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Automatic Camera and Infrared Movement Detection and Email Alert System

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Abstract: ***In order to improve security and monitoring capabilities, this project demonstrates the creation of an automated motion detection and alarm system utilising a Raspberry Pi, camera, and infrared (IR) sensors. In order to detect movement, the system uses infrared (IR) sensors that are attached to the Raspberry Pi. The camera then takes pictures of the action that is observed. Users are notified instantly upon detection, as an email notice is created that includes the taken image. With real-time monitoring and the ability to notify users of any unexpected behaviour, this system provides a productive and economical means of keeping an eye on particular regions. In both residential and commercial settings, the combination of visual data and immediate warnings improves situational awareness and supports preventative security actions.***

Keywords: Motion detection, Raspberry Pi, Infrared sensors, Camera surveillance, Email alert, Intrusion detection, Security system, Real-time monitoring, Image processing, IoT-based security.

I. INTRODUCTION

Security and surveillance have become essential concerns in both residential and commercial environments, necessitating the development of efficient and reliable intrusion detection systems. Traditional motion detection systems primarily rely on either infrared (IR) sensors or image-based techniques. While IR sensors effectively detect movement based on heat signatures, they lack the ability to provide visual verification. Conversely, image-based systems offer detailed monitoring but may struggle in low-light conditions. The lack of integration between these approaches often results in false alarms, reduced reliability, and delayed response times, limiting their effectiveness in real-time security applications.

To address these limitations, this project proposes an automated motion detection and alert system using a Raspberry Pi, infrared sensors, and a camera. The system integrates both sensor-based and image-based techniques to improve detection accuracy and ensure real-time alerts. Upon detecting motion, the camera captures an image of the detected activity, which is then sent via email notification to the user. This enhances situational awareness, enabling immediate action in response to potential threats.

The proposed system offers a cost-effective and efficient solution for real-time intrusion detection. By leveraging the advantages of both IR sensors and image-based surveillance, it minimizes false alarms and improves the reliability of motion detection. Additionally, the integration of email alerts ensures that users receive timely notifications with visual proof, enhancing security management. This system can be widely implemented in homes, offices, and restricted areas where enhanced monitoring is required.

II. EXISTING SYSTEM

Current intrusion detection systems primarily rely on either infrared (IR) sensors or image-based techniques, each with its own limitations. IR sensor-based systems use passive infrared (PIR) technology to detect motion by sensing heat signatures, making them effective in low-light conditions. However, they lack the ability to provide visual confirmation, leading to potential false alarms. On the other hand, image-based systems utilize cameras to capture visual data for monitoring and identification of intruders. While these systems offer detailed surveillance, they often struggle in low-light environments and require constant video processing, which can be resource-intensive.

Additionally, most existing systems operate in isolation, meaning they either rely solely on IR sensors or cameras without an integrated approach. This separation reduces their effectiveness in providing comprehensive security and real-time alerts, often leading to delayed responses, privacy concerns, and unreliable intrusion detection.

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III. PROPOSED SYSTEM

The proposed system integrates both infrared (IR) sensors and image-based techniques using a Raspberry Pi to create a more reliable and efficient intrusion detection system. By combining the strengths of both technologies, the system ensures accurate motion detection through IR sensors while simultaneously capturing real-time images with a camera for visual verification. This approach minimizes false alarms and enhances security by providing both motion-based detection and image-based identification.

Upon detecting movement, the IR sensors trigger the camera to capture an image of the detected activity. The system then sends an instant email alert to the user, including the captured image, ensuring real-time notification. This feature enhances situational awareness and allows immediate response to potential threats. Additionally, the system incorporates an LCD display to provide status updates, such as "Motion Detected" or "System Armed," and a buzzer for audible alerts, further improving security measures.

By leveraging Raspberry Pi as the central processing unit, the system offers a cost-effective and scalable solution suitable for residential and commercial applications. The integration of visual data with instant notifications ensures proactive security management, making the system more efficient than existing standalone IR sensor or image-based solutions.

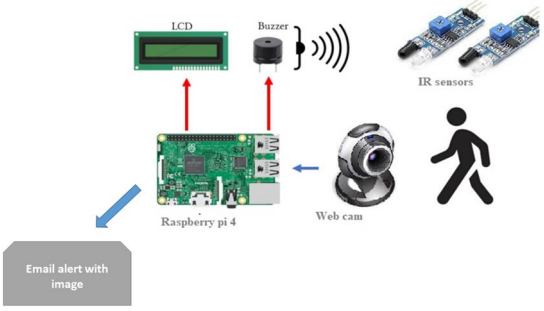


Fig.1. General Block diagram

IV. COMPONENTS USED AND DESCRIPTION

A. Arduino UNO

The newest model in the well-liked Raspberry Pi computer line is the Raspberry Pi 4 Model B. In comparison to the previous generation Raspberry Pi 3 Model B+, it delivers revolutionary improvements in CPU speed, multimedia performance, memory, and connection while maintaining backward compatibility and comparable power consumption. The Raspberry Pi 4 Model B offers end users desktop performance on par with entry-level x86 PCs. High-performance 64-bit quad-core processor, dual-display support at up to 4K resolutions via two micro-HDMI ports, hardware video decoding at up to 4Kp60, 4GB of RAM, dual-band 2. 4/5. 0 GHz wireless LAN, Bluetooth 5. 0, Gigabit Ethernet, USB 3. 0, and PoE capability (through an additional PoE HAT add-on) are some of this product's main features. Due to their modular compliance certification, Bluetooth and dual-band wireless LANs may be integrated into final devices with much less compliance testing, which lowers costs and speeds up time to market. Operating temperature: ambient between 0 and 50 degrees Celsius.

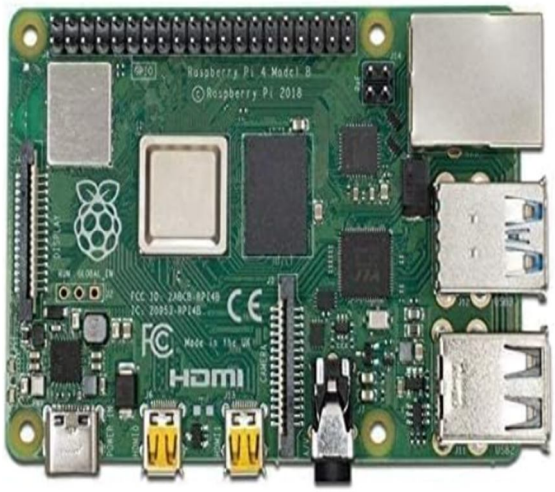


Fig.2. Arduino UNO

B. Power Supply

Either an external power source or a USB cable can be used to power the Arduino Uno. An AC to DC converter is the most common external power source; batteries are sometimes used. The adapter can be connected to the Arduino Uno by plugging into the power jack of the Arduino board. The Vin and GND pins of the POWER connector can also be used to connect the battery leads. Seven to twelve volts is the recommended voltage range.

C. LCD Display

Designed for a variety of electronic applications, the Robocraze 0802 LCD Module is an 8x2 character display module. For easy visibility, it has a blue backlight and a 5x7 dot matrix. With a 14-pin double-row parallel interface and the SPLC780D controller as its power source, it provides effective data management. The module is adaptable to a variety of applications since it can run on either 3.3V or 5V. In addition to offering helpful display commands like cursor control, display shifting, and clearing, it enables custom character storage via CGRAM. It is perfect for educational, hobbyist, and professional usage in equipment like copiers and printers because of its small size (58 x 32 mm) and viewing surface (38 x 16 mm).

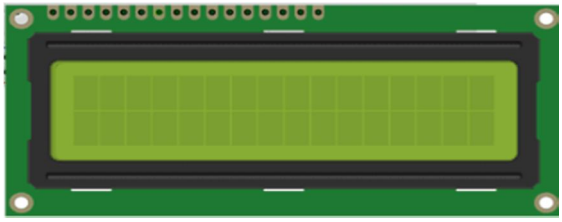


Fig.3. LCD Display

D. IR Sensors

Anyone interested in robotics, automation, or electronics will find this project useful: connecting an Arduino to an infrared sensor module. Infrared (IR) sensors are widely employed in communication systems, object detection, and distance measurement. The goal of this project is to use an infrared sensor module to identify barriers and react appropriately. This tutorial will teach you how to connect an Arduino to an infrared sensor, comprehend how it operates, and use the information for useful purposes. This An electrical gadget that analyses and picks up infrared radiation in its surroundings is called an infrared (IR) sensor. Infrared light reflection is the basis for the operation of the IR sensor module. The IR sensor emits infrared light, which strikes an item when it approaches it and bounces back towards the sensor. The distance, shape, and surface properties of the item all affect the kind and strength of the reflection.

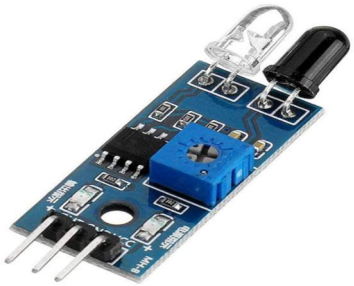


Fig.4. IR Sensor

E. Buzzer

A buzzer is used to provide audio feedback for system notifications. It sounds an alert when an order is placed, a payment is completed, or when a customer presses the waiter call button. This feature ensures staff members are immediately notified, reducing response time and enhancing service quality.



Fig.5. Buzzer

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F. Web Cam

This video explains in detail how to use a basic website and the free SensorMonkey service to remotely operate a pan and tilt camera that is connected to an Arduino. Any PC, smartphone, or tablet with a suitable web browser may see the webpage. I offer interactive pan and tilt controls using the jQuery UI framework, and I utilise Justin.tv to give the webcam's live streaming audio and video output. Ethernet shielding and server-side coding are not necessary.



Fig.6. Web cam

V. WORKING

The proposed system operates based on the following step-by-step process:

1) *Motion Detection Using IR Sensors:* The system continuously monitors its surroundings using infrared (IR) sensors. These sensors detect motion by sensing changes in infrared radiation, which occur when a person or object moves within the sensor's range. If no movement is detected, the system remains in an idle state.
2) *Triggering the Camera Upon Detection:* When motion is detected by the IR sensors, a signal is sent to the Raspberry Pi, which then activates the connected webcam. The camera captures an image of the detected movement to provide visual confirmation of the intrusion or activity.
3) *Generating an Email Alert:* After capturing the image, the Raspberry Pi processes the data and sends an email notification to the registered user. The email includes the captured image as an attachment, allowing the user to verify the detected movement in real-time.
4) *Displaying Status on LCD Screen:* The LCD screen provides real-time feedback about the system's status. It displays messages such as "System Armed" when the system is active and "Motion Detected" when an intrusion is identified. This allows users to understand the system's current operation at a glance.
5) *Activating the Buzzer Alert:* Along with sending an email notification, the system also triggers a buzzer to produce an audible alarm. This immediate alert helps in deterring intruders and notifying people nearby about unauthorized movement.
6) *System Reset and Continuous Monitoring:* After sending the alert and activating the buzzer, the system resets itself to continue monitoring for further movement. This ensures continuous security surveillance without manual intervention.

VI. RESULTS

The implemented motion detection and alert system successfully detects movement using infrared (IR) sensors and captures real-time images through a connected camera. Upon detecting motion, the system triggers an email notification containing the captured image, ensuring that users receive instant alerts. Additionally, the LCD display provides real-time status updates, such as "Motion Detected," while the buzzer generates an audible alert to deter potential intruders. The system operates efficiently in different lighting conditions, demonstrating its reliability in both residential and commercial security applications.

Through testing, the system exhibited high accuracy in detecting motion and sending timely notifications. The integration of IR sensors and image-based detection significantly reduced false alarms compared to standalone infrared or camera-based systems. The combination of real-time monitoring, instant alerts, and visual confirmation enhances security, making the system a cost-effective and efficient solution for intrusion detection and surveillance.

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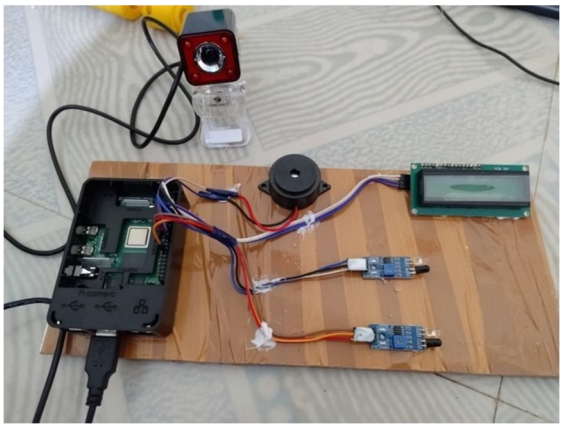


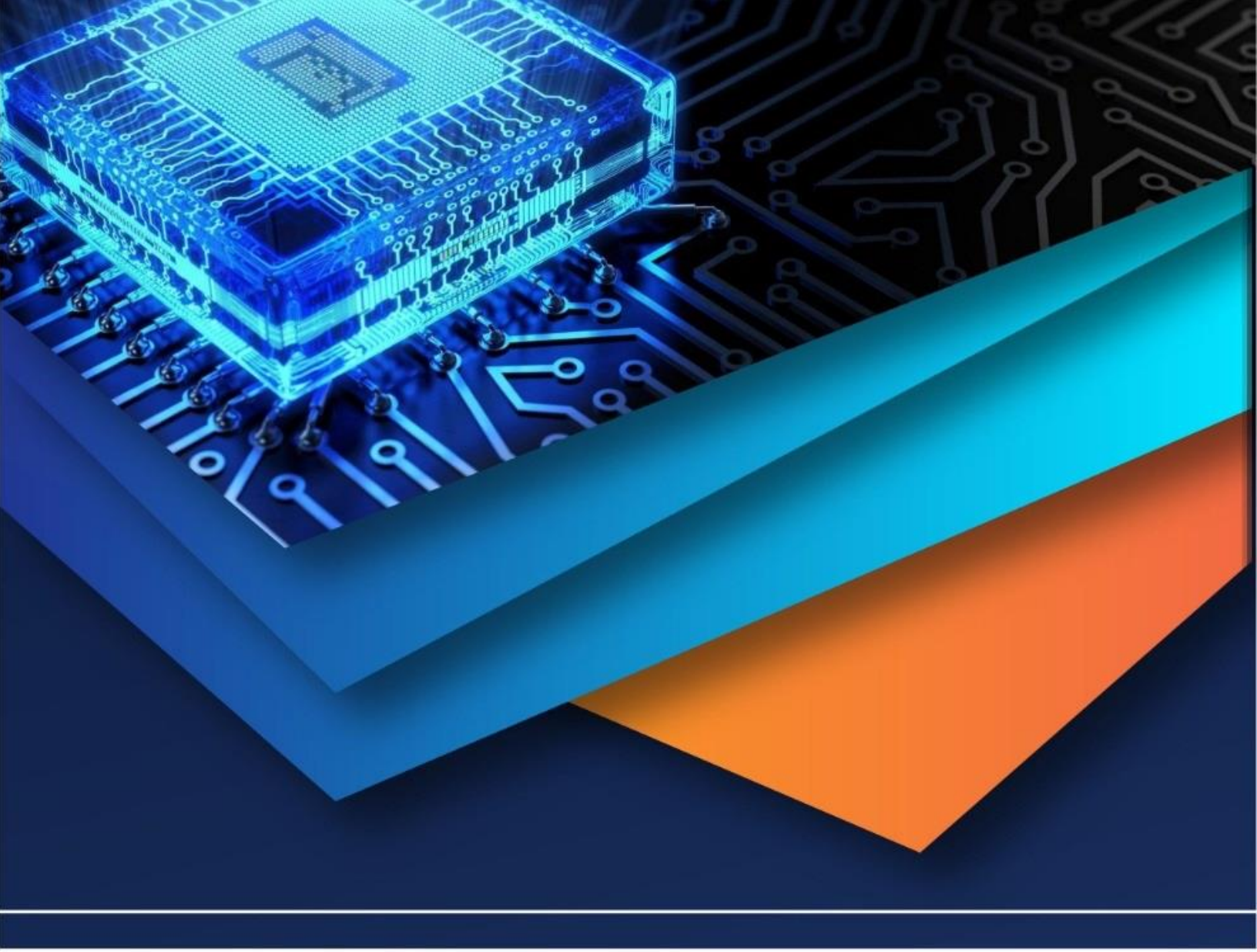
Fig.7. architecture

VII. CONCLUSION

The proposed automated motion detection and alert system effectively integrates infrared sensors and image-based techniques to enhance security monitoring. By utilizing a Raspberry Pi, the system reliably detects movement, captures real-time images, and sends instant email notifications, ensuring users are promptly informed of any suspicious activity. The inclusion of an LCD display and buzzer further improves situational awareness. Compared to traditional systems, this approach reduces false alarms and enhances reliability, making it a cost-effective and efficient solution for both residential and commercial security applications.

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