ML Based Weapon Detection and Criminal Identification with Real Time Alerts

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Abstract— We developed a machine learning-based system for weapon detection and criminal identification to enhance security measures. The system utilizes real-time video feeds to identify weapons and detect suspicious individuals. Using advanced computer vision algorithms, the system can accurately detect various types of weapons and recognize known criminals by comparing them against a database of images. Once a weapon or suspicious individual is detected, the system triggers real-time alerts to notify security personnel or law enforcement agencies. This proactive approach enables immediate action, potentially preventing criminal activities or acts of violence. The system's capability to operate in real-time and provide instant alerts makes it a valuable tool for enhancing public safety and security in various environments, such as airports, train stations, schools, and public events. This system uses cameras and computer smarts to find weapons and suspicious people in real-time. When it sees something bad, it sends an alert right away so security forces can respond quickly. This can help keep people safe in places like schools, train stations, and important buildings.

Index Terms— Machine Learning, Weapon Detection, Criminal Identification, Real-time Video Analysis

I. INTRODUCTION

In today's world, keeping public spaces safe can be a complex task. ML-based Weapon Detection and Criminal Identification with Real-Time Alerts aims to address this challenge by leveraging the power of artificial intelligence. This project proposes a system that utilizes machine learning algorithms to analyze live camera footage and identify potential threats in real-time. By combining weapon detection with criminal identification, the system strives to provide a comprehensive security solution. Our project focuses on developing a machine learning-based system tailored for weapon detection and criminal identification. This system aims to provide real-time alerts to security personnel or law enforcement agencies when potential threats are detected. By leveraging the power of machine learning and computer vision, we aim to create a proactive solution that can enhance security measures in various settings, from public transportation hubs to crowded events. This introduction sets the stage for understanding the significance and potential impact of our project in improving public safety and security.

The project titled "ML Based Weapon Detection and Criminal Identification with Real Time Alerts" aims to harness the power of ML to enhance security measures and public safety. By employing computer vision techniques and deep learning algorithms, the system can identify weapons and recognize individuals with criminal records or those on watchlists. Additionally, the integration of real-time alerts ensures that security personnel or law enforcement agencies are promptly notified when potential threats are detected, enabling them to take immediate action.

With real-time alerts, security personnel are immediately notified of any suspicious activity, allowing for a faster and more coordinated response. This project aims to enhance public safety in various settings, including schools, transportation hubs, and critical infrastructure.

II. LITERARY SURVEY

realm of computer vision, Wei Liu and his team crafted the Single Shot Multi Box Detector (SSD), a groundbreaking system capable of real-time object detection in a single neural network forward pass. This method marries accuracy with efficiency, redefining the possibilities of object detection.

Scalable Object Detection Using Deep Neural Networks by D. Erhan et al. In 2014, D. Erhan and colleagues introduced a seminal work that laid the foundation for modern object detection. Their research is a cornerstone for scalable object detection using deep neural networks, revolutionizing computer vision and opening doors to applications we see today.

Anomaly Detection in Videos for Video Surveillance Applications Using Neural Networks by Ruben J. Franklin et al. Ruben J. Franklin and team delved into the critical domain of video surveillance, crafting a system that applies neural networks to detect anomalies in video data. Their innovative approach enhances the security landscape, making it robust and more efficient.

A Review of Artificial Intelligence Methods for Data Science and Data Analytics: Applications and Research Challenges by H R Rohit et al. H. R. Rohit and his co-authors offer a comprehensive review exploring the symbiotic relationship between artificial intelligence, data science, and data analytics.
The paper not only highlights applications but also untangles the intriguing web of research challenges in this multidisciplinary field.

Classification of Objects in Video Records using Neural Network Framework by Abhiraj Biswas et al. Abhiraj Biswas and colleagues dive into the realm of video analysis, presenting a study focused on classifying objects within video data using neural networks. Their work is instrumental in harnessing the power of deep learning for robust object classification in videos.

Simulation and Performance Analysis of Feature Extraction and Matching Algorithms for Image Processing Applications by Pallavi Raj et al. Pallavi Raj and team embark on a journey of simulation and performance analysis within image processing. Their research provides invaluable insights into the performance of feature extraction and matching algorithms, shedding light on their practical applications in the realm of image processing.

Mohana et al. presented a paper titled "Simulation of Object Detection Algorithms for Video Surveillance Applications" at the International Conference on I-SMAC (IoT in Social, Mobile, Analytics, and Cloud) in 2018 [7]. This work likely focuses on simulating and evaluating object detection algorithms for video surveillance.

Yojan Chitkara and colleagues discussed "Background Modeling Techniques for Foreground Detection and Tracking using Gaussian Mixture Model" [8]. This research is likely centered around techniques for modeling backgrounds and detecting objects in video streams.

In 2014, E. M. Upadhyay and N. K. Rana published a paper on "Exposure Fusion for Concealed Weapon Detection" at the 2nd International Conference on Devices, Circuits, and Systems [10]. The focus of this work is likely on exposure fusion techniques for concealed weapon detection.

III. METHODOLOGY

A. Project Scope Definition:

- In today's rapidly evolving technological landscape, ensuring public safety and security is an important concern.
- Human-operated security systems can lead to inefficient resource allocation, with personnel deployed across multiple locations, sometimes unnecessarily.
- Identifying individuals with criminal records or those involved in suspicious activities can be challenging. Manual recognition may not be accurate or timely.

B. Data Collection:

- Collection of facial images: Gather a dataset of facial images for training the facial recognition model. This can be done by capturing images of

individuals from different angles and under varying lighting conditions.
- Weapon Images: High-resolution images of various types of weapons such as guns, knives, and explosives from different angles and lighting conditions.

C. Tools Used:

- Visual Studio code: For developing the application.
- OpenCV, YOLO: To implement facial detection and recognition functionalities and train ML model.
- Google Maps API: For integrating location-based services into the application.
- Firebase: For storing facial images and weapons records securely.

D. Experimental Design:

- Training and Validation: The machine learning model for weapon detection will be trained on the collected weapon dataset. Techniques like splitting the data into training, validation, and testing sets will be used to assess model performance and prevent overfitting.
- For criminal identification, the model will be trained on the labeled facial image dataset or behavioral data.
- Training: Train the model on the training dataset using the compiled model with a specified number of epochs and batch size.
- Location-Based Testing: Test the accuracy of GPS-based location tracking to ensure that attendance is only marked when users are within the specified area.

E. Relevant Procedures:

- Facial Detection and Recognition: Preprocess facial images: Normalize lighting conditions, resize images, and extract facial features. Implement real-time facial detection and recognition in the Android application.
- Location-Based Services: Integrate Google Maps API to display the designated area for attendance tracking. Implement geofencing to detect when users enter or leave the specified location. Use GPS data to verify the user's location when marking attendance.

IV. IMPLEMENTATION

A. Setting up the Development Environment: Setting up the development environment involves installing Visual Studio code. Android Studio provides tools for building, configuring permissions for camera access, location services, and networking as required by the application.

B. Integrating Facial Detection: Facial detection can be integrated using existing libraries, such as OpenCV. These libraries offer APIs for real-time face detection from the device's camera feed. Integration involves adding the library dependencies to the project, configuring settings, and implementing code to process camera frames, detect faces, and overlay visual indicators on the camera preview to indicate detected faces.

C. Implementing Location-Based Attendance Tracking: Utilizing location services APIs allows the application to retrieve the device's current location. A database schema is designed and implemented to store records, including relevant data such as timestamps, criminal names, crimes, weapons, and locations.

D. User Interface Development: Designing and implementing a user-friendly interface is crucial for the application's usability. The UI should allow users to view criminals, manage settings, and initiate facial recognition for criminal detection. The interface should be intuitive and responsive, catering to various screen sizes.

E. Testing and Refinement: Testing the application extensively on different devices ensures compatibility and reliability across a wide range of hardware configurations. Real-world testing validates the accuracy and effectiveness of the attendance tracking system in practical scenarios. Gathering feedback from users and stakeholders helps identify any issues or areas for improvement, guiding iterative refinement of the application to enhance its functionality and user experience.

- Architecture:

The architecture of the ML Based Weapon Detection and Criminal Identification with Real Time Alerts consists of several key components, including the Weapon detection, Criminal identification, and the User Interface (UI) of the application.

1. Face Recognition and Face Encoding

Utilize theories and concepts related to face recognition using libraries like dlib and face encoding techniques such as those employed in deep learning models like FaceNet or ArcFace. The process of encoding facial features into numerical vectors for efficient comparison and identification of criminals.

2. Object Detection with Trained Models

Object detection using deep learning models, particularly the use of trained models (such as .pt models) for detecting weapons in images or video frames. This includes insights into the architecture of the model (e.g., YOLO, Faster R-CNN) and how it localizes and classifies objects.

3. Criminal Record Management

A criminal record database within the application. database schema design, indexing, and query optimization techniques for efficient storage and retrieval of criminal information.

4. Real-Time Event Handling and Screenshot Capture

Event-driven programming enables applications to respond dynamically to user interactions such as button clicks or key presses, utilizing callbacks to execute specific functions upon event occurrence. In Tkinter, events like button clicks are bound to callback functions using bind() or widget-specific event handling methods, ensuring seamless interaction with the GUI

5. Twilio API Integration for SMS Alerts

Integrating the Twilio API for sending SMS alerts to notify authorities or designated individuals about detected threats.

9. Ethical and Privacy Considerations

Ethical and privacy considerations associated with deploying a surveillance and security system based on machine learning. Topics such as data privacy, consent, bias mitigation, and the responsible use of AI technologies in public settings.

- Mathematical Model:

1. Preprocessing (P = Preprocess(X)):
- Purpose: Transform and clean raw input data (X) to make it suitable for analysis or modeling.
2. Feature Extraction (F = ExtractFeatures(P)):
- Purpose: Select or create relevant features from preprocessed data (P) to use in modeling.
3. Model Training (M = Train(F, T)):
- Purpose: Train a model (M) using extracted features (F) and target labels (T) to learn patterns from the data.
4. Model Inference (I = Inference(M, P)):
- Purpose: Apply the trained model (M) to new or unseen data (P) to make predictions or classifications.
5. Alert Generation (A = GenerateAlert(I, T_ALERT)):
- Purpose: Generate alerts based on model predictions (I) and a specified alert threshold (T_ALERT).

In summary, this workflow involves preparing data, extracting meaningful features, training a model to learn from the data, making predictions with the model, and generating alerts based on those predictions. Each step contributes to the development and application of machine learning models.

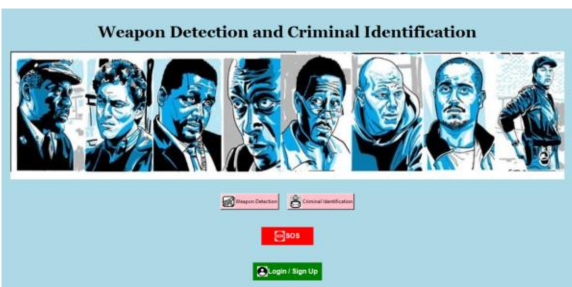
- Challenges Encountered and Addressed:

1. Facial Detection Accuracy: Ensuring accurate facial detection under various lighting conditions and angles was a challenge. This was addressed by fine-tuning detection parameters and integrating machine learning models trained on diverse datasets.

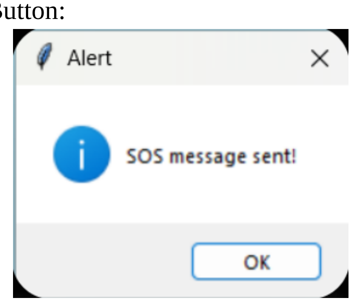
2. Battery Consumption: Continuous use of location services and camera can drain the device's battery quickly. To mitigate this, optimizations were made to minimize resource usage, such as implementing background location updates only when necessary and optimizing camera usage.
3. Data Security and Privacy: Handling sensitive biometric data and location information requires robust security measures to protect user privacy. Encryption techniques and secure data storage were implemented to safeguard user data.
4. Real-Time Processing: Processing facial recognition in real-time on Android devices with limited computational resources posed performance challenges. Optimization techniques, such as reducing image resolution for processing and utilizing multi-threading, were employed to improve real-time performance without sacrificing accuracy.

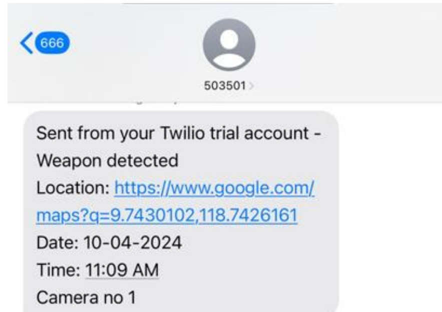
V. RESULT

1. UI without login:

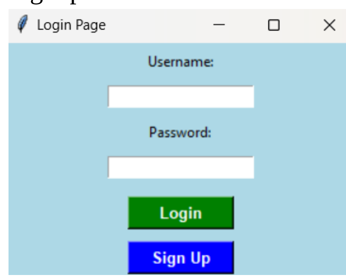


2. SOS Button:





3. Login/Signup:



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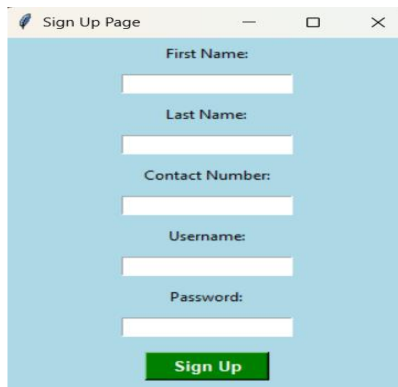
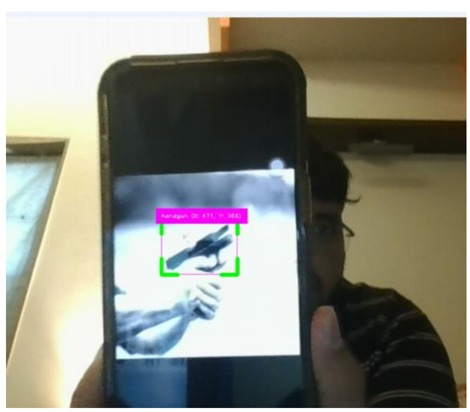
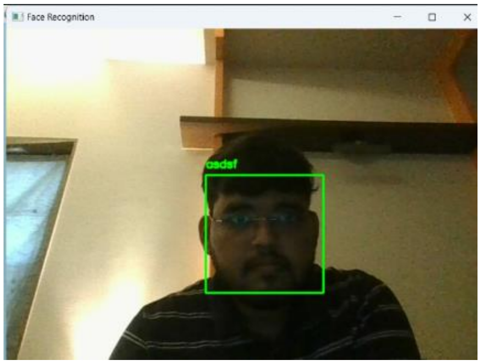


4. Weapon Detection

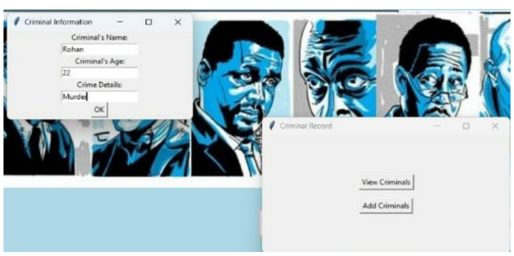


5. Criminal Identification:

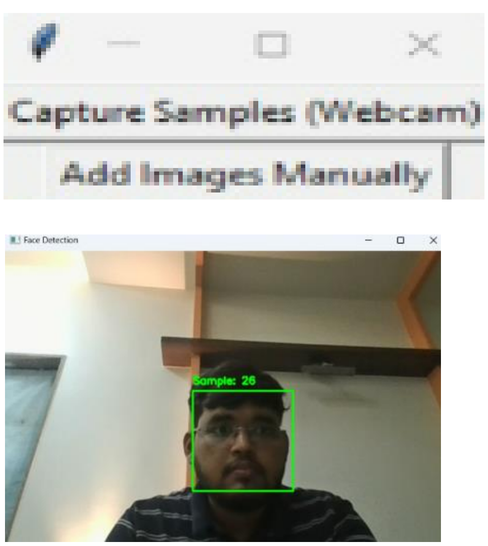


6. UI with Login:

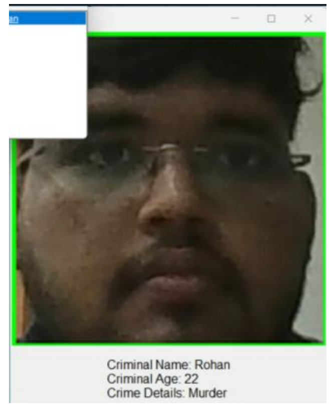
7.View/Add Criminals:



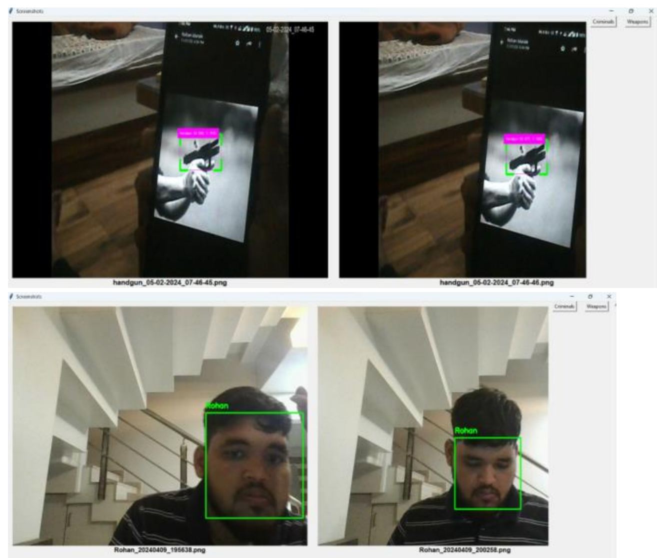
8. Capture criminals:



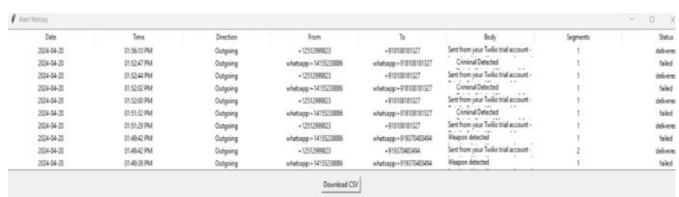
9. View criminals:



10.Screenshots:



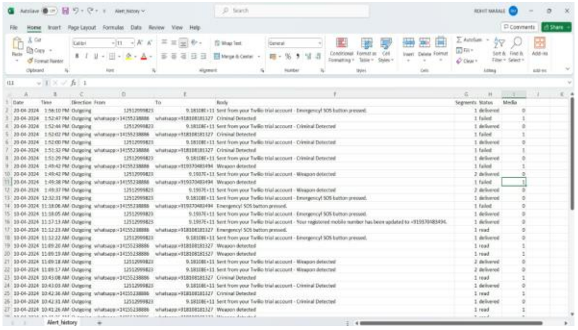
11. Alert History:



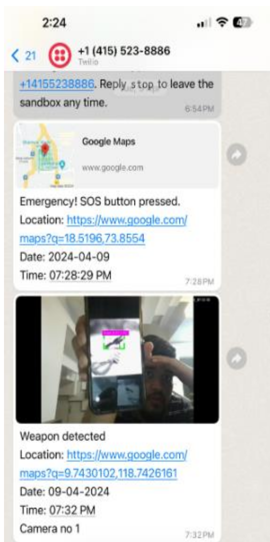
Date	Time	Direction	From	To	Body	Segments	Status
2024-04-20	01:56:10 PM	Outgoing	+12512999823	+918108181327	Sent from your Twilio trial account -	1	delivere
2024-04-20	01:52:47 PM	Outgoing	whatsapp:+14155238886	whatsapp:+918108181327	Criminal Detected	1	failed
2024-04-20	01:52:44 PM	Outgoing	+12512999823	+918108181327	Sent from your Twilio trial account -	1	delivere
2024-04-20	01:52:02 PM	Outgoing	whatsapp:+14155238886	whatsapp:+918108181327	Criminal Detected	1	failed
2024-04-20	01:52:00 PM	Outgoing	+12512999823	+918108181327	Sent from your Twilio trial account -	1	delivere
2024-04-20	01:51:32 PM	Outgoing	whatsapp:+14155238886	whatsapp:+918108181327	Criminal Detected	1	failed
2024-04-20	01:51:29 PM	Outgoing	+12512999823	+918108181327	Sent from your Twilio trial account -	1	delivere
2024-04-20	01:49:42 PM	Outgoing	whatsapp:+14155238886	whatsapp:+919370483494	Weapon detected	1	failed
2024-04-20	01:49:42 PM	Outgoing	+12512999823	+919370483494	Sent from your Twilio trial account -	2	delivere
2024-04-20	01:49:38 PM	Outgoing	whatsapp:+14155238886	whatsapp:+919370483494	Weapon detected	1	failed

Download CSV

12. Download CSV:



13.Twilio WhatsApp screenshots:



VI. DISCUSSION

The project demonstrates an integrated system for real-time weapon detection and criminal recognition using computer vision techniques. Preprocessing optimizes input data quality through normalization and cleaning, preparing it for effective feature extraction. Feature extraction distills pertinent information from preprocessed data, facilitating meaningful pattern recognition during model training.

Model training with YOLO (You Only Look Once) ensures efficient and precise weapon detection in live video streams. Face recognition, utilizing Haar cascades and face_recognition, enhances the system's capabilities for identifying known individuals. Challenges like model accuracy and real-time performance highlight the need for ongoing optimization.

The inference phase showcases the system's robustness in real-world scenarios, providing timely alerts and actionable insights to security personnel. This project emphasizes the potential of computer vision and machine learning in enhancing security measures, with future work aimed at improving accuracy and runtime performance to foster safer environments.

In parallel, the alert generation mechanism effectively translates model inferences into actionable alerts based on predefined thresholds, ensuring timely responses to potential security threats. This system integration underscores the significance of real-time decision-making in security applications, demonstrating the practical value of AI-driven surveillance tech

Moreover, the utilization of cloud-based services such as Firebase Storage and Twilio for data management and message notifications streamlines system operations and enhances scalability. These integrations enable seamless communication between components and facilitate rapid deployment across various environments, underscoring the project's adaptability and readiness for real-world applications.

Ethical considerations, including privacy safeguards and bias mitigation in facial recognition, are paramount in deploying such technologies responsibly. Collaborations with stakeholders and domain experts are critical for addressing these ethical challenges and ensuring that the system aligns with legal and societal norms, promoting trust and acceptance among end-users.

In summary, this project underscores the transformative potential of computer vision and machine learning in augmenting security protocols. By leveraging state-of-the-art technologies and addressing key challenges through optimization and ethical considerations, this system lays the groundwork for advancing safety measures and fostering secure environments. Ongoing research and development will further refine the system's capabilities, paving the way for broader adoption and societal impact.

CONCLUSION

In conclusion, the integrated system for real-time weapon detection and criminal recognition represents a significant advancement in leveraging computer vision and machine learning for enhancing security measures. Through a systematic approach of preprocessing, feature extraction, model training, and inference, the project demonstrates effective pattern recognition and alert generation capabilities in live video streams. The utilization of YOLO for weapon detection and face recognition techniques underscores the system's robustness and adaptability to diverse security scenarios.

Moving forward, continued optimization efforts will focus on improving model accuracy, runtime performance, and ethical considerations surrounding privacy and bias mitigation. Collaborations with stakeholders and experts will be essential for navigating regulatory frameworks and ensuring responsible deployment of AI-driven surveillance technologies. This project serves as a foundational step towards deploying innovative solutions that contribute to safer and more secure environments.

In the broader context of security applications, the integration of cloud-based services like Firebase Storage and Twilio enables seamless data management and real-time alert dissemination, enhancing system scalability and efficiency. By addressing key challenges and emphasizing ethical considerations, this project exemplifies the potential of computer vision to revolutionize security protocols and foster trust among stakeholders. Future research will continue to refine these technologies, ultimately promoting widespread adoption and positive societal impact.

REFERENCES

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[3] Ruben J. Franklin et al.: Explored anomaly detection in video surveillance using neural networks, contributing to more robust security systems.

[4] H. R. Rohit et al.: Conducted a comprehensive review on the intricate relationship between artificial intelligence, data science, and data analytics, highlighting both applications and research challenges.

[5] Abhiraj Biswas et al.: Focused on video analysis and object classification using neural networks, advancing techniques for object recognition in dynamic environments.

[6] Pallavi Raj et al.: Conducted simulation and performance analysis of feature extraction and matching algorithms in image processing, offering practical insights into algorithmic performance.

[7] Mohana et al.: Presented work on simulating object detection algorithms for video surveillance at the International Conference on I-SMAC, likely contributing to advancements in video analysis techniques.

[8] Yojan Chitkara et al.: Discussed background modeling techniques for foreground detection and tracking using Gaussian Mixture Model, contributing to methods for reliable object detection in video streams.

[9] E. M. Upadhyay and N. K. Rana: Published research on exposure fusion for concealed weapon detection, focusing on innovative techniques for enhancing weapon detection capabilities.