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AI - Powered Pedestrian Safety Surveillance Camera

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Abstract: This paper presents an innovative AI-powered surveillance camera system designed to enhance pedestrian safety in urban environments. The system utilizes efficient algorithm to monitor pedestrian behavior, detect potential hazards, and assess the environmental risks. By leveraging real-time data analytics, the system can identify suspicious activities or accidents and trigger automated alerts. It also supports a rapid response, the system incorporates contextual audio-visual monitoring, allowing it to capture and transmit relevant evidence when critical events are detected. These insights are securely and discreetly communicated to nearby enforcement units, enabling timely and informed intervention. This system serves as a vital asset in modern urban safety infrastructure, enhancing situational awareness and aiming to reduce response times and improve public security outcomes.

Keywords: Hazard detection, Real-time data analytics, AI-powered surveillance, Emergency response

I. INTRODUCTION

In the context of rapidly expanding urban environments, ensuring pedestrian safety has become an increasingly complex and challenge. The confluence of high population density, growing vehicular congestion, and the dynamic nature of modern infrastructure has led to a notable rise in pedestrian-related incidents continue to witness a disproportionate number of safety breaches. Despite investments in physical infrastructure and the deployment of conventional surveillance systems, these solutions largely operate passively and depend heavily on human monitoring, which is often inefficient and prone to delay.

A primary concern with existing surveillance and safety systems is their inability to intelligently interpret and respond to dynamic human behavior and environmental variables. Incidents such as jaywalking, erratic driver movement, unlawful encroachments, and sudden crowding events require immediate detection and assessment something beyond the scope of static, non-analytical systems. Furthermore, unpredictable urban scenarios, including poor lighting, weather conditions, and background noise, complicate incident detection, often resulting in missed threats or an overwhelming number of false positives. Compounding these issues is the lack of seamless, context-aware communication between surveillance units and response teams, which delays intervention and hinders the collection of critical situational evidence.

To overcome these persistent challenges, this paper introduces a robust AI-powered surveillance camera system specifically designed to enhance pedestrian safety through the integration of advanced computer vision and real-time analytics. The proposed system continuously monitors pedestrian environments, intelligently detects hazardous patterns or suspicious behavior, and autonomously triggers alert protocols. A key innovation lies in its contextual audio-visual capability, which enables it to not only capture but also securely transmit high-relevance data including live video and ambient audio to nearby enforcement units when a critical event is identified. This ensures a more informed and immediate response, effectively bridging the gap between incident detection and actionable enforcement, all while maintaining discretion and data integrity.

II. LITERATURE SURVEY

AI Based Smart Surveillance System: This study, conducted by Rasadurai Kumaravel et al, presents a foundational approach to AI-based smart surveillance systems aimed at enhancing urban pedestrian safety. The proposed system is characterized by its ability to autonomously respond to environmental stimuli, having been trained across multiple

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operational scenarios. This adaptability allows it to function effectively in real-time, without the need for continuous human oversight. This paper outlines a generalized framework for such intelligent surveillance systems, detailing their operational structure and core functionalities.

The paper emphasizes key AI processing stages including [1] object detection, multi-object tracking, classification, and behavioural analysis. These components are integral to identifying unusual or potentially dangerous activities in pedestrian zones. By utilizing deep learning and computer vision techniques, the system is capable of discerning complex behavioural patterns that may signal a security risk.

A review on the use of top-view surveillance videos for pedestrian detection, tracking and behavior recognition across public spaces: In their study, Hongliu Li and Jacqueline Tsz Yin Lo provide a critical overview of recent developments in surveillance technologies, with a particular emphasis on the use of top-view video analytics for pedestrian safety in public spaces. The paper investigates how top-view camera systems often deployed in transport hubs and large public buildings serve as a foundational layer for AI-powered pedestrian detection, tracking, and behavior analysis. The authors systematically examine the strengths of top-view surveillance, noting its ability to minimize visual obstructions and enhance the accuracy of pedestrian monitoring. Such perspectives are especially effective when integrated with AI algorithms for real-time scene interpretation. Their review highlights how computer vision techniques, trained on top-view datasets [2], contribute significantly to identifying abnormal behaviours, tracking movement patterns, and predicting potential hazards within crowded environments. Furthermore, the study explores the architecture and deployment of top-view surveillance systems, detailing how camera placement and environmental factors influence detection performance. It also presents a comparative analysis of several benchmark datasets designed specifically for top-view pedestrian analytics, offering insight into their utility for training deep learning models used in AI-driven surveillance.

Novel Automatic Video Surveillance System for Pedestrian Crossing Using Machine Learning: In the paper B.S.H. Prasad, K. Swathi, and K.V.N. Vijay proposes an intelligent surveillance framework designed to enhance pedestrian safety at road crossings using machine learning techniques. The study emphasizes the growing need for adaptive surveillance systems, especially in environments where conventional traffic control mechanisms fall short, such as unsignalized crosswalks or areas with high pedestrian density. The authors develop a video-based system capable of real-time pedestrian and vehicle detection, utilizing machine learning models to monitor crowd movement and vehicular patterns. A key aspect of their approach involves identifying pedestrian presence and dynamically analyzing traffic conditions to ensure safe crossing opportunities. The system is particularly geared towards to reducing time and improving situational awareness through automated alerts. By leveraging computer vision for motion tracking and object detection, [3] the proposed method contributes to the broader field of AI-based urban safety technologies. The paper concludes that such automated systems can significantly reduce pedestrian-related incidents and offers a scalable foundation for future smart traffic infrastructure.

A Literature Review of AI-Powered Systems for Monitoring Suspicious and Anomalous Activities: This paper by Hamsa D R, Harsha N, A S Vinay Raj, examines the deployment of AI-powered surveillance systems within educational environments, with a specific focus on their capacity to monitor suspicious and anomalous activities. The reviewed studies highlight how advancements in machine learning, artificial intelligence, and [4] data analytics have enabled the development of intelligent monitoring systems capable of real-time behavioural assessment. The existing body of work explores various technologies and methodological approaches that underpin these systems, such as anomaly detection algorithms, behavioural modelling, and automated pattern recognition. These systems are designed to identify irregular behaviours within student populations, contributing to the early detection of potential security threats in academic settings.

Integrating Artificial Intelligence with Camera Systems for Automated Surveillance and Analysis: In the paper authored by Abhishek Patil, Diya Raut, Roshani Prasad, and Charudatta Shimpi, the integration of Artificial Intelligence (AI) with camera-based surveillance systems is explored as a means to improve monitoring efficiency and accuracy. The study emphasizes AI to increase the capability and efficiency of the surveillance system. The authors discuss how traditional cameras, commonly used for security and surveillance, can be significantly enhanced when coupled with AI and programming languages such as Python. [5] This integration enables automated data processing and intelligent monitoring without the need for continuous human supervision. The system is capable of covering multiple locations and individuals simultaneously, thereby improving the precision and reliability of surveillance. The literature further highlights that such AI-driven systems are particularly effective in scenarios where human monitoring becomes impractical due to scale or complexity. By leveraging machine learning algorithms and real-time analytics, the system ensures high levels of accuracy and responsiveness, making it well-suited for modern surveillance applications.

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A Survey on AI Based Smart CCTV Surveillance System: In their study, Saranya E., Vanitha A., et al., present a comprehensive overview of Smart CCTV systems for home use, focusing on their role in enhancing residential security through the integration of advanced technologies. The authors emphasize the evolution of conventional surveillance into intelligent systems that utilize high-resolution cameras, motion detection, and object recognition to provide real-time monitoring and automated threat identification. The literature highlights how these [6] smart surveillance systems are seamlessly connected to mobile applications, enabling homeowners to remotely monitor their property with ease and immediacy. The system is designed to deliver instant alerts upon detecting suspicious or abnormal activities, allowing users to respond promptly to potential security threats. This automation reduces reliance on manual observation and enhances situational awareness for homeowners. Furthermore, the study underscores the dual benefits of safety and convenience, positioning Smart CCTV as a critical element in modern home protection. The system not only strengthens physical security but also provides users with a sense of peace of mind, thereby redefining the standards of residential surveillance.

On using AI-Based Human Identification in Improving Surveillance System Efficiency: In the journal conducted by Eman Alajrami, Hani Tabash, et al., an AI-based desktop surveillance application is proposed to address the limitations of conventional continuous or motion-triggered CCTV systems. Traditional surveillance setups often require extensive storage capacity and substantial time for manual review due to prolonged and unfiltered recording. To overcome these inefficiencies, the authors developed a smart recording system that activates only when a human body or face is detected.

The system [8] leverages deep learning algorithms, OpenCV libraries, and is deployed on a Linux-based environment. It features two primary detection modes human body identification and facial recognition with adaptive algorithms triggered based on the selected mode. This selective recording mechanism optimizes storage usage and significantly reduces the time required for video retrieval and analysis. The proposed solution was evaluated through testing by various organizations utilizing surveillance systems, with data collected via structured questionnaires and interviews. Evaluation results demonstrated that the system effectively met user needs, showcasing its practicality and potential impact in improving surveillance efficiency and responsiveness.

AI enabled smart surveillance system: In their research, T. Keerthana et al. propose an intelligent security system that integrates facial recognition and object detection using Convolutional Neural Network (CNN) [10] algorithms to enhance door-level surveillance and access control. Unlike traditional video surveillance systems that rely solely on passive recording, the proposed model introduces active threat detection and remote proctoring capabilities for homeowners.

The system is designed to identify anomalous activity near entry points by detecting unfamiliar faces and objects. Upon detecting a person near the door, an ultrasonic sensor measures the distance, triggering facial recognition when the individual crosses a predefined threshold. If the captured face does not match the database, the system records the image and flags it as potentially suspicious. An electric door lock solenoid is used to manage physical access, while the system simultaneously notifies the registered user via SMS alerts and sends the captured image to their email. This enables the property owner to remotely verify and control access decisions in real-time. The authors highlight the efficiency and responsiveness of this AI-powered solution in reducing unauthorized access risks. By combining CNN-based detection with hardware components and communication protocols, the system presents a robust alternative to conventional locking and surveillance methods, emphasizing automation, accuracy, and user control.

III. PROBLEM IDENTIFICATION

- **Pedestrian Safety in Public and Private Areas:** The safety of pedestrians in both public and private spaces continues to be a significant concern for communities and city planners. Ensuring that pedestrians can navigate these areas without the risk of accidents is essential to improving overall public safety.

- **Absence of Proactive Detection and Response Systems:** Currently, there is a noticeable gap in the availability of systems that can proactively detect potential safety risks to pedestrians. Without real-time detection and immediate response capabilities, there is a delay in addressing issues that could potentially lead to accidents or injuries.

- **Demand for Automated Surveillance Solutions with Alerts:** To address these concerns, there is an increasing demand for automated surveillance systems that not only monitor public spaces but also provide real-time alerts. These systems can improve the efficiency of response times, reduce human error, and enhance overall safety by enabling quicker intervention when risks arise.

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IV. SUMMARY

This advanced surveillance system integrates high-performance hardware with intelligent automation to enable efficient real-time monitoring and evidence collection. A high-resolution CCTV camera is coupled with a microphone to capture synchronized visual and audio data. The microphone is programmed to detect specific distress-related keywords, which serve as triggers for automatic video recording. Upon detecting such keywords, the processor core that is managed by an Arduino Uno, immediately activates the camera to ensure the timely capture of critical events. Simultaneously, the system prepares the footage for transmission to a designated police station via email. This process is facilitated by a secure WiFi connection and a dedicated server, ensuring fast and reliable data delivery. The inclusion of GPS allows precise location tagging of the incident, improving the situational context for responders. Adafruit IO is used to provide real-time system updates and remote access through a web interface. Together, these elements enable the system to function autonomously, reducing the delay between threat detection and response initiation. This design greatly enhances situational awareness and improves emergency response coordination.

Complementing the real-time transmission is a robust data management strategy that leverages cloud storage for secure archival of video evidence. Once uploaded, the footage can be retained for review or deleted securely after confirmation to optimize storage efficiency. This ensures that only relevant and necessary data is preserved, while sensitive or redundant footage can be responsibly discarded. The system's modular design supports scalability, allowing it to be deployed across various settings without major reconfiguration. Its architecture supports seamless integration with law enforcement databases and communication networks.

Automation reduces manual oversight, lowering the chances of human error during critical moments. Additionally, the use of microcontrollers and embedded software makes the system cost-effective and energy efficient. With continuous monitoring and intelligent triggering, the system ensures that no crucial moment goes unrecorded. The combination of real-time detection, automated communication, and intelligent data management provides a comprehensive framework for modern surveillance. Overall, the system exemplifies a forward-thinking approach to public safety and digital monitoring infrastructure.

V. CONCLUSION AND FUTURE SCOPE

The integration of artificial intelligence into pedestrian surveillance systems marks a transformative shift in how urban safety is managed and maintained. By leveraging real-time data analytics, and behavioural pattern recognition, AI-powered surveillance cameras offer a proactive approach to monitoring pedestrian environments. These systems not only enhance situational awareness but also significantly reduce human dependency in identifying critical incidents or threats. Furthermore, the incorporation of contextual audio-visual data capture ensures that accurate and actionable information is securely relayed to appropriate response units, enabling faster intervention and potentially life-saving outcomes. As cities grow more complex and densely populated, such intelligent surveillance solutions are essential for creating safer public spaces. In conclusion, AI-powered pedestrian surveillance systems represent a vital advancement in public safety infrastructure, combining efficiency, precision, and reliability to support smarter, safer urban living.

AI-powered safety surveillance cameras future lies in the integration of advanced machine learning techniques for sound classification, enabling the system to accurately identify distress sounds such as gunshots, screams, and breaking glass. Complementing this, intelligent video analytics can detect suspicious behaviours or movement patterns, even in the absence of audio input, enhancing proactive threat detection. Incorporating night vision capabilities further extends operational effectiveness in low-light or night-time environments. Additionally, these systems are designed for scalability, making them well-suited for deployment in smart cities, where multiple surveillance units across diverse locations can be centrally monitored and managed for unified, city-wide security oversight.

REFERENCES

[1]. Rasadurai Kumaravel et al., "AI Based Smart Surveillance System'' published in: Researchgate, January 2023, Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 10 Issue 1, pp. 10-15. [1]

[2]. Hongliu Li and Jacqueline Tsz Yin Lo, "A review on the use of top-view surveillance videos for pedestrian detection, tracking and behavior recognition across public spaces" published in: ScienceDirect, March 2025, ISSN 0001-4575. [2]

[3]. B.S.H. Prasad, K. Swathi, and K.V.N. Vijay, "Novel Automatic Video Surveillance System for Pedestrian Crossing Using Machine Learning", published in: 4th International Conference on Communication & Information Processing (ICCIP)", December 2022. [3]

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[4]. Hamsa D R, Harsha N, A S Vinay Raj, "A Literature Review of AI-Powered Systems for Monitoring Suspicious and Anomalous Activities", published in: IJARSCT, February 2024, ISSN (Online) 2581-9429. [4]

[5]. Abhishek Patil, Diya Raut, Roshani Prasad, and Charudatta Shimpi, "Integrating Artificial Intelligence with Camera Systems for Automated Surveillance and Analysis", published in: IJIREM, April 2024, ISSN (Online): 2350-0557. [5]

[6]. Saranya E., Vanitha A., et al., "A Survey on AI Based Smart CCTV Surveillance System", published in: IEEE Xplore, March 2024, Electronic ISBN:979-8-3503-8436-9, ISBN:979-8-3503-8437-6. [6]

[7]. Arnold Dsouza, Aryan Fernandes, et al., "Artificial Intelligence Surveillance System", published in: IEEE *Xplore,* June 2022, Electronic ISBN:978-1-6654-6883-1, ISBN:978-1-6654-6884-8. [7]

[8]. Eman Alajrami, Hani Tabash, et al., "On using AI-Based Human Identification in Improving Surveillance System Efficiency", published in: IEEE *Xplore*, December 2019, Electronic ISBN:978-1-7281-2337-0, ISBN:978-1-7281-2338-7. [8]

[9]. Ghazi Alhwarin et al., "AI-Based Pedestrian Detection and Avoidance at Night Using Multiple Sensors", published in: MDPI, June 2024, journal no.10.3390/jsan13030034. [9]

[10]. T. Keerthana et al., "AI enabled smart surveillance system", published in: Researchgate, May 2021, DOI:10.1088/1742-6596/1916/1/012034. [10]

