STM JOURNALS

Journal of
Aerospace Engineering & Technology

ISSN: 2231-038X (Online)
ISSN: 2348-7887 (Print)
Volume 14, Issue 2, 2024
May–August
DOI (Journal): 10.37591/JoAET

https://journals.stmjournals.com/joaet

Review JoAET

Battlefield Sentry-Military Grade Intruder Detection System

Mohit Butale[1], Swati Savkare[2,*], Mrunal Agade[1], Vaibhav Chavan[1]

Abstract

The invasion of intruders is a huge challenge for the security of any country. It is an enormous task for the security force to monitor huge international borders. Deploying a bot who is technically advanced and smart enough to find an intruder as well as sending an alert message to the department is enough to strengthen the security. This slight change can bring a dramatic difference to the security system. This bot can be deployed in hostile areas where it is a life threat for the soldiers, but by deploying the bot, the situation can be controlled. The proposed work aims to develop and deploy an automated stand-alone bot to detect the presence of an intruder in the targeted area. This system consists of a robotic car for continuously monitoring the allocated area. Whenever the sensors sense the momentum in the environment, it will check for the intruder, and if it is present, it will take the photos and email them to the department. The bot will check within the pre-stored data if the face matches with the intruder or not. This is how it can differentiate between an intruder and its own people. This system also provides live streaming of surveillance data to the department. This is done using Raspberry Pi and Tiger VNC viewer.

Keywords: Surveillance, strengthen security, deploying bot, facial recognition, Tiger VNC viewer, real-time

INTRODUCTION

The amplification of intruder threats across international borders necessitates robot-based security measures to lower risk factors and safeguard domains [1]. Traditional security mechanisms often fall short in addressing evolving threats, highlighting the need for innovative solutions capable of detecting intruders. Therefore, automated standalone bots are evolving and effective system.

The proposed automated standalone bot for intruder detection represents an advanced surveillance model. This system offers real-time monitoring as well as live streaming and can differentiate between intruders and their own people. Images or videos are continuously captured by a webcam mounted on a robot chassis, which is further interfaced with the Raspberry Pi. The OpenCV library is used for object detection, which processes images and parameters used to guide robots. The sensor, which is embedded in the system, will sense the environment, and if an intruder is detected, it will send an email to the authority.

***Author for Correspondence**
Swati Savkare
E-mail: s.savkare13@gmail.com

[1]Student, Department of Electronic and Telecommunication Engineering, Smt. Kashibai Navale College of Engineering (SKNCOE), Savitribai Phule Pune University (SPPU), Pune, Maharashtra, India
[2]Assistant Professor, Department of Electronic and Telecommunication Engineering, Smt. Kashibai Navale College of Engineering (SKNCOE), Savitribai Phule Pune University (SPPU), Pune, Maharashtra, India

Receiving Date: July 16, 2024
Accepted Date: July 30, 2024
Published Date: August 05, 2024

Citation: Mohit Butale, Swati Savkare, Mrunal Agade, Vaibhav Chavan. Battlefield Sentry-Military Grade Intruder Detection System. Journal of Aerospace Engineering & Technology. 2024; 14(2): 1–7p.

Image Processing

It plays a crucial role in the surveillance system. Image processing algorithm enables bot to detect and recognize intruders by analyzing the images and videos in real time. These algorithms can detect a specific person or an object with great accuracy.

These image processing algorithms simultaneously monitor its surroundings and search for the intruder or unauthorized person. They also help in reducing the false alarms by filtering the non-threatening objects or movements.

Detection and Recognition of Intruder

Detection and recognition are the initial stages of surveillance. This ability of recognizing is provided by OpenCV (open-source computer vision). It is mostly used as a library for image processing. It provides various functionalities for image processing and video analyzing. It has developed data history from live streaming and pre-stored data. Thus, it goes through the stored data and can differentiate between intruders and their own people.

Interfacing Hardware with Software

The project aims to deploy a technically advanced bot capable of detecting and recognizing intruders. Thus, the motor drive must be interfaced with the Raspberry Pi to fulfill the requirement. Therefore, the RPI.GPIO Library must be used, as it helps in accessing GPIO pins on the Raspberry Pi. These pins are general-purpose input and output pins that help in interfacing the Raspberry Pi with external hardware. In this surveillance system, a Raspberry Pi will be interfaced with an L298N motor drive and a PIR (passive infrared) sensor.

Send E-mail

The critical stage of this system is to alert the department about the invasion of an intruder. This is achieved by using the Smtplib Python library. It helps in establishing the connection between host and receiver. The address must be specified to establish connection. This library is essential when email is to be sent upon intruder detection.

LITERATURE SURVEY

Margapuri et al., in 2021 [2], authorized access and intruder detection for “smart” environments are topics covered in their article. PiBase is a suggested Internet of Things program that helps with security and intruder detection. The Raspberry Pi, an Android smartphone, a PIR motion sensor that detects motion from infrared radiation in the surroundings, and a camera make up the application's hardware. The application's software is written in NodeJS, Python, and Java. Human intrusion detection is aided by the Pi camera module and PIR sensor that are attached to the Raspberry Pi.

Hashib et al., in 2020 [3], delve into the implementation of an intelligent security system using machine learning algorithms and the Viola-Jones algorithm for object detection. Running on a Raspberry Pi 3 B, this cost-effective system identifies trespassers and multiple objects in real-time. The security administrator receives timely alerts via email, coupled with an activated alarm, mitigating the drawbacks of conventional security cameras.

Hemalatha et al., 2021 [4], propose a real-time image processing-based robotic arm control system. With a focus on object detection and recognition using the open CV library in MATLAB, the system operates on a Raspberry Pi. This standalone system facilitates surveillance and object tracking without manual control, demonstrating the potential of the Raspberry Pi in advanced robotic applications.

Sequeira and Shanmuga Priya et al., in 2022 [5], shed light on the utilization of the Raspberry Pi as a low-cost computing platform for implementing machine learning techniques and image processing. Their article explores the effective integration of Raspberry Pi with current technologies, showcasing its versatility and affordability in deploying advanced computing applications.

Horak and Zalu et al., in 2020) [6], present a paper on image processing methods using Raspberry Pi, implemented via Simulink in MATLAB. Designed for real-time applications, this framework offers feature extraction and image transformation methods. The Raspberry Pi 2, equipped with a native

camera board, becomes a cost-effective platform for robotics, demonstrating the feasibility of fast image processing.

Lokesha Hlmg et al., 2021 [7], introduces the implementation of image processing operations on Raspberry Pi. Focusing on the Raspberry Pi's role as a basic embedded system, the article showcases its utility in real-time applications, specifically for Micro Aerial Vehicles. The incorporation of the Raspberry Pi camera module enhances image quality, enabling the identification of specific regions in dark and low-contrast images.

The robot developed by Pallavi P. Saraikar et al. is able to detect objects, spin in a left or right direction, and move forward or backward in response to the motion of the objects. We maintain the distance between the object and the robot to avoid obstacles by using an ultrasonic sensor and Python scripting to recognize the object with OpenCV. The image is captured by a Pi camera that is mounted on the robot chassis [8].

Earlier research has explored varied factors or methodology to enhance security [9]. They have used different sensors and camera modules to achieve clarity. They have used different machine learning techniques, different programming platforms so that it would get easier to interface and deploy. However, automated stand-alone bots for intruder detection comprise advanced Python libraries and machine learning techniques that enhance the clarity of images and give fewer false alerts. It has an alarming system, which is the crucial part of the system, which helps in alerting the authorities and thus required measures can be taken [10, 11].

SYSTEM ARCHITECTURE

The proposed model comprises four main components, PIR sensor module, microcontroller unit, motor drive, and camera module.

Raspberry Pi3B+

The Raspberry Pi is a single computer board, that can be used for many tasks, like games, word processing, and HD video. It was founded by the Raspberry Pi Foundation from the United Kingdom. There are two models, namely model A and model B. The only difference between model A and model B is the USB port. Model A board consumes less power and does not include an Ethernet port. Model B board contains an Ethernet port. Raspberry Pi3B+ shown in Figure 1.

Motor Drive

L298N module is a dual full-bridge motor driver used to control DC and stepper motors. It can control the speed as well as the rotation direction of two DC motors. Motor Drive shown in Figure 2. The L298N module has a dual-channel H-Bridge motor driver IC. A heat sink is a passive heat exchanger that transfers the heat generated by a mechanical device to a fluid medium, often air or a liquid coolant.

Camera Module

A webcam is a digital camera that can hook upon a computer to broadcast images in real time. It captures light via a small lens at the front using a tiny grid of microscopic light-detectors built as an

Figure 1. Raspberry Pi3B+.

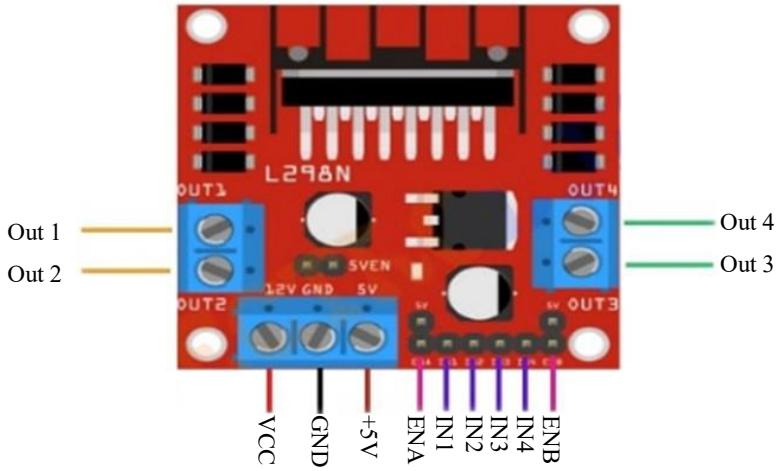

Figure 2. Motor drive.

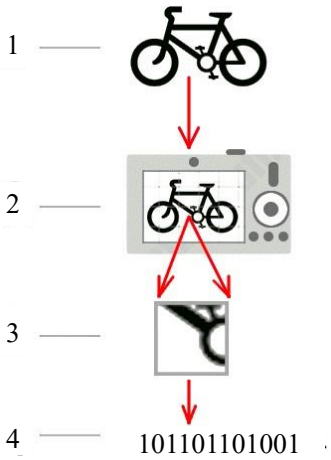

Figure 3. Camera module.

image-sensing microchip. Camera Module shown in Figure 3. It catches moving images and converts them into streams of digits by using image sensors.

METHODOLOGY

- *Installation of the operating system:* Install the Raspberry Pi operating system on the micro-SD card and connect it to the Raspberry Pi board.
- *Installation of the required libraries:* Install the required Python libraries like OpenCV, NumPy, Flask, and Face Recognition library using pip command in the terminal.
- *Training the model:* To recognize the faces, we must train the face recognition model with a dataset of known faces. Use the Face Recognition library to train the model with a dataset of images of known faces.
- *Integration with the database:* Connect the face recognition system with an SQLite database to store the attendance records. Create a table to store the name of the person, date, and time of attendance. Block Diagram shown in Figure 4.
- *Developing the user interface*: Develop a simple web-based user interface using HTML/CSS. The user interface should allow the user to take attendance, view attendance records, and add or delete users. The DC motors are connected to the L298N motor drive, and further, it is interfaced with the Raspberry Pi, so that it can take the commands. This robot is controlled by the user via laptop, thus can be sent to any location for surveillance. As the intruder is detected, the Raspberry Pi camera will take the picture and will further send it to the registered email.

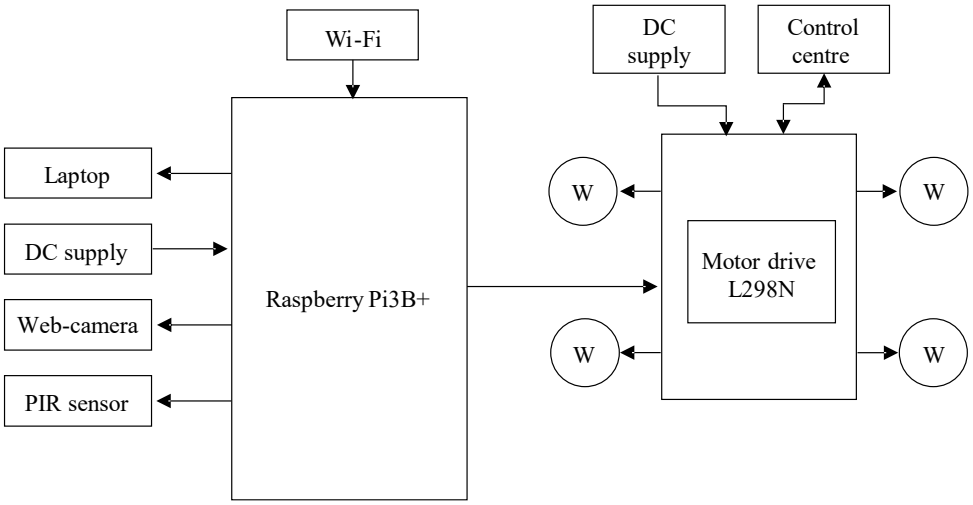

Figure 4. Block diagram of the intruder detection system.

IMPLEMENTATION AND RESULTS

Algorithm used to implement the bot are as follows:

- *Haar cascade:* This requires a lot of positive images of faces and negative images of non-faces to train the classifier, like other machine learning models. Initially, it collects the Haar features. The calculations are performed on adjacent rectangular regions at a specific location in a detection window. The calculation involves adding up the pixel intensities in each region and calculating the differences between the sums. Haar cascade collecting HAAR features shown in Figure 5. This calculation can be difficult to determine for a large image. Thus, integral images come into play because it reduces the number of operations.
- *TensorFlow:* It is a library for numerical computation by using data flow graphs where nodes in the graph represent mathematical operations. Email of the alert message and photo of the intruder being detected shown in Figure 6.

Result

- The automated standalone bot system achieved an accuracy rate of 98% in recognizing faces and sending email.
- This system eliminates the need for human beings, thus eliminating extra work.
- This system continuously checks the status of the place with the help of a PIR sensor to sense the intruder.
- Finally sends the alert message to the owner with live images.
- In this security system, human bodies are detected by the Haar cascade module.

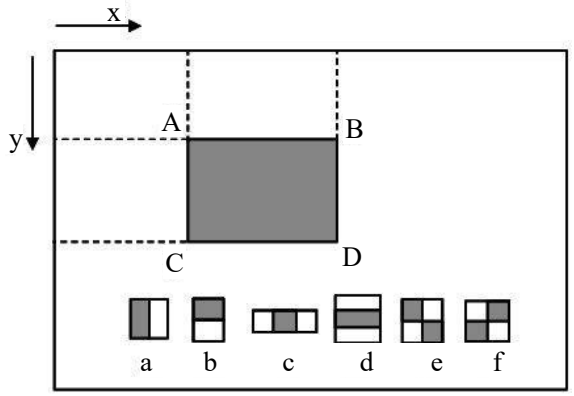

Figure 5. Haar cascade collecting HAAR features.

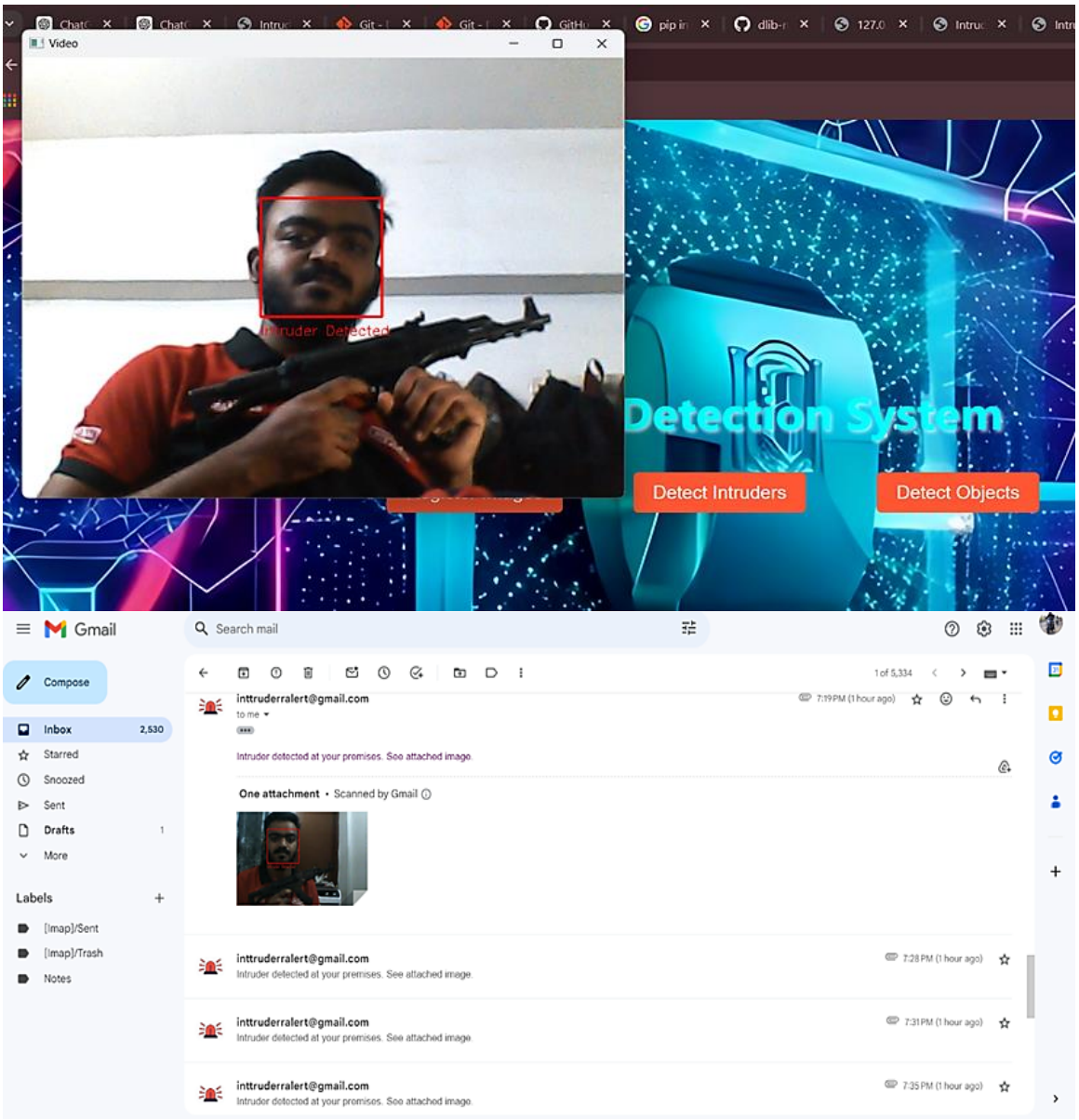

Figure 6. Email of the alert message and photo of the intruder being detected.

CONCLUSION

The proposed intruder detecting robot system with face recognition is continuously surveying the surrounding area. When the objects get detected, the robot detects them and then takes the decision whether the detected person is an intruder or not. The system continuously monitors the given area and detects an intruder. If the detected person is unknown, it will take a picture and send it to the registered email. The system can provide live streaming of images and alert messages. Hence, it is applicable to surveys in war fields or borders. The proposed work also detects unusual objects carried by humans in high-security zones. Overall, the stand-alone bot for intruder detection system using Raspberry Pi is a valuable project that displays the potential of emerging technologies in solving practical problems. With further development and refinement, this system could become a standard feature in surveillance systems.

REFERENCES

1. Kumar J, Kumar S, Kumar A, Behera B. Real-time monitoring security system integrated with Raspberry Pi and email communication link. In: Proceedings of the 9th International Conference on Cloud Computing, Data Science, and Engineering (Confluence); Noida, India: IEEE; 2020. 79–84 p.

2. Margapuri V, Penumajji N, Neilsen M. PiBase: An IoT-based security system using Google Firebase and Raspberry Pi. In: 2021 IEEE International Conference on Internet of Things and Intelligence Systems (IoTaIS); Bandung, Indonesia: IEEE; 2021. 79–85 p. Doi: 10.1109/IoTaIS53735.2021.9628513.
3. Hashib H, Leon M, Salaque AM. Object detection-based security system using machine learning algorithm and Raspberry Pi. In: Proceedings of the International Conference on Computer, Communication, Chemical Materials and Electronics Engineering (IC4ME2); Rajshahi, Bangladesh: IEEE; 2019. 1–4 p.
4. Hemalatha P, Hemantha Lakshmi CK, Jilani SA. Real-time image processing based robotic arm control standalone bot using Raspberry Pi. Int J Electron Commun Eng. 2019; 8 (2): 1–6.
5. Sequeira SM, Priya S. Use of Raspberry Pi in implementation of machine learning and image processing. Int J Adv Res Basic Eng Sci Technol. 2020; 6 (3): 1–6.
6. Horak K, Zalu L. Image processing on Raspberry Pi for mobile robotics. Int J Signal Process Syst. 2021; 6 (4): 1–6.
7. Shilpashree KS, Lokesha H, Shivkumar H. Implementation of image processing on Raspberry Pi. Int J Adv Res Comput Commun Eng. 2015; 4 (5): 199–202.
8. Saraikar PP, Ingle KS. OpenCV-based object tracking robot using image processing with Raspberry Pi. Int Res J Eng Technol. 2022; 6 (1): 1–6.
9. Sai TV, Aditya B, Reddy AM. Real-time object detection using Raspberry Pi. Int J Res Appl Sci Eng Technol. 2023; 11 (1): 1–6.
10. Xenya M, Kester A, Kwayie C. Intruder detection with alert using cloud-based convolutional neural network and Raspberry Pi. In: Proceedings of the International Conference on Computing, Computational Modelling, and Applications (ICCMA); Noida, India: IEEE; 2023. 5–6 p.
11. Joseph R, Varughese RR. Wi-Fi monitored autonomous robotic car using Raspberry Pi. Int J Creat Res Thoughts. 2023; 6 (2): 1–6.

