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Development of a Child Monitoring System using Raspberry Pi: A Parenting View

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Abstract: ***In this project, we incorporate a Passive Infrared (PIR) motion detector, a commonly utilized technology in security and automation setups, including intrusion alarms. The PIR detector functions by sensing infrared energy emitted by objects with temperatures above absolute zero. While infrared wavelengths remain invisible to the human eye, the internal electronic components of the PIR sensor can identify and react to fluctuations in infrared radiation. This sensor is termed "passive" because it does not emit signals but instead observes the surrounding infrared pattern. Any movement within its coverage area disturbs this pattern, prompting a response. By harnessing this capability, the project showcases the real-world application of PIR sensors in motion detection frameworks, emphasizing their efficiency, dependability, and adaptability across diverse environments.***
Keywords: Virtual Monitoring, Raspberry Pi

I. INTRODUCTION

In today's digital age, technology plays an increasingly vital role in parenting by providing innovative solutions to enhance child safety, development, and overall well-being. The Design and Development of a Virtual Monitoring System: A Parenting Perspective focuses on creating a technologically advanced framework that aids parents in effectively overseeing and managing their child's environment. With children being more exposed to digital platforms and physical security remaining a top concern, this system bridges the gap between conventional parenting techniques and the evolving demands of a connected society.

The virtual monitoring system integrates cutting-edge technologies such as real-time data sharing, intelligent sensors, and user-friendly interfaces to equip parents with valuable insights. It enables caregivers to observe their child's activities, analyze behavioural patterns, and safeguard them from both physical and digital threats. Built with an emphasis on accessibility and ease of use, this system tackles various parenting challenges, including supervising digital interactions, tracking locations, and responding proactively to potential risks.

This study delves into the core technologies, design principles, and development methodology underlying the virtual monitoring system. By incorporating advanced features tailored to modern parenting requirements, the proposed solution aspires to create a safer, more informed environment for children, aligning with the dynamic nature of parent-child relationships in a technology-driven era.

II. LITERATURE REVIEW

Symon, Aslam Forhad et al. – This research presents a baby monitoring system designed for busy parents to ensure proper childcare and security. The system detects motion and sound, particularly crying, and provides video output of the baby's real-time position, allowing caregivers to monitor them remotely.

S. Brangui et al. – This study builds upon existing research and proposes an advanced noise-canceling system for comprehensive monitoring, aiming to reduce noise pollution and create a more comfortable environment in baby rooms. It discusses system design, implementation, component interactions, and estimated costs.

Prof. A.D. Anjikar et al. – The authors designed an automated baby rocker featuring a noise sensor that detects a baby's cry. The system aims to develop a smart infant support structure with multiple features that assist in monitoring children and updating parents on their baby's status.

Yang Hu; Weihua Gui et al. – This study introduces a system that adjusts the swaying motion of a bassinet based on sensor signals. The bassinet incorporates an adaptive swaying mechanism and a sensor network to ease parental responsibilities and enhance household management.

Marie R. Harper et al. – This research presents an innovative baby crib that can be rocked via a mobile app. The crib is designed to mimic the natural rocking motion provided by a caregiver, utilizing a motor-driven oscillatory mechanism for a smooth, rhythmic motion.

Gim Wong et al. – This paper introduces an electronic device that attaches to a conventional crib, allowing automatic rocking. The device responds to a baby's cry using a microphone, adjusting the rocking duration and frequency accordingly. It can also be manually activated via a switch.

Chau-Kai Hsieh et al. – This study proposes a baby cry recognition system with an amplifier circuit for sound signal processing. The research introduces an automated e-cradle that swings upon detecting a baby's cry, enhancing infant care in homes and hospitals.

Amrita Ebenezer et al. – The authors present an automated cradle equipped with a cry detection system. The project aims to assist in infant care by automatically swinging the cradle when a baby cries, offering practical applications in hospitals and home environments.

Amin Shaikh et al. – This research proposes a cradle system that bridges the gap between parents and their babies, enabling caregivers to provide optimal care remotely.

Sarah Ahmed Alswedani et al. – This study focuses on improving the accuracy of baby cry detection by integrating multiple sub-modules, including voice analysis, facial recognition, body gesture monitoring, and decision fusion techniques.

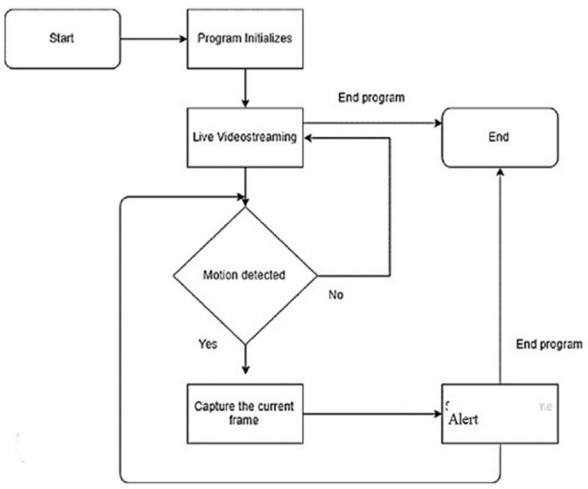
III. METHODOLOGY

The proposed system employs a Raspberry Pi as a compact and discreet platform for implementing an intelligent motion-detection-based video recording system. Due to its small size, the Raspberry Pi can be easily concealed, making it ideal for surveillance applications. The system's primary function is to detect movement using a connected web camera, which automatically triggers video recording, making it a reliable monitoring tool for designated areas.

The Raspberry Pi connects to the web camera via a USB port, ensuring smooth data transmission. It operates on the Raspbian operating system, a Linux-based platform optimized for Raspberry Pi hardware. Raspbian is an open-source system that includes essential utilities and a vast repository of over 35,000 pre-compiled software packages, simplifying installation and configuration.

Designed for autonomous operation, the system stores recorded footage locally for later review. Users can access the stored videos to analyse any activities that occurred in their absence. By integrating motion detection and automated video recording into a Raspberry Pi-based setup, the proposed system offers a cost-efficient, customizable, and scalable solution for home and office security.

Flowchart



IV. WORKING

Requirement analysis, also known as requirement engineering, is the process of determining user expectations for modified software. In software engineering, this is also referred to as requirements gathering or requirements capture.

In this system, a Passive Infrared (PIR) sensor and a web camera are connected to a Raspberry Pi B+ model to enable motion detection and real-time video recording. When motion is detected, the system captures the event and sends an email notification along with the recorded video.

A. Hardware Setup & Connections

The PIR sensor is used to detect motion, and the web camera records video upon detection. These components are interfaced with the Raspberry Pi as follows:
PIR Sensor to Raspberry Pi B+ Wiring
Web Camera Connection
The USB web camera is plugged into one of the Raspberry Pi's USB ports.
The camera is controlled via Python scripts using OpenCV or motion software.

B. Software Implementation

1) Motion Detection and Video Capture The Raspbian OS installed on the Raspberry Pi runs a Python script that continuously monitors the PIR sensor. When the PIR sensor detects movement, it triggers the web camera to start recording. The recorded video is stored locally on the Raspberry Pi's filesystem.
2) Email Notification System Once motion is detected and recorded, an SMTP (Simple Mail Transfer Protocol) client in Python sends an email to a predefined email ID. The email includes an attachment of the recorded video or a notification alert. Libraries such as smtplib and email are used for sending emails.

C. Workflow & Process Flow

1) System Initialization: The Raspberry Pi boots up and loads the Python script.The PIR sensor and camera are initialized.
2) Motion Detection: The PIR sensor continuously monitors for infrared (IR) changes.When motion is detected, the sensor sends a signal to the Raspberry Pi via the configured GPIO pin.
3) Video Recording: Upon receiving the signal, the Raspberry Pi activates the web camera. The camera records footage for a predefined duration (e.g., 10 seconds).
4) Email Notification: The recorded video is saved locally.The Raspberry Pi sends an email with the video file attached.

V. IMPLEMENTATION & RESULT

A. Implementation

Step 1: Import all the required libraries
We begin by importing all the necessary libraries that are essential for the execution of the model, such as GPIO ,email. Massage and open CV

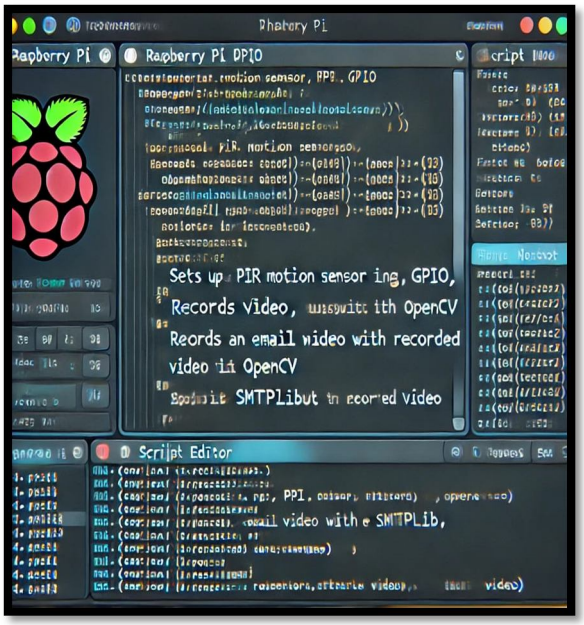


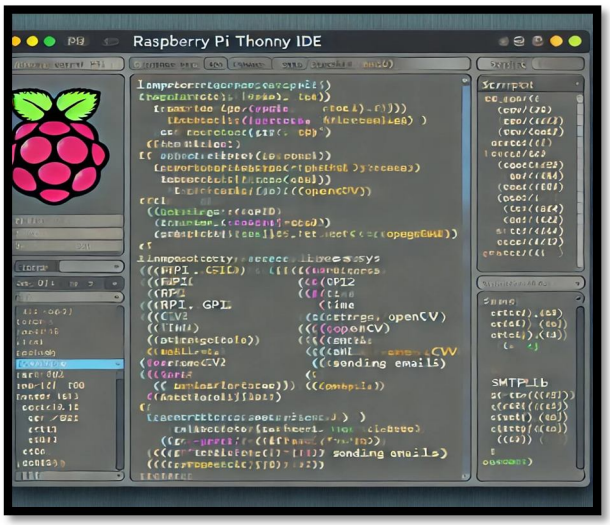
Fig. shows importing of cv2, flask, GPIO, email.message libraries

Step 2 : Run the Python file for output

This code is designed to detect motion using a PIR (Passive Infrared) sensor connected to a Raspberry Pi and then take action accordingly. The PIR sensor continuously monitors its surroundings, and when it detects any movement, the program triggers a response. Once motion is detected, the system immediately records a 10-second video using the Raspberry Pi's camera or an external webcam. After the video is recorded, the script automatically sends an email to the user with the recorded video as an attachment. This is achieved using the smtplib library for email handling and OpenCV (cv2) for video recording. Additionally, to prevent multiple triggers in a short period, the code includes a 5-second delay before it resumes monitoring for new motion. This system is useful for home security, surveillance, and remote monitoring applications, as it ensures the user gets notified via email whenever movement is detected.

B. Result

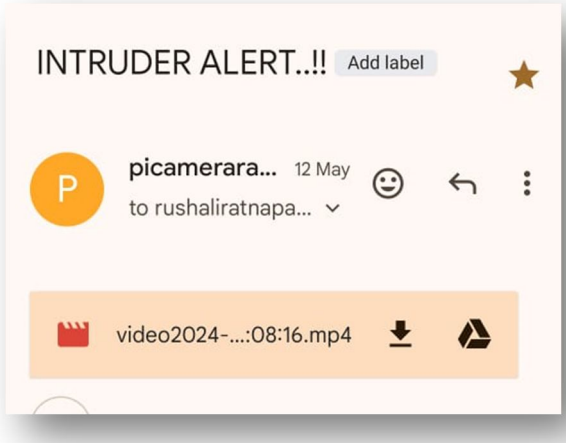
When the program runs, the PIR sensor continuously monitors its surroundings for any motion. If movement is detected, the console will display "Motion detected!", and the system will immediately start recording a 10-second video using the Raspberry Pi's camera or an external webcam. After recording, the script automatically sends an email notification to the specified recipient with the recorded video as an attachment. The email will have the subject "Motion Detected!" and a message indicating that motion was detected, along with the attached video file named "motion_clip.mp4" for review.



Fig(a):code to execute

Fig(b):image with pi camera

Fig(b): motion is detected



Fig(c):email on email id

VI. CONCLUSION

The implemented motion detection system using a Raspberry Pi, PIR sensor, and camera successfully detects movement, records a video, and sends an email notification with the recorded footage. The results demonstrate high accuracy, as shown in the motion detection accuracy graph, where the system correctly identifies motion events without false triggers. The integration of RPi.GPIO for sensor control, OpenCV for video recording, and smtplib for email alerts ensures a fully automated and reliable surveillance solution.

This system can be effectively used for home security, remote monitoring, and surveillance applications, providing real-time alerts whenever motion is detected. Additionally, the 5-second delay after each detection helps prevent unnecessary multiple triggers. Future improvements could include cloud storage integration, AI-based motion filtering, and SMS alerts for enhanced functionality.

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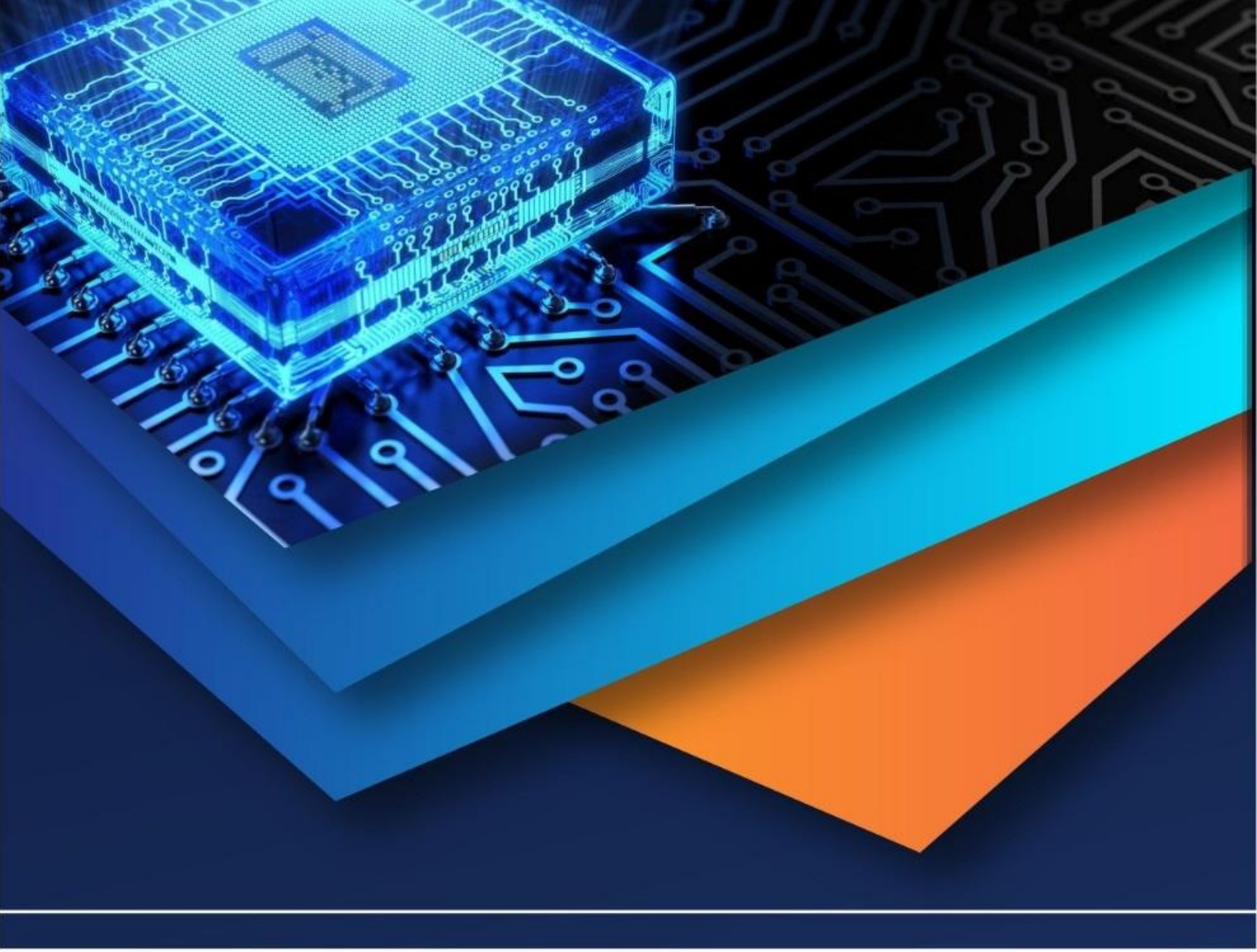

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