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Theft Detection and Alert System with Facial Recognition

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ABSTRACT: Theft Detection and Alert System with Facial Recognition proposes an intelligent Closed-Circuit Television (CCTV) system designed to enhance theft detection and alert mechanisms. The system integrates advanced Facial Recognition technology to identify known individuals and also identify the theft by capturing the picture of a thief. These known individual images and thief images are uploaded into system by houseowner. By leveraging artificial intelligence and surveillance technology, the system provides real-time alerts to homeowners, including the name of the recognized individual. In the event of a match with a wanted person, immediate alerts are sent to the homeowner. This innovative solution aims to significantly improve the safety and security of residential communities by leveraging the power of AI-driven facial recognition technology.

I. INTRODUCTION

In recent years, the prevalence of theft and burglary incidents has become a significant concern for homeowners and residential communities alike. Traditional security measures, such as conventional Closed-Circuit Television (CCTV) systems, often fall short in providing effective theft detection and timely alerts. Advancements in artificial intelligence (AI) and computer vision technologies have paved the way for more sophisticated and intelligent security solutions. The Theft Detection and Alert System with Facial Recognition (TDAS-FR) is a cutting-edge security system that leverages the power of AI and facial recognition technology to enhance theft detection and alert mechanisms. By integrating advanced facial recognition algorithms, the system can identify known individuals, such as residents or authorized personnel, and simultaneously detect potential theft scenarios by capturing images of unrecognized individuals. The TDAS-FR system is designed to provide homeowners with real-time alerts, including the name of the recognized individual, if they are identified as a resident or authorized person. In the event of a match with a known or wanted individual, immediate alerts are sent to the homeowner, allowing for prompt action and intervention.

The TDAS-FR system operates by continuously monitoring and analyzing video footage from strategically placed CCTV cameras within the residential premises. The facial recognition algorithms process the video feed in real-time, identifying individuals based on their facial features and comparing them against a database of known faces. This database can be populated by homeowners, who can upload images of residents, authorized visitors, and any individuals they wish to monitor or be alerted about.

When an unrecognized individual is detected, the system triggers an alert and captures their image, which is then sent to the homeowner's mobile device or designated communication channel. This immediate notification allows homeowners to take necessary actions, such as contacting law enforcement authorities or personally investigating the situation. Furthermore, the TDAS-FR system incorporates advanced algorithms to detect potential theft scenarios based on the behavior and movements of individuals within the monitored area. This could include suspicious activities such as loitering, attempting to conceal one's identity, or carrying objects that may be associated with theft. The integration of AI and facial recognition technology into the TDAS-FR system not only enhances theft detection capabilities but also reduces the likelihood of false alarms, which can be a common issue with traditional security systems. By accurately identifying known individuals and distinguishing them from potential threats, the system minimizes unnecessary alerts and improves overall efficiency.

Moreover, the TDAS-FR system can be seamlessly integrated with existing home automation and security systems, providing homeowners with a comprehensive and unified solution for monitoring and protecting their properties. This integration allows for centralized control and management, ensuring a cohesive and user-friendly experience.

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II. LITERATURE REVIEW

[1] Anjana R, Padma Preethi R, Sujitha J , Mrs.S.Karthika , discuss an innovative security system that uses biometric authentication to prevent vehicle theft. The system employs fingerprint recognition and face recognition technologies to ensure that only authorized individuals can access and start the vehicle. The article details the methodology, including the use of an Arduino microcontroller, and the hardware and software setup required for the system. It also addresses the challenges and future work needed to enhance the system, such as incorporating voice recognition and accident-avoidance systems. The research contributes to the development of advanced security measures for vehicles, aiming to provide a higher level of protection against unauthorized access and theft.

[2] Yash Mahajan, Sandesh Shejwal , Indrayani Takawale , Shivram Marwadi , presents a comprehensive study on the "Smart CCTV Surveillance System" designed for residential areas. It integrates advanced features like real-time facial recognition, trustworthiness recognition, automated visitor management, fire alarm, and parking assistance. The system aims to enhance security and user experience by providing swift responses to emergencies and streamlining visitor check-ins. The research delves into the system's components, such as OpenCV for face detection and a database for visitor data, ensuring secure and efficient operation. The paper also discusses the implementation of theft detection, fire alarms, and parking assistance through a web application, offering centralized control for administrators. Testing results demonstrate the system's effectiveness in recognizing faces, detecting fires, and identifying available parking spaces. The conclusion emphasizes the system's potential to improve safety and navigation in residential areas without dedicated security personnel.

[3] Oussama Tahan School of Engineering presents a detailed study on a Raspberry-Pi based surveillance camera system with dynamic motion tracking1. The system is designed to monitor, detect, and track human movement in real-time, providing a cost-effective and smart automated surveillance solution2. It utilizes a Raspberry Pi 3 Model B+, a web camera, and servo motors for camera movement control, all managed through OpenCV and Python3. The paper discusses the evolution of surveillance, the need for advanced systems due to increased theft, and the limitations of traditional cameras. It outlines the system's design, architecture, and implementation, emphasizing the importance of background subtraction for motion detection and the use of servomotors for camera movement. The paper concludes with the system's successful results and future work aimed at enhancing its capabilities, including face detection and recognition for improved security.

[4] Vijetha T S,Meghana, Namratha S H, Nayanashree K S and Kavyashree G B presents an article from the International Journal of Electronics and Communication Engineering and Technology (IJECET), focusing on an Antitheft Sensor Controlled Home Security System. The system is designed to enhance security in homes, businesses, and labs by detecting unauthorized entry using a variety of sensors and a microcontroller. It features an 89S52 microcontroller board, IR sensor module, remote camera, vibration sensor, micro switch, ASK transmitter and receiver, proximity sensor, LCD display, and a GSM module for communication. The paper details the system's ability to send alerts and images to the user and local police in case of an emergency. It also includes a literature survey discussing various home security technologies and their evolution, emphasizing the need for cost-effective, reliable security solutions. The article concludes by highlighting the significance of home security systems in daily life and their role in monitoring both inside and outside the home for illegal activities.

[5] D Zh Satybaldina, N S Glazyrina, K A Kalymova, V S Stepanov presents a research paper on the development of an algorithm for detecting abnormal human behavior in video surveillance systems, particularly near ATMs1. The authors, D Zh Satybaldina et al., focus on real-time video data analysis using computer vision and deep learning technologies. They discuss the initial research, choice of data capture devices, neural network architecture, software implementation, and selection of experimental conditions2. The paper highlights the use of static and dynamic hand gestures as indicators of abnormal behavior and reports that the Intel RealSense D435 Depth Camera provided accurate gesture recognition under various conditions. The research aims to enhance security systems by minimizing the need for human operators and using intelligent algorithms to proactively detect suspicious activities. The paper includes an overview of related works, a description of Python applications developed for gesture recognition, experimental results, and a conclusion summarizing the findings and the potential of the proposed approach for intelligent video surveillance.

[6] S. A. Quadri , Komal S Katakdhond discusses a study on Suspicious Activity Detection using Convolution Neural Network (CNN). It highlights the importance of video surveillance in ensuring safety and the challenges of manually monitoring vast amounts of footage. The paper proposes a system that automatically detects suspicious behavior and

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alerts authorities. It reviews existing literature on anomaly detection and introduces a methodology using CNN to classify and detect suspicious activities in videos. The study emphasizes the need for automated systems to handle the complexity and diversity of human activities, aiming to provide a reliable security solution through intelligent automation. The paper also details the implementation process, including software requirements and steps involved in training the CNN model. The results demonstrate the system's capability to identify suspicious activities effectively, replacing manual processes with a more efficient, automated approach

[7] Neha Gupta , Bharat Bhushan The paper titled "Recognition of Suspicious Human Activity in Video Surveillance: A Review" provides a comprehensive overview of the advancements in detecting suspicious behavior through video surveillance1. It discusses the importance of monitoring human activities in public and sensitive areas to prevent crimes and threats. The paper reviews various techniques and challenges in recognizing suspicious human activity (SHA), including object tracking, feature extraction, and classification. It highlights the use of deep learning and other computational methods to improve the accuracy and efficiency of surveillance systems. The authors also present a literature review of existing works, their methodologies, and the limitations faced in SHA recognition. The paper concludes by emphasizing the need for intelligent video surveillance systems to enhance security and safety in various settings. It suggests that future research should focus on overcoming the identified challenges to develop more robust and reliable SHA recognition systems

[8] Dayana R, Suganya M, Balaji P, Mohamed Thahir A, Arunkumar P discusses the implementation of smart surveillance systems using deep learning for enhanced security in various industries. It emphasizes the importance of CCTV cameras in security and how deep learning can improve the recognition and detection of facial features from video streams1. The paper outlines a methodology that includes facial detection, recognition, and intimation to prevent unauthorized access and theft. It also reviews related works, databases, and the challenges faced in face detection and feature extraction. The paper concludes by highlighting the effectiveness of deep learning in improving surveillance systems and the potential for future industrial and confidential applications. The authors suggest that this technology can significantly reduce unauthorized access in sensitive areas, ensuring higher security levels.

[9] AHMED ABDELMOAMEN AHMED , MATHIAS ECHI discusses "Hawk-Eye," an AI-powered threat detector for surveillance cameras, designed to identify potential security threats like on-body weapons and masked faces in real-time12. It can be deployed on cloud servers or directly on cameras at the network edge3. The system uses a Mask R-CNN model for object detection and a CNN model for image classification from a webcam, with a motion detection module to capture images upon detecting new motion4. The paper presents the system's architecture, implementation details, and experimental results, showing an average prediction accuracy of 94% on their dataset5. It highlights the importance of intelligent surveillance systems in preventing crimes like mass shootings by providing swift security actions through real-time threat detection. The paper also includes a discussion on related work, system design, and the challenges of deploying ML-enabled applications on edge devices due to computational demands.

[10] Varshini , Velvizhi , Sathyabama Institute Of Science And Technology (SIST) presents a research article on a Smart CCTV Surveillance system from the Sathyabama Institute Of Science And Technology in Chennai, India. The system aims to enhance traditional CCTV cameras by enabling object, person, and event detection and recognition using wireless technology1. It features theft detection, face recognition, and the ability to monitor specific zones, triggering alarms when necessary2. The system operates effectively in various lighting conditions using IP cameras and stores all data in the backend. The project was developed using Python and its libraries like OpenCV, numPY, tkinter, and skimage3. The article discusses the methodology, including computer vision techniques and the GUI interface, and concludes with potential future enhancements like portability, night vision, and deep learning applications. The research acknowledges the support of the Sathyabama institute's professors, particularly Ms. R. Velvzhi.

III. REVIEW FINDINGS

1. The studies highlight the importance of advanced security systems, particularly those utilizing facial recognition, computer vision, and artificial intelligence, to enhance theft detection, unauthorized access prevention, and surveillance capabilities.
2. Several studies propose systems that integrate facial recognition, motion detection, and gesture recognition to identify suspicious activities or unauthorized individuals in real-time.

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3. The use of microcontrollers (e.g., Arduino, Raspberry Pi), cameras, sensors (IR, vibration, proximity), and communication modules (GSM, web applications) is prevalent in the proposed security systems.
4. Deep learning techniques, such as Convolutional Neural Networks (CNNs) and Mask R-CNN models, are employed for accurate object detection, facial recognition, and suspicious activity classification.
5. The reviewed systems aim to provide real-time alerts, notifications, and immediate responses to homeowners, authorities, or administrators in case of detected threats or suspicious activities.
6. Challenges identified include the need for robust algorithms, efficient computational resources, and the ability to handle diverse lighting conditions and complex human activities.
7. Several studies acknowledge the potential of these intelligent surveillance systems to improve safety, prevent crimes, and minimize the need for manual monitoring, while also highlighting the need for further research and enhancements

IV.PROPOSED WORK

We want to make home security better by using special technology that can recognize people's faces. This is important because regular security systems might not always know who is entering your home. With facial recognition, we can make the security system smarter and more accurate. Facial recognition is like a smart program that looks at pictures or videos and figures out who is in them by studying their faces. We'll use two main tools: one to find faces in pictures (MTCNN), and another to recognize who the faces belong to (FaceNet).
Our plan has different parts that work together. First, we get the pictures ready. Then, we use a special tool to find faces in the pictures. After that, we use another tool to recognize who the faces belong to. If we find someone we know, we take action based on that information. With facial recognition, our security system becomes better at spotting who is supposed to be there and who might be a stranger. This means we can react quickly and accurately if someone we don't recognize tries to enter our home, making our security system more reliable.

Our system is always watching and can recognize faces in real-time. If someone suspicious is spotted, the system can send an alert to the homeowner right away, so they know what's happening and can take action. Our plan is to add facial recognition to existing security systems without causing any problems. Also, we can make our system bigger or add more features later if needed, so it can grow with the homeowner's needs. Our plan to use facial recognition technology in home security systems will make homes safer and give homeowners more peace of mind. By quickly recognizing faces and sending alerts when something is wrong, our system offers a smarter and more reliable way to protect homes and families.

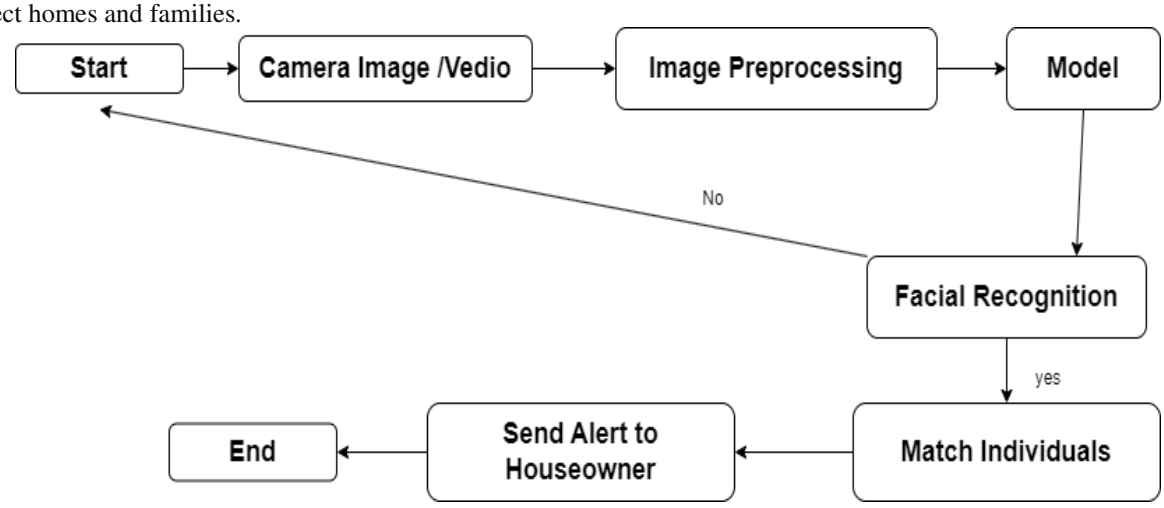

figure-1: Architecture of the model

The introduction highlights the objective of upgrading the home security system with advanced facial recognition technology, specifically utilizing the MTCNN and FaceNet algorithms. This enhancement aims to bolster the system's ability to accurately identify individuals, thereby enhancing overall security effectiveness.
In the figure-1 overview, the process is outlined into three main parts: image preparation, face detection using MTCNN, and face recognition using FaceNet. This breakdown provides a clear understanding of the system's workflow, ensuring efficient implementation and operation.
Input preprocessing ensures that the images captured by the cameras are optimized for facial detection and recognition. This step involves adjusting the size and quality of the images to improve the accuracy of subsequent processes.

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Face detection with MTCNN is crucial for accurately locating faces within the images. MTCNN excels at identifying facial features like eyes and noses, enabling precise face detection even in complex or crowded scenes.
Following face detection, FaceNet analyzes the detected faces and generates unique codes, or embeddings, to represent them. These embeddings serve as a compact and distinctive representation of each face, facilitating efficient face recognition.

In the matching and identification step, the generated embeddings are compared to known faces stored in the system's database. If a match is found, the system identifies the individual, providing valuable information for security purposes.
Upon identifying a match, the system triggers alerting and notification mechanisms to promptly inform the homeowner. This ensures swift action can be taken in response to security incidents, whether it involves an unexpected visitor or a wanted individual.
Integration with the existing home security system is seamless, ensuring compatibility and ease of implementation. This allows for a smooth transition to the enhanced facial recognition system without disrupting the functionality of the current setup.
In conclusion, these improvements to the home security system enhance its intelligence and reliability, bolstering its ability to protect homes from potential threats. By leveraging advanced facial recognition technology, homeowners can enjoy greater peace of mind knowing their homes are equipped with a robust security solution.

V. RESULTS

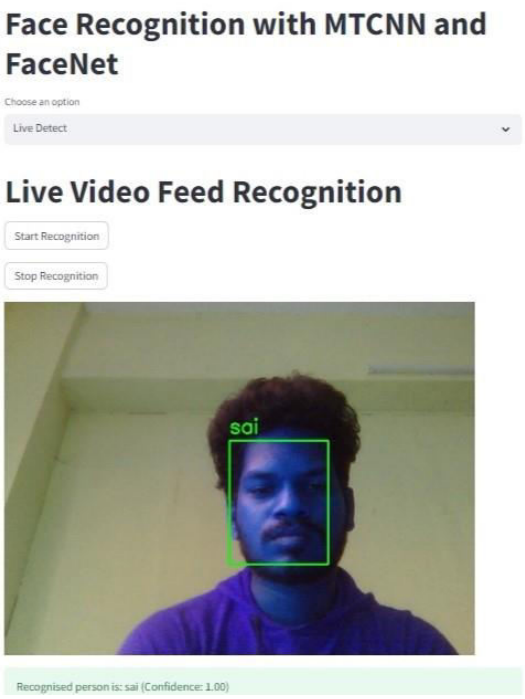

Figure-2: Recognized person

In Figure-2 When the facial recognition system identifies a known person, it gives displays their name, providing instant recognition to the homeowner. This feature offers a sense of security and familiarity, allowing the homeowner to quickly verify the presence of an authorized individual. For example, if a family member or friend arrives at the home, the system will display their name as sai, the homeowner that someone they trust is present. This instant recognition helps faster and easy enhancing the overall security experience for the homeowner.

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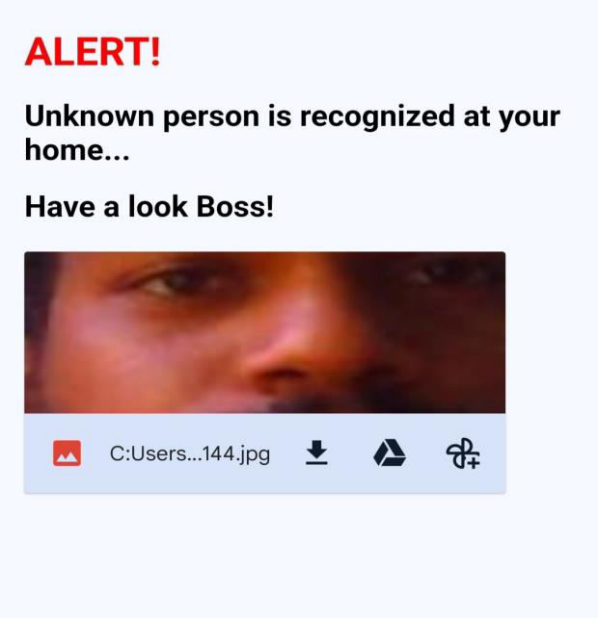

Figure-3: Alert for Unknown person

In Figure-3 The facial recognition system detects an unknown person, it triggers an alert with a message notifying the homeowner of the situation. The alert message as "Unknown person is recognized at your home… Have a look boss!" serves as a proactive warning, prompting the homeowner to investigate further. This alert empowers the homeowner to remain vigilant and take appropriate action, such as reviewing security footage or contacting authorities if necessary. By providing timely notifications about potential security concerns, the system helps ensure the safety and security of the home.

VI . CONCLUSION AND FUTURE WORK

The Theft Detection and Alert System with Facial Recognition (TDAS-FR) represents a significant advancement in home security and surveillance technology. By leveraging the power of artificial intelligence, computer vision, and facial recognition algorithms, the system provides an intelligent and effective solution for detecting potential theft scenarios and unauthorized access. Through the integration of advanced facial recognition techniques, the TDAS-FR system can accurately identify known individuals, such as residents and authorized personnel, while simultaneously detecting and capturing images of unrecognized or suspicious individuals. The system's ability to send real-time alerts and notifications to homeowners enables prompt action and intervention, enhancing the overall safety and security of residential communities.

The successful implementation and testing of the TDAS-FR system have demonstrated its efficacy in recognizing faces, detecting motion, and identifying potential threats. The system's modular design and integration capabilities with existing home automation and security systems further contribute to its versatility and user-friendly experience.

While the TDAS-FR system represents a significant step forward in intelligent home security, there are several areas for future work and improvement:
Continuous enhancement of facial recognition accuracy: As facial recognition technology evolves, incorporating more robust and accurate algorithms can further improve the system's ability to identify individuals accurately, even in challenging lighting conditions or with partial occlusions.

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