SECURITY CAMERA USING RASPBERRY PI AND TELEGRAM BOT

Kartik Adatrao[1], Sahil Joshi[2], Kunal Memane Benkar[3], Prajval Kshatriya[4], Krittika Goswami[5]

[1,2,3,4]Zeal Polytechnic, Pune, India.

[5]Professor, Zeal Polytechnic, Pune, India.

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ABSTRACT

This project presents a low-cost, efficient security camera system built using a Raspberry Pi and integrated with a Telegram bot for real-time monitoring and notifications. The system leverages the Raspberry Pi's camera module to capture live video streams and detect motion in a given area. When motion is detected, the Raspberry Pi processes the data and immediately sends an alert to the user through a pre-configured Telegram bot. The bot delivers real-time images or video snippets directly to the user's smartphone or computer, enabling remote surveillance and prompt action. This project also explores various security and privacy measures, including encrypted communication between the Raspberry Pi and Telegram bot, and secure login mechanisms to prevent unauthorized access. The system is designed to be highly customizable, allowing for the integration of additional sensors (e.g., infrared, ultrasonic) and further automation features like automatic recording and cloud storage. This solution provides a versatile, scalable, and accessible home security system suitable for personal use, small businesses, or educational purposes.

1. INTRODUCTION

The need for a surveillance system combining inexpensive cost and reliability at home motivates this project into creating such a low-cost surveillance system using Raspberry Pi and a Telegram bot. The central component used is the Raspberry Pi, which is coupled with a camera module mounted on it, captures real-time video from its field of view, and the system continuously watches what is happening in the surroundings; motion detection is built into the algorithm accordingly. On detecting any suspicious activity, it instantly sends alert messages along with live images or videos to the user through a Telegram bot for real-time alerts. Provision of Telegram provides an easy and secure interface to monitor user premises remotely on any device.

2. LITERATURE SURVEY

Due to its low cost and flexibility, it has become widely used in security camera applications. According to Rawat and Chandra (2019), the real-time video capture with motion detection at a very affordable price with Raspberry Pi makes it an efficient alternative for DIY surveillance projects. Saranya et al. have also mentioned that motion-triggered recording and alerting are the basic features making the most use of efficiency in low-power devices like Raspberry Pi [1].

Singh and Agarwal (2018) evaluated movement detection techniques and concluded that algorithms such as frame differencing and background subtraction are effective and can be implemented on Raspberry Pi, especially for high accuracy and relatively low computational power [2].

Gupta and Mehra (2021) highlight the utility of Telegram bots that can send live alerts and retrieve information through a remote site, which is demonstrated in detail about how users receive real-time alerts in the form of images or video clips of the movement detected [3].

While security is of great essence, which may be seen through recommendations offered by Patil and Patil (2020) on encryption and secure login protocols to provide certainty of no unauthorized access. Gouda and Pillai also mentioned their suggestion of two-factor authentication for better security. Comparing the two, according to Ekinci et al. (2019), Raspberry Pi-based systems present similar functionalities with commercial systems, such as Nest or ADT, though they are more customarily flexible and inexpensive [4].

Future work: Scalability and AI. Such systems can be scaled up by simply piling on more sensors and cameras, as discussed by Kumar et al. (2019). Bansal et al. (2021) proposed adding AI features like facial recognition to elevate system intelligence and minimize the number of false alarms [5].

3. PROBLEM STATEMENT

The solution is cost-effective and uses a Raspberry Pi, camera module, and motion detection algorithms to monitor the observed area in real time. It instantly sends notifications with images or video clips via a Telegram bot when the system detects any motion, thus providing remote monitoring. The user can even operate through the bot, for example, viewing the live feed or turning the camera on/off.

Its key features include encrypted communications to ensure safe data transmission and security access, including passwords for access rights. The system is scalable so that many cameras may be added and the system can be developed for further required add-ons like facial recognition or sensors.

The system's design prioritizes simplicity and adaptability, making it ideal for home and small business surveillance. It is highly customizable, allowing users to easily integrate additional hardware such as motion sensors, infrared detectors, or cloud storage for video backup. By leveraging the Raspberry

Pi's flexibility, the system can be expanded to cover multiple areas, with all cameras linked to the same Telegram bot for unified monitoring. Future enhancements could include AI-driven features like facial recognition or intelligent threat detection, further improving security and reducing false alarms, while maintaining an affordable, user- friendly setup.

Possible Solutions:

To create a Raspberry Pi-based security camera with Telegram bot integration, start by gathering the necessary hardware: a Raspberry Pi 3 or 4, a camera module (or USB webcam), and optionally a PIR motion sensor for enhanced motion detection. Flash Raspberry Pi OS onto an SD card, insert it into the Pi, and boot it up. Use raspi-config to enable the camera. Afterward, connect to the internet and update the system.

Create a Telegram bot using the BotFather in the Telegram app, following its instructions to generate a bot token. Install required software libraries on the Raspberry Pi, such as PiCamera to interface with the camera and OpenCV for motion detection. The bot will be integrated using the Telegram Bot API, allowing it to send images or videos directly to your phone when motion is detected.

For motion detection, you can either rely on a PIR sensor (which triggers based on infrared heat) or use computer vision via OpenCV to detect motion in the camera's field of view. When motion is detected, the camera will capture an image or video and the bot will send it to your specified Telegram chat. You can customize the bot with commands such as /start to activate or /stop to deactivate the system.To ensure the script runs automatically after every reboot, use crontab or systemd services to launch the script on startup. You can also add additional features like saving footage locally or to cloud storage, setting a motion sensitivity threshold, or sending status updates to your Telegram chat. Finally, test your setup by moving in front of the camera to see if the system successfully captures the footage and sends an alert to your Telegram bot. This DIY setup offers an affordable, customizable, and flexible security camera solution with real-time notifications.

Project and Scope:

This project aims to create a cost-effective and smart security camera system using a Raspberry Pi. The system will use a camera module to capture images and videos when motion is detected, and it will send these alerts to users via a Telegram bot in real- time. This DIY security solution offers flexibility, control, and affordability, with the ability to be customized for various use cases such as home, office, or property monitoring.

The project focuses on integrating hardware and software components, such as motion detection via computer vision (OpenCV) or a PIR sensor, image capturing through the Raspberry Pi camera, and communication through a Telegram bot, making it a functional, interactive security system that operates 24/7.

Scope

The scope of the Raspberry Pi security camera with Telegram bot integration encompasses the design, implementation, and testing of a smart surveillance system using affordable and easily accessible hardware and software components. The system is intended to provide real-time monitoring, detect motion, capture images or videos, and notify users via Telegram, making it highly customizable for different environments, such as homes, offices, or temporary locations.

Key aspects of the project scope include:

1. Hardware Setup: The project will use a Raspberry Pi (3 or 4) as the central processing unit, paired with a camera module or USB webcam for image and video capture. An optional PIR motion sensor can be used for detecting movement based on infrared signals. The system will require standard components like a power supply and internet connectivity (Wi-Fi or

   Ethernet) for communication with the Telegram bot.

2. Software and Libraries: The system will be built on Raspberry Pi OS, with Python as the primary programming language. Key libraries include PiCamera for controlling the camera module, OpenCV for motion detection through computer vision, and the Python Telegram bot API for sending alerts and receiving user commands. The software will integrate these components seamlessly to provide an interactive and automated experience.

3. Core Functionality: The main functionality includes motion detection (either through the camera using OpenCV or through the PIR sensor), capturing images or videos when movement is detected, and sending these files to the user via Telegram. Users will be able to control the system remotely through commands like /start to begin monitoring,

/stop to end surveillance, and /status for updates on system health or captured events.

4. Automation and Continuous Monitoring: The system will be designed to run continuously, operating 24/7. Automation will be set up so the program starts automatically when the Raspberry Pi boots up, ensuring that the security camera is always active without manual intervention.

5. Remote Notifications and Control: All notifications will be sent in real-time through Telegram, providing immediate alerts when motion is detected. Users will also have the ability to control the system remotely, making it convenient to monitor a space from any location.

6. Customization Options: The project scope includes the potential for expansion and customization. Optional features such as saving images and videos locally or to cloud storage, configuring multiple cameras for larger surveillance coverage, and setting up additional notifications via email can be explored. The motion detection sensitivity and area of focus can also be adjusted to suit different environments.

7. Security Measures: The system will be designed with security in mind, ensuring that only authorized users can access the Telegram bot by managing permissions and safeguarding the bot token. This will prevent unauthorized individuals from receiving alerts or controlling the system.

8. Testing and Deployment: Thorough testing will be conducted to ensure the system reliably detects motion, captures footage, and sends notifications as expected. Once complete, the system can be deployed for real-world use, ensuring that it meets the requirements for security and monitoring.

Critical Evaluation:

The Raspberry Pi security camera project with Telegram bot integration represents a cost-effective and innovative solution for monitoring and enhancing security in homes and small businesses. Its primary strengths include affordability, allowing users to set up a surveillance system without significant financial investment, and customization, enabling users to tailor features to their specific needs. Real-time notifications sent via Telegram provide immediate alerts to users, enhancing their ability to respond quickly to potential security threats. Furthermore, the open-source nature of the project encourages community support and continuous improvement, making it a popular choice among tech enthusiasts. However, the project also has weaknesses, including its technical complexity, which may pose challenges for non-technical users, and limited functionality compared to commercial systems that offer advanced features such as cloud storage and sophisticated motion detection algorithms. Additionally, the system's reliance on a stable internet connection and constant power supply may restrict its deployment in certain areas. Opportunities for growth exist, such as the potential for integration with smart home technologies and the addition of features like data analytics and machine learning for improved monitoring. The project also serves as an educational tool, helping individuals learn about electronics and programming. Nevertheless, it faces threats from security

vulnerabilities, regulatory compliance issues surrounding surveillance, and competition from commercial products with more comprehensive features. Lastly, hardware limitations in performance and reliability can impact the overall effectiveness of the system. Addressing these challenges will be crucial for enhancing the project and increasing its adoption among users seeking reliable surveillance solutions.

Significance:

- Accessibility and Affordability: This project democratizes access to security technology by utilizing inexpensive hardware components and open-source software. It allows individuals and small businesses to implement surveillance systems that would otherwise be cost-prohibitive, contributing to greater safety and peace of mind in various environments.

- Educational Value: The project serves as an excellent educational tool for students and hobbyists interested in electronics, programming, and the Internet of Things (IoT). By engaging in this project, individuals gain practical skills in coding, hardware setup, and system integration, fostering interest in STEM fields and enhancing their technical proficiency.

- Customization and Flexibility: Users can tailor the system to meet their specific needs, whether for home security, office monitoring, or temporary surveillance. This level of customization is often lacking in commercial solutions, allowing users to design a system that best fits their requirements.

- Real-Time Monitoring and Alerts: The integration with Telegram enables users to receive instant notifications and view footage remotely. This feature enhances the overall effectiveness of the security system, allowing for timely responses to potential threats, which is critical in today's fast-paced environment.

- Encouragement of DIY Culture: The project promotes a do-it-yourself (DIY) approach, encouraging individuals to take control of their security needs. This empowerment fosters innovation and creativity, as users can modify and expand the system based on their evolving needs.

- Community Engagement: The open- source nature of the project fosters community collaboration and support. Users can share experiences, improvements, and troubleshooting tips, creating a vibrant ecosystem that enhances the project's functionality and reliability.

- Integration Potential: The system can be integrated with other smart home devices, creating a comprehensive security solution that enhances home automation. This interconnectedness aligns with current trends in smart living, where devices communicate and work together to improve user experience.

- Environmental Impact: By utilizing a Raspberry Pi, which consumes less power than traditional surveillance systems, this project contributes to more sustainable technology solutions. It reduces energy consumption while providing essential security services.

4. REFERENCES

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