

Raspberry Pi Based Tactical Autonomous Surveillance System

S.S. Kamble^{1*}, Atharva Deshpande², Kunal Kumbhar², Vedant Rajput²

Abstract

In the ever-evolving realm of security and surveillance, the need for autonomous systems capable of operating in challenging environments has become increasingly evident. The Raspberry Pi-Based Tactical Autonomous Surveillance and Self-Destruction System addresses this need by combining advanced sensor technology, robust communication capabilities, and a self-destruction mechanism to provide a comprehensive security solution. This project proposes a Raspberry Pi-based tactical autonomous surveillance system that can be used to monitor and track people and objects in a variety of environments. The system uses a combination of sensors, including an IR sensor, metal proximity sensor, gyroscope, and ESP32 camera, to collect data about its surroundings. At the core of the system lies the Raspberry Pi, a powerful and versatile single-board computer responsible for processing sensor data, managing system operations, and executing self-destruction protocols. An array of sensors, including an IR sensor, metal detector, gyroscope sensor, and GPS module, provides real-time information about the surrounding environment, enabling the system to detect and track objects of interest. For remote monitoring and control, the system incorporates a GSM module, facilitating secure communication over cellular networks. This allows operators to access sensor data, control system movements, and initiate self-destruction if necessary.

Keywords: IR sensors, GSM (Global System for Mobile Communication), GPS, Raspberry Pi

INTRODUCTION

In recent generations, it has been proved that the world is moving towards innovation with the automation of robots, and they not only help in the day-to-day life needs but also play an essential role in the defence workforce by replacing humans. In-order to save mankind, they are easy to implement and work at a much faster rate compared to a human with all its essential components. Robots are much better at surveillance and destruction especially in the army field. It is done by default preset programs on software with desired optimizations. The project titled is “Raspberry Pi Based Tactical Autonomous -Surveillance System” is the revolutionary project that allows for - monitoring on border or war field

which will very helpful for our soldiers. The Raspberry Pi-Based Tactical Autonomous Surveillance and Self Destruction System addresses this need by combining advanced sensor technology, robust communication capabilities, and a self-destruction mechanism to provide a comprehensive security solution. At the core of the system lies the Raspberry Pi, a powerful and versatile single-board computer responsible for processing sensor data, managing system operations, and executing self-destruction protocols.

LITERATURE SURVEY

The presented robotic system for mine disposal and high-risk missions demonstrates a sophisticated

*Author for Correspondence

S.S. Kamble
E-mail: sskamble.scoe@sinhgad.edu

¹Assistant Professor, Department of Electronics and Communication Engineering, Sinhgad college of Engineering, Pune, Maharashtra, India

²Student, Department of Electronics and Communication Engineering, Sinhgad college of Engineering, Pune, Maharashtra, India

Received Date: April 03, 2024
Accepted Date: May 06, 2024
Published Date: May 10, 2024

Citation: S.S. Kamble, Atharva Deshpande, Kunal Kumbhar, Vedant Rajput. Raspberry Pi Based Tactical Autonomous Surveillance System. Recent Trends in Electronics & Communication Systems. 2024; 11(1): 1–7p.

integration of technologies to enhance its capabilities. Incorporating a night vision camera ensures continuous surveillance during both day and night, addressing the challenges faced by mine disposal technicians and mission controllers. Control of the system is executed through an Android application, transforming a standard smartphone into a remote-control device via a Bluetooth module connected to an Arduino [1]. The presented concept focuses on the development of a robotic system designed for espionage purposes, particularly in military settings. The primary objective is to enhance surveillance capabilities and reduce the risks faced by military personnel during reconnaissance missions. The proposed robotic design incorporates features such as a night vision camera for clear imaging in low-light conditions, remote control through an Android application, and communication modules like Wi-Fi and Zigbee for extended ranges. The envisioned future scope includes modifications to include gas sensors for detecting harmful substances, potentially transforming the robot into a bomb diffuser [2]. In recent years, advancements in robotics have led to the development of sophisticated unmanned systems tailored for surveillance and reconnaissance missions in high-risk environments such as war zones. One such project focuses on equipping robots with an array of sensors and cameras to effectively gather intelligence from enemy territories and monitor activities within restricted areas [3]. The proposed wireless bomb disposal robot represents a significant advancement in defence technology, aiming to enhance national security by mitigating threats posed by terrorist activities, including suicide bombings. Traditional bomb detection and disposal methods often rely heavily on expert analysis, which can be time-consuming and perilous for personnel involved [4]. The recent global landscape emphasizes the paramount importance of national security, prompting significant advancements in defence technologies. The integration of artificial intelligence and automation into military equipment has become prevalent, particularly in surveillance and reconnaissance operations. This paper proposes the development of an autonomous RF-based spy robot equipped with a wireless camera, designed to discreetly gather ground-level intelligence in enemy territories [5]. The proposed system aims to enhance security measures by leveraging robotics and wireless technology to mitigate the risks of terrorist attacks such as the 26/11 incident. By developing an RF-based spy robot equipped with wireless devices, the system enables discreet surveillance of adversaries' territories, facilitating timely examination when necessary [6]. The unmanned ground vehicle described integrates various technologies to address security concerns, particularly in remote combat scenarios and border surveillance, minimizing soldier involvement. It employs a wireless HD camera for live streaming to headquarters via Wi-Fi, controlled either by a 2.4 GHz radio controller or a Python-based GUI. Face recognition, utilizing Haar-cascade classifiers and LBPH algorithms, enables real-time identification [7]. The abstract outlines the challenges faced in surveillant international borders and proposes the use of a spy robot system to address them. This system, based on the Raspbian operating system and utilizing IoT technology, aims to enhance border security by automatically detecting trespassers and reporting to security units. It employs Raspberry Pi, night vision pi camera, PIR sensor, and obstacle-detecting sensors to capture and transmit data to users via a web server [8]. The described system integrates both a robotic arm and a robotic vehicle, designed for high-risk operations such as bomb disposal and reconnaissance in military settings. It utilizes a night vision camera for day and night surveillance, while an IR sensor detects obstacles to ensure safe navigation. Control of the system is facilitated through an Android application or laptops, utilizing a server to send commands to the Raspberry Pi microcontroller mounted on the vehicle [9]. The paper discusses the development of an intelligent spybot capable of adjusting its actions and responses based on inputs influenced by its environment. It emphasizes the importance of remotely controlling robot functions using multiple modalities for applications in security, automation, and surveillance. The prototype spybot showcased in the paper features multi-modal control via text, touch, speech, and gestures, enabling remote operation through various devices such as smartphones, websites, and laptops [10].

PROPOSED SYSTEM

The block diagram of the transmitter and receiver communication by the Raspberry pi presented in Figure 1 and Figure 2.

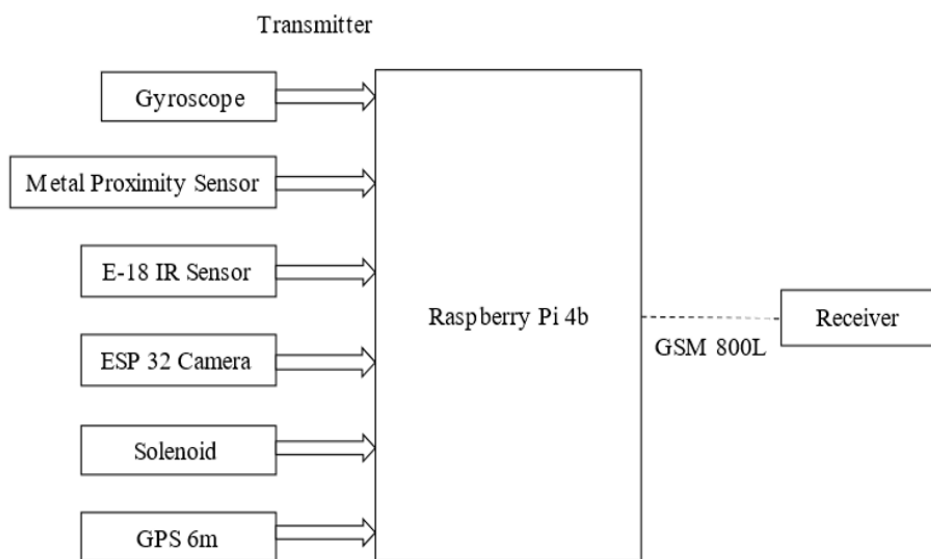


Fig 1. Raspberry pi as a Transmitter

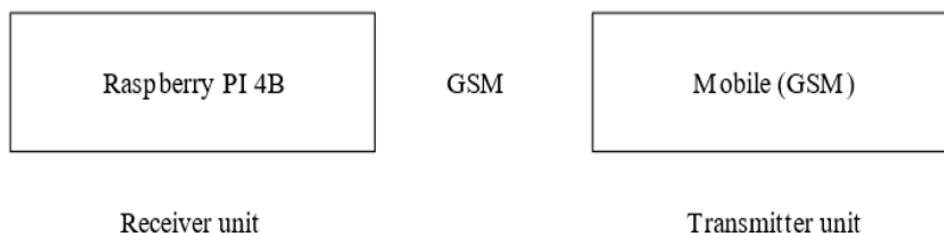


Figure 2. Raspberry pi as a Receiver.

HARDWARE COMPONENTS

- *Raspberry pi:* The Raspberry Pi is a single-board computer that is well-suited for developing autonomous surveillance systems. It is small, lightweight, and affordable. It also has a variety of interfaces that can be used to connect to sensors, cameras, and other devices.
- *Gyroscope sensor:* A gyroscope sensor is used to measure the orientation of the Raspberry Pi. This information can be used to control the movement of the surveillance system and to keep it stable.
- *IR sensor:* An IR sensor is used to detect objects in the path of the surveillance system. This information can be used to avoid collisions and to navigate around obstacles.
- *Metal proximity sensor:* A metal proximity sensor is used to detect nearby metal objects. This information can be used to detect the presence of vehicles or other metal objects.
- *GPS module:* A GPS module is used to track the location of the surveillance system. This information can be used to create a map of the surveillance area and to identify the locations of objects and events.
- *GSM module:* A GSM module is used to communicate with the operator of the surveillance system. This information can be used to send status updates and to receive commands.
- *Camera:* A camera is used to capture images and videos of the surveillance area. This information can be used to detect and track objects and events, and to classify the objects and events.
- *Battery:* A battery is used to power the surveillance system. The battery should be large enough to power the system for the desired amount of time.
- *Solenoid:* A solenoid is a wire coil that functions as a magnet while carrying an electric current. The cylindrical coil is twisted into the densely packed helix.

SOFTWARE

- a. *Raspbian OS*: - Raspbian is the official operating system for Raspberry Pi single-board computers. Based on Debian Linux, it's optimized for the Pi's ARM architecture. Raspbian provides a user-friendly interface, pre-installed software like the Chromium browser and Python, and extensive community support, making it ideal for beginners and experienced users alike.
- b. *Python*: - Python is a high-level, interpreted programming language known for its simplicity and versatility. It emphasizes readability and concise syntax, making it popular for beginners and professionals alike. With extensive libraries and frameworks, Python supports various applications such as web development, data analysis, artificial intelligence, and automation, fostering a vibrant community.
- c. *Open CV Library*: - OpenCV (Open-Source Computer Vision Library) is a popular open-source computer vision and machine learning software library. It provides a wide range of tools and algorithms for image processing, object detection, facial recognition, and more. Used in various fields, OpenCV offers cross-platform support and extensive documentation, making it invaluable for developers.
- d. *Pygps Library*: - As of my last update in January 2022, there isn't a widely recognized Python library named "pygps". However, Python offers several libraries for working with GPS data, such as Geopy and gpsd-py. These libraries enable developers to interact with GPS receivers, parse GPS data, and perform geolocation tasks within Python applications.

PROPOSED WORKFLOW

- *Start*: Power on the Raspberry Pi and initiate the system.
- *Initialise the System*: Upon startup, initialize all necessary components including sensors, communication modules, and processing algorithms.
- *Sensor Data Collection*: Begin collecting data from various sensors such as cameras, motion sensors, temperature sensors, etc. This data will be used for surveillance purposes.
- *Data Analysis*: Process the collected sensor data to identify relevant information such as motion detection, anomalies, or specific objects of interest.

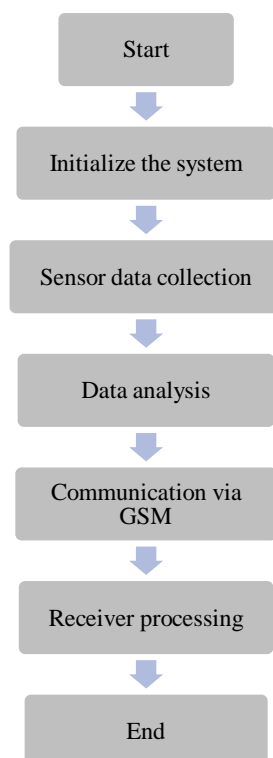


Figure 3. Flow chart of the proposed system

- *Communication through GSM:* Establish communication using GSM (Global System for Mobile Communications) to transmit the analysed data to a remote server or designated recipient. This could involve encoding the data for secure transmission.
- *Receiver Processing:* On the receiving end, process the transmitted data to extract actionable insights or trigger alerts if necessary. This could involve further analysis or integration with existing surveillance systems.
- *End:* Conclude the surveillance operation or enter a standby mode until further instructions or triggers are received as shown in Figure 3.

IMPLEMENTATION HARDWARE

The proposed prototype shown in Figure 4 and Figure 5. The front and back side of the system are arranged in way as shown in the prototype assembly.

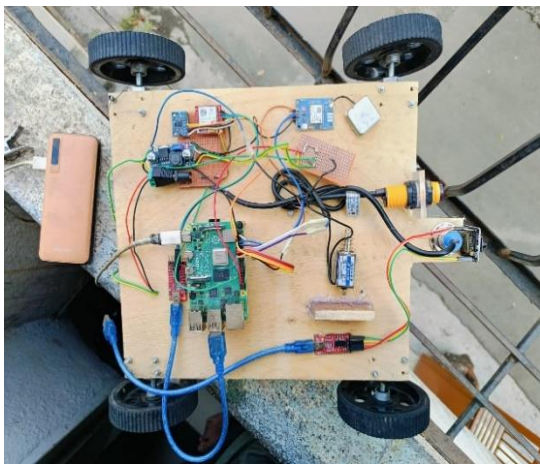


Figure 4. Front side of surveillance system

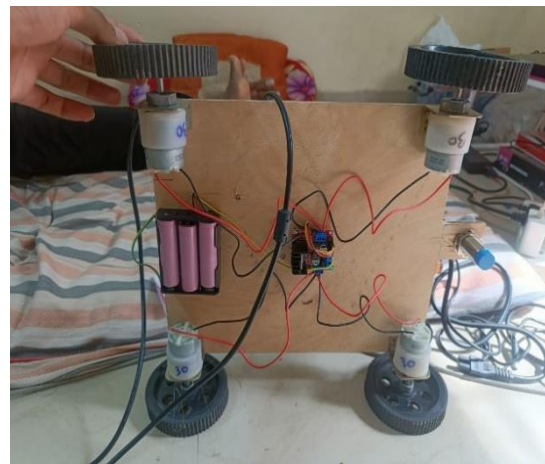


Figure 5. Back side of surveillance system

RESULT

The working of proximity sensor shown in Figure 6 and system live streaming done as shown in Figure 7.

The working of system can be evaluated in the snapshot shown in Figure 8. The parameters evaluated.

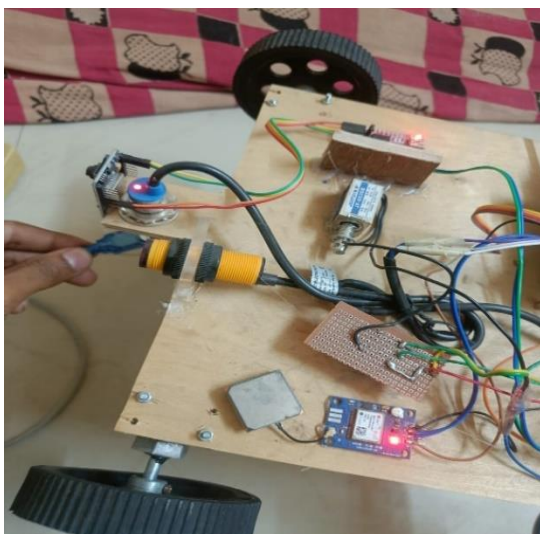


Figure 6. Working of metal proximity sensor

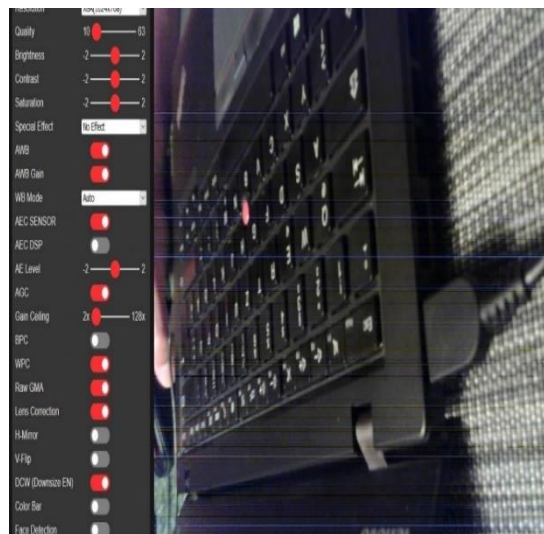


Figure 7. Live Streaming.

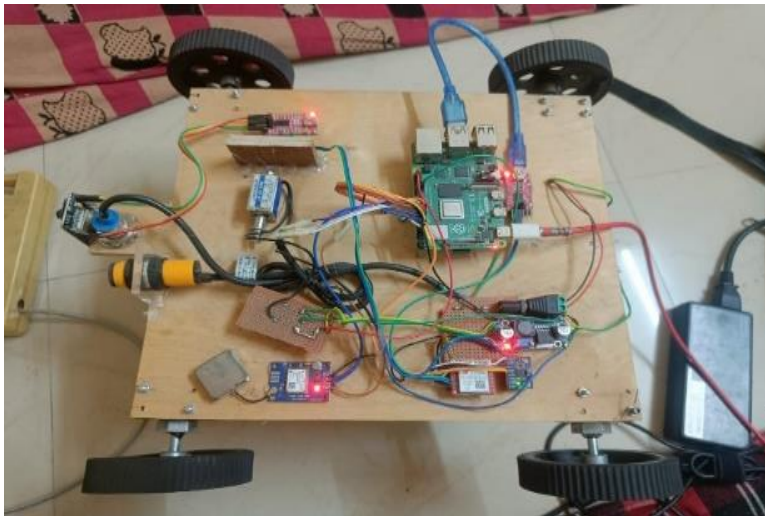


Figure 8. Raspberry pi based tactical autonomous surveillance system.

Performance Evaluation

Evaluation of the performance of surveillance system before and after imparting raspberry pi is shown in Table 1.

Table 1. Comparison of performance of surveillance system with reference to various parameters

Parameter	Before	After
Raspberry pi model	MODEL 3	MODEL 4B
Ir sensor range	150 cm	200 cm(max)
Metal proximity sensor range	5mm	8mm
Gyroscope model	MODEL BMI-160	MODEL IMPACT MPU-6050
Camera resolution	720P	(1024 X 800)p

CONCLUSION

A Raspberry Pi based tactical autonomous surveillance system is a low-cost, portable, and versatile system that can be used in a variety of military and civilian applications. The system can be programmed to detect and track objects with a high degree of accuracy and reliability, and it can stream real-time video and audio footage to the operator's mobile device. The system can also be programmed to operate autonomously, reducing the need for human intervention. A Raspberry Pi based tactical autonomous surveillance system has a number of potentials benefits, including Cost-effectiveness: Raspberry Pi boards are relatively inexpensive, making it possible to develop low-cost surveillance systems. Portability and versatility: Raspberry Pi boards are small and lightweight, making them easy to transport and deploy in a variety of environments. Customizability: Raspberry Pi boards can be equipped with a variety of sensors and actuators, making it possible to customize the system to meet specific needs.

FUTURE SCOPE

The future scope for the Raspberry Pi-based tactical autonomous surveillance system involves a multifaceted approach to enhancing its capabilities. This includes integrating advanced sensors such as LIDAR, thermal imaging, and sound sensors for comprehensive environmental perception. Furthermore, leveraging AI and machine learning algorithms will enable the system to autonomously recognize objects, detect anomalies, and analyse behaviours in real-time. To facilitate efficient communication, advanced modules like 5G or satellite communication will be integrated, ensuring connectivity in remote or challenging environments. Additionally, autonomous navigation capabilities will be enhanced through the integration of path planning algorithms, enabling the system to navigate complex environments independently while adhering to mission objectives. Scalability and modularity

will be prioritized to accommodate the integration of additional sensors or functionalities as surveillance requirements evolve. Energy efficiency measures, including smart power management systems and renewable energy sources like solar panels, will prolong operational endurance.

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