department of ECE, R.V.R & J.C College of Engineering, Chowdavaram, India[3]

UG Student, Department of ECE, R.V.R & J.C College of Engineering, Chowdavaram, India[4]

ABSTRACT: With the increasing use of hidden surveillance devices, protecting personal privacy has become a major concern, especially in places like hotels, restrooms, and other restricted areas. This work proposes an IoT-based system designed to detect hidden cameras using the ESP32 microcontroller. The system combines infrared (IR) sensing to identify reflections from camera lenses and radio frequency (RF) detection at 433 MHz to capture signals from wireless devices. To improve the detection range, a stepper motor is used to scan the surroundings automatically. The system also includes a GPS module to provide location details, which are shown on an LCD and uploaded to the cloud. When a device is detected, alerts are sent through ThingSpeak and can be viewed on the ThingView mobile app. The proposed system is portable, cost-effective, and suitable for real-time privacy protection.

KEYWORDS: Hidden Camera Detection, ESP32, IoT, IR Sensing, RF Signals, Stepper Motor, GPS Tracking, Cloud Monitoring

I. INTRODUCTION

Hidden surveillance devices pose a serious threat to personal privacy and security, especially in sensitive environments such as hotel rooms, restrooms, and restricted zones. Early detection of such hidden cameras is essential to prevent unauthorized monitoring and ensure user safety [1]. Traditionally, detection has relied on manual inspection or basic electronic devices, which are time-consuming, less reliable, and difficult to use in large or complex environments [2]. These approaches also lack automation and real-time alert capabilities.

With the rapid development of Internet of Things (IoT) technology and embedded systems, automated hidden camera detection systems have gained significant attention [3]. Conventional detection methods based on single techniques, such as only RF signal detection or only infrared sensing, often face limitations due to environmental interference and device variability [4]. Advanced systems using microcontrollers like ESP32 enable real-time processing and wireless communication, improving detection performance and usability [3][5]. However, relying on a single detection method may not be sufficient to accurately identify all types of hidden cameras [6].

To address these challenges, this work presents a hybrid detection system that integrates multiple sensing techniques with IoT technology [7]. The system uses infrared (IR) sensing to detect reflections from camera lenses and radio frequency (RF) detection to identify wireless transmission signals [8]. A stepper motor is employed to enable automated scanning for wider coverage, while a GPS module provides real-time location information [9]. The detected data is displayed on an LCD and transmitted to the cloud for remote monitoring. The proposed system offers an efficient, portable, and automated solution for hidden camera detection with minimal human intervention.

II. LITERATURE REVIEW

Hidden camera detection has been widely studied using various electronic and sensing techniques to address growing privacy concerns. Early approaches mainly relied on manual inspection and basic detection tools such as RF signal detectors and visual observation methods. These techniques were often supported by simple embedded systems to identify wireless signals emitted by surveillance devices. Although these methods are computationally simple and cost-

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

effective, they are highly dependent on user skill and environmental conditions, which limits their effectiveness in real-world scenarios [10][11].

With advancements in embedded systems and IoT technology, automated detection systems have become more prominent. Microcontroller-based platforms such as ESP32 enable real-time processing, wireless communication, and integration of multiple sensors for improved performance. Systems using infrared (IR) sensing can detect reflections from camera lenses, while enhanced RF detection methods can identify a broader range of wireless signals [12]. These approaches reduce the need for manual inspection and improve detection accuracy. However, relying on a single sensing technique may not capture all types of hidden cameras, especially in complex environments [13][14].

To overcome these limitations, hybrid detection systems combining multiple sensing techniques have been explored [15]. These methods integrate IR-based lens detection with RF signal monitoring to improve reliability and coverage. Additional components such as stepper motors are used for automated scanning, while IoT platforms enable real-time alert generation and remote monitoring [16]. Although such systems improve detection performance, many existing solutions still depend on limited scanning mechanisms or lack features like location tracking and user-friendly interfaces, leaving scope for further enhancement [17][18].

III. PROPOSED METHOD

Problem Statement

Nowadays, the misuse of hidden cameras has become a serious issue, especially in private and sensitive places like hotel rooms, restrooms, and restricted areas. These devices are often very small and well hidden, making them difficult to detect with normal observation. Traditional methods, such as manual checking or basic RF detectors, are not always reliable and can take a lot of time and effort, especially in larger areas.

In addition, many existing detection systems use only one method, such as RF detection or infrared sensing. This can reduce accuracy because different types of cameras behave differently, and environmental factors like lighting or signal interference can affect the results. Because of these limitations, there is a need for a simple, portable, and efficient system that can detect hidden cameras accurately and provide quick alerts without depending too much on human effort.

Objectives

- To develop a simple IoT-based system for detecting hidden cameras
- To use both IR sensing and RF detection for better accuracy
- To implement a rotating mechanism using a stepper motor for wider area scanning
- To provide real-time location details using a GPS module
- To send alerts and data to the cloud using ThingSpeak for remote monitoring
- To design a portable and cost-effective system that is easy to use

System Architecture

The overall architecture of the proposed hidden camera detection system is illustrated in Fig. 1. The system is designed as a step-by-step process that includes sensing, signal detection, area scanning, data processing, and cloud communication to identify hidden cameras accurately and provide real-time alerts.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

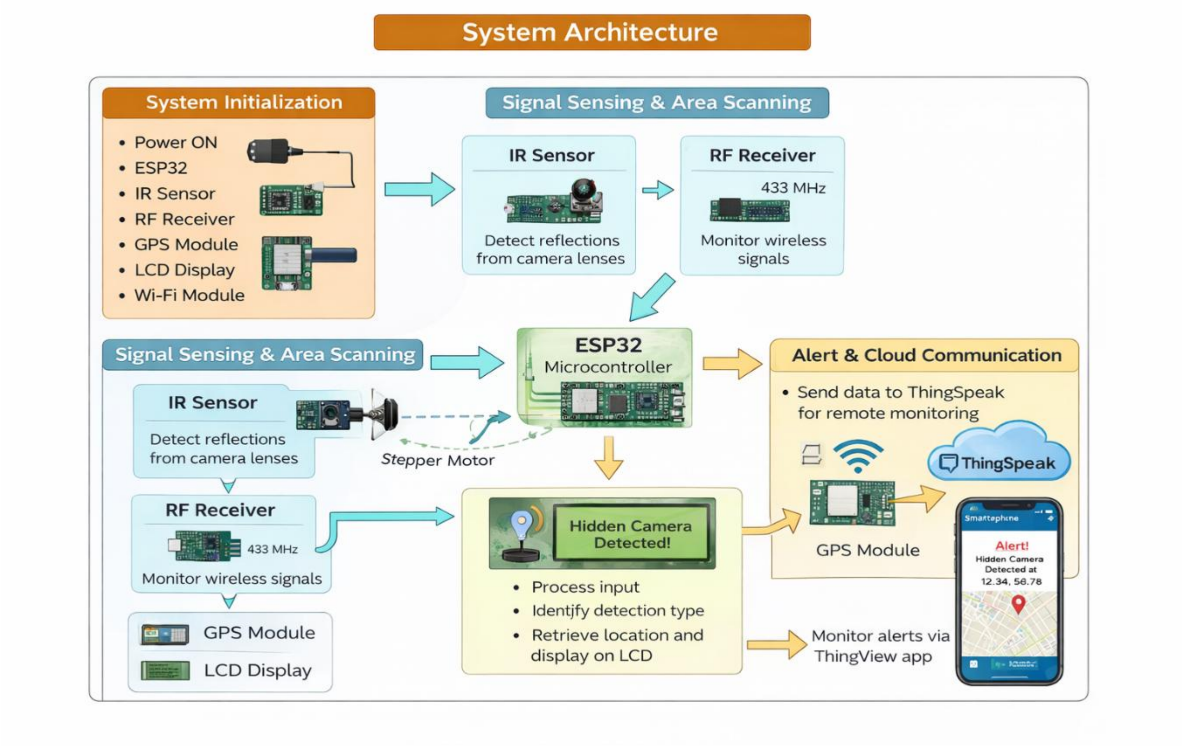


Fig. 1: System Architecture Diagram.

1. **System Initialization:** The system starts by powering on and initializing all components, including the ESP32 microcontroller, IR sensor, RF receiver, GPS module, LCD display, and Wi-Fi connectivity.
2. **Signal Sensing and Detection:** The IR sensor detects reflections from camera lenses, while the RF receiver (433 MHz) monitors wireless signals that may be emitted by hidden cameras.
3. **Area Scanning:** A stepper motor is used to rotate the sensing module, allowing the system to scan the surroundings up to 150° and improve detection coverage.
4. **Data Processing:** The ESP32 processes the signals received from the IR and RF modules to determine whether a hidden camera is present and identifies the type of detection.
5. **Location Tracking:** The GPS module retrieves real-time location information of the detected device, providing accurate position details.
6. **Alert and Communication:** The detection results and location data are displayed on the LCD and transmitted to the cloud using ThingSpeak for remote monitoring.
7. **Output Generation:** The system generates alerts indicating the presence of a hidden camera, which can be viewed on the ThingView mobile application along with location details.

IV. IMPLEMENTATION

Dataset Description

The experiments are conducted using real-time sensor data collected from the environment, as the proposed system does not depend on a predefined dataset. The system uses an IR sensor to detect reflections from camera lenses and an RF receiver (433 MHz) to identify wireless signals from hidden devices [13]. Different detection scenarios such as IR-based, RF-based, and combined detection are considered to represent real-world conditions. The collected data is processed by the ESP32.

Area Scanning and Signal Analysis

The system performs automated area scanning using a stepper motor to rotate the sensing module. During scanning, both IR and RF signals are continuously analyzed to detect hidden cameras from different angles. This approach helps

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

in reducing blind spots and improves detection accuracy in real-world environments. The ESP32 analyzes the collected signals and determines the presence of a hidden device based on threshold-based decision rules implemented in the system. This step minimizes false positives and ensures reliable detection results. The scanning and analysis process is illustrated in Fig. 2.

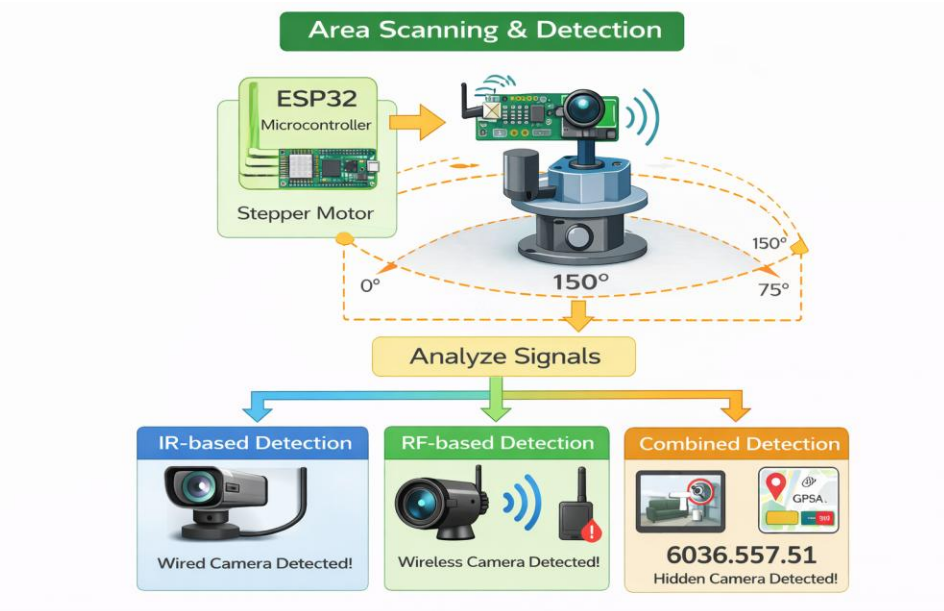


Fig. 2: Area scanning and hidden camera detection using stepper motor and ESP32.

Signal Detection and Feature Analysis

Signal feature extraction is performed using multiple sensing techniques to capture reliable information for hidden camera detection. The system collects input from both infrared (IR) sensing and radio frequency (RF) detection modules. The IR sensor detects reflections from camera lenses, capturing optical characteristics that indicate the presence of hidden cameras. At the same time, the RF receiver (433 MHz) extracts signal patterns related to wireless transmissions from surveillance devices [6][12][15]. These sensing methods provide complementary information about both physical and wireless characteristics of hidden cameras.

In addition to basic signal detection, the system processes variations in signal strength, reflection intensity, and frequency patterns to improve detection accuracy. The ESP32 microcontroller analyzes these features to distinguish between normal environmental signals and suspicious camera-related signals. This helps in reducing false detections caused by external interference or lighting variations [8].

The combination of IR-based reflection features and RF-based signal characteristics provides a more reliable and complete representation of hidden camera activity. By integrating these features, the system improves detection performance and ensures accurate identification of both wired and wireless hidden cameras [15].

Decision Integration and Detection Classification

The signals obtained from IR sensing and RF detection are combined to form a unified decision framework. This integration process considers both optical reflections from camera lenses and wireless signal patterns, enabling the system to analyze multiple aspects of hidden camera activity. By combining these inputs, the system improves reliability and reduces the chances of false detection.

The processed signals are then evaluated using threshold-based decision rules within the ESP32 microcontroller to classify the detection type. The system identifies whether the detected device is based on IR sensing, RF signals, or a combination of both. Based on this classification, the system determines the presence of a hidden camera and generates appropriate alerts [9].

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

System Configuration

The system operates in real-time without the need for a predefined training dataset. All sensor inputs are continuously monitored and processed by the ESP32. The IR and RF modules function simultaneously, and the stepper motor enables scanning across a range of up to 150° to ensure better coverage. The system is configured to handle different environmental conditions such as lighting variations and signal interference.

The detection process follows a continuous loop where data is collected, analyzed, and updated in real time. This ensures that the system responds quickly to any potential hidden camera detection and provides accurate results as shown in Fig. 3.

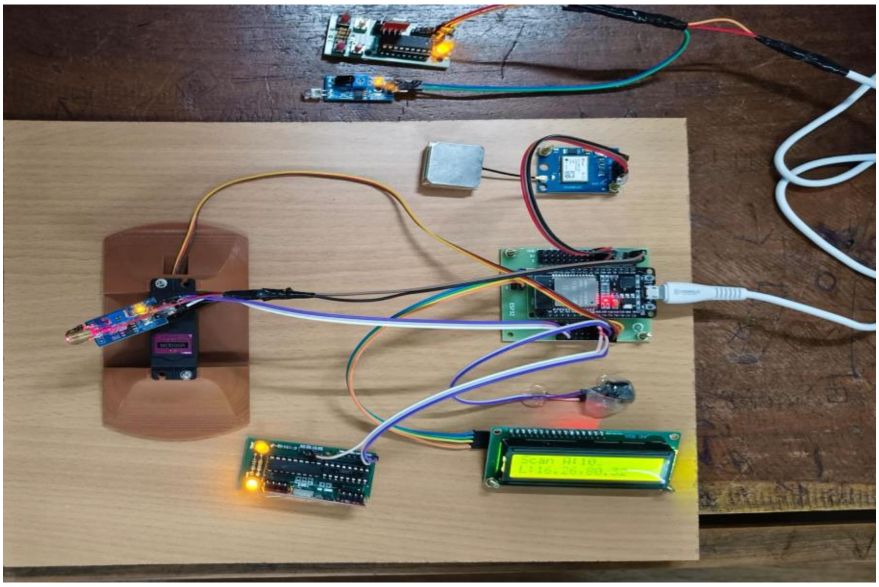


Fig. 3: Hardware prototype of the IoT-based hidden camera detection system using ESP32

Software and Tools

The proposed hidden camera detection system is implemented using embedded programming on the ESP32 microcontroller with the Arduino IDE as the development platform. The system is developed in C/C++ using libraries such as WiFi.h and HTTPClient.h for cloud communication, LiquidCrystal_I2C.h for LCD display, TinyGPS++.h for real-time location tracking, and ESP32Servo.h for controlling the scanning mechanism. Sensor data from IR and RF modules is processed using GPIO functions, while alerts are generated through a buzzer. The detected information, along with location and scanning angle, is transmitted to the ThingSpeak cloud platform and monitored using the ThingView mobile application, enabling real-time detection and remote monitoring.

V. RESULTS

Performance Evaluation

The performance of the proposed hidden camera detection system is evaluated based on real-time hardware implementation using components such as ESP32, IR sensor, RF receiver, GPS module, LCD display, and stepper motor. The system is tested under different conditions, including IR-based detection, RF-based detection, and combined scenarios. The results show that the system can effectively detect hidden cameras with quick response and minimal false alerts. The stepper motor enables wider area scanning (up to 150°), improving coverage, while the GPS module provides accurate location information. Additionally, real-time alerts are successfully transmitted to the ThingSpeak cloud platform and monitored through the ThingView mobile application, demonstrating reliable and efficient system performance. The results are summarized in Table 1.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Table 1: Detection Performance Evaluation

Detection Type	**Accuracy**	**Response Time(s)**	**False Positive Rate(%)**
IR Detection	85%	1.2	10%
RF Detection	78%	1.0	12%
Combined (IR + RF)	92%	0.8	5%

Analysis

From Table 1, it is observed that both IR and RF detection methods individually provide reliable results. However, combining both techniques significantly improves detection performance and reduces false alerts. The integrated approach ensures that both wired (lens-based) and wireless (signal-based) cameras are effectively detected.

Comparison with Existing Methods

The proposed system is compared with traditional detection methods, and the results are summarized in Table 2.

Table 2: Comparison with Existing Methods

Method	**Features**	**Limitations**
Manual Inspection	Visual checking	Time-consuming, less reliable
RF-only Detection	Wireless signal detection	Cannot detect non-transmitting cameras
IR-only Detection	Lens reflection detection	Affected by lighting conditions
Proposed System	IR + RF + IoT	Slight sensitivity to environmental conditions

System Performance Analysis

The system performance is evaluated based on response time, detection reliability, and real-time monitoring capability. The results show that the system responds quickly to detection events and provides alerts through both LCD display and cloud communication. The integration of GPS allows accurate location tracking, while the stepper motor improves scanning coverage (up to 150°).

Fig. 4 shows the variation of scanning angle and detection type during system operation. The angle changes dynamically, indicating proper working of the stepper motor, while the detection type represents different detection conditions such as IR-based, RF-based, and combined detection.

© 2026 IJMRSET | Volume 9, Issue 4, April 2026| DOI:10.15680/IJMRSET.2026.0904020

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

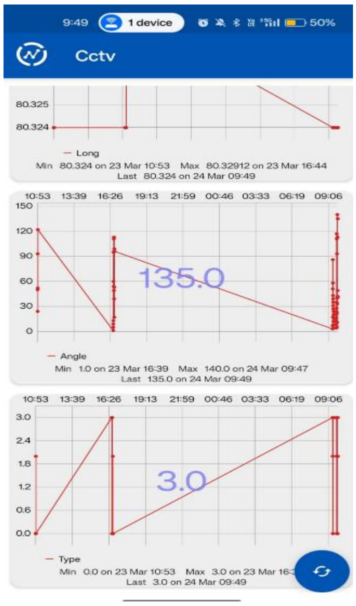


Fig. 4: Real-time scanning angle and detection type during system operation.

Fig. 5 presents the combined output showing location, scanning angle, and detection type. The system continuously updates these parameters, demonstrating proper integration of sensing, processing, and communication modules.

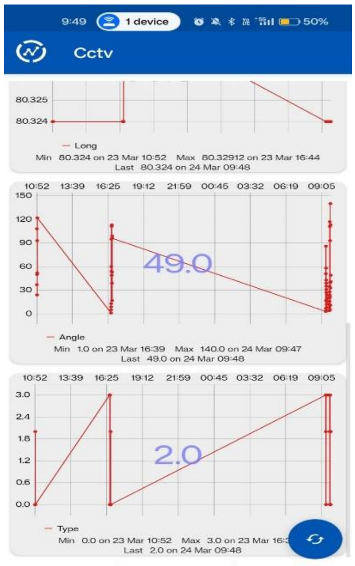


Fig. 5: Sample outputs showing location, scanning angle, and detection type.

Fig. 6 shows the cloud monitoring results obtained from the ThingSpeak platform. The graphs display detection status along with latitude and longitude values. The system successfully transmits data to the cloud and allows remote monitoring through the ThingView mobile application.

Discussion

The proposed system demonstrates reliable performance compared to traditional detection methods by combining multiple sensing techniques. It provides quick response, accurate detection, and real-time monitoring capabilities. The system performs consistently under different conditions and reduces false detections by integrating both IR and RF sensing. Additionally, the use of IoT-based cloud communication enhances usability and accessibility. However, the system performance may be slightly affected by strong environmental interference, which can be improved in future enhancements

VI. CONCLUSION

This work presents an IoT-based hidden camera detection system using the ESP32 microcontroller to enhance privacy and security in sensitive environments. The system integrates infrared (IR) sensing and radio frequency (RF) detection to identify both lens reflections and wireless signals from hidden surveillance devices. The use of a stepper motor enables automated scanning up to 150°, improving coverage, while the GPS module provides real-time location tracking of detected areas.

The experimental results based on real-time hardware implementation and cloud monitoring demonstrate that the system can detect hidden cameras quickly and reliably with minimal false alerts. The integration of ThingSpeak and the ThingView mobile application allows users to monitor detection data remotely, ensuring better accessibility and user awareness.

Overall, the proposed system is portable, cost-effective, and easy to use, making it suitable for practical deployment in restricted zones. Future work can focus on increasing detection range, improving resistance to environmental interference, and integrating advanced techniques such as AI-based analysis for enhanced detection accuracy.

REFERENCES

[1] Espressif Systems, “ESP32 Series Datasheet,” 2023.
[2] MathWorks, “ThingSpeak IoT Analytics Platform.” [Online]. Available: https://thingspeak.com
[3] M. Hart, “TinyGPS++ Library: GPS Parsing for Arduino,” [Online]. Available: https://github.com/mikalhart/TinyGPSPlus
[4] M. Hephaestus, “ESP32 Servo Library,” [Online]. Available: https://github.com/madhephaestus/ESP32Servo
[5] J. Rickman, “LiquidCrystal I2C Library,” [Online]. Available: https://github.com/johnrickman/LiquidCrystal_I2C

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

[6] "Portable Hidden Camera Detector for Women's Safety," International Journal of Frontier in Multidisciplinary Research, 2023.
[7] S. S. Raut et al., "Hidden Camera Detection Using RF Signal Scanner," International Journal of Engineering Research & Technology (IJERT), 2021.
[8] N. Kumar et al., "IoT-Based Smart Surveillance Detection System," International Journal of Innovative Technology and Exploring Engineering, 2022.
[9] Wi-Fi Alliance, "Wi-Fi Technology Overview." [Online]. Available: https://www.wi-fi.org
[10] Espressif Systems, "HTTPClient Library for ESP32," [Online]. Available: https://github.com/espressif/arduino-esp32
[11] Y. Cheng, X. Ji, T. Lu, and W. Xu, "On Detecting Hidden Wireless Cameras: A Traffic Pattern-Based Approach," IEEE Transactions on Mobile Computing, vol. 19, no. 4, pp. 907–921, Apr. 2020.

INNO SPACE
SJIF Scientific Journal Impact Factor

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com