SMART CCTV DOCUMENTATION WITH FACE RECOGNITION

Miniproject Report

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by

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DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

MES COLLEGE OF ENGINEERING KUTTIPPURAM

CERTIFICATE

This is to certify that the report entitled **SMART CCTV DOCUMENTATION WITH FACE RECOGNITION** submitted by **NUHA JAMAL A** (MES21AD050), **SALMAN FARIS C K** (MES21AD051), **THAHSEEN** (MES21AD058), **ZEBA SAKKIR** (MES21AD061) to the APJ Abdul Kalam Technological University in partial fulfillment of B.Tech degree in Artificial Intelligence and Data Science is a bonafide record of the miniproject work carried out under our guidance and supervision during the year 2021-2025.

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ABSTRACT

In today's dynamic security environment, the demand for robust surveillance systems is ever-growing. Traditional Closed-Circuit Television (CCTV) setups, while proficient in capturing footage, often lack the sophistication required for modern security needs. This project presents a comprehensive solution aimed at bridging this gap by integrating CCTV documentation with advanced face recognition capabilities. The objectives of this project are twofold. Firstly, to enhance the efficiency of surveillance and monitoring in various public spaces, including campuses, markets, and commercial areas. Secondly, to bolster security measures by automating the process of people counting and integrating facial recognition technology with CCTV systems. By achieving these objectives, the proposed solution not only improves the overall effectiveness of surveillance but also streamlines monitoring processes, making it an invaluable asset in today's security landscape.

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Abbreviations

OPENCV	Open Source Computer Vision Library
YOLO	You Only Look Once
CCTV	Closed Circuit Television
FRD	Facial Recognition Database

Chapter 1

Introduction

In today's dynamic security landscape, the need for efficient surveillance and monitoring systems has become paramount. Traditional Closed-Circuit Television (CCTV) setups, though effective in capturing footage, often lack advanced features like automated counting and face recognition, crucial for modern security needs. Our project presents a comprehensive solution that integrates CCTV documentation with advanced face recognition capabilities to address these shortcomings and enhance security measures.

The primary objectives of our project are twofold. To improve surveillance efficiency in public spaces like campuses and markets, and to enhance security measures by seamlessly integrating facial recognition technology with CCTV systems. By automating the process of counting people entering and exiting premises, our solution aims to provide accurate insights into crowd movement, facilitating better resource allocation and crowd management..

Furthermore, the integration of facial recognition technology adds an extra layer of security by enabling instant identification of individuals of interest or potential threats. This capability empowers security personnel to respond swiftly to security breaches or suspicious activities, thereby enhancing overall safety within monitored environments. In subsequent sections, we delve deeper into the motivation, literature survey, system requirements, and analysis of our smart CCTV documentation with face recognition system, showcasing its effectiveness in addressing the evolving security challenges of today's world.

Chapter 2

Review of Literature

In 2018, a paper titled ”Face Recognition in Surveillance Video for Criminal Investigations: A Review” delved into the challenges associated with recognizing faces in forensic scenarios, with a focus on the application of deep learning-based face recognition algorithms. Through exploration, the review highlighted techniques aimed at addressing challenges such as low-resolution inputs and pose variations. It underscored the significance of utilizing deep learning algorithms for improving the accuracy of face recognition in surveillance videos, particularly in the context of criminal investigations.[6]

In 2022, ”A Real-Time Framework for Human Face Detection and Recognition in CCTV Images” introduced a real-time framework for human face detection and recognition in CCTV images. Leveraging techniques such as PCA and Convolutional Neural Network (CNN) for feature extraction and various algorithms including KNN, Decision Tree, Random Forest, and CNN for recognition, the system achieved an impressive accuracy rate of 99 percentage. This framework aimed to enhance both the accuracy and efficiency of real-time face recognition tasks in surveillance applications, contributing to advancements in video analysis and security monitoring systems.[7]

In 2023, ”Improving CCTV Footage in Computer Vision Using Deep Learning Techniques” focused on enhancing the quality of CCTV footage through the application of deep learning techniques. By employing CNNs, Recurrent Neural Networks (RNNs), and Generative Adversarial Networks (GANs), the research aimed to elevate the overall quality of surveillance videos. With a notable accuracy rate of 99 percentage, the study aimed to enhance the interpretability and analysis of surveillance footage, thereby improving the efficacy of computer vision applications in security and monitoring domains.[8].

Chapter 3

Methodology

3.1 System Design:

The specific functionalities of our system are defined within the context of its intended application. We determine whether the system will concentrate solely on people detection and counting or if it will also integrate face recognition for identification purposes. Moving on to the overall system architecture, we consider hardware requirements such as processing power and storage capacity. This ensures adequate resources for real-time processing of video feeds. On the software side, our architecture includes essential components like the YOLO model for object detection, OpenCV libraries for image processing and anomaly detection, a potential face recognition model for identification tasks, and a database for storing and managing detected objects or recognized faces. By meticulously integrating these hardware and software components, we aim to construct a robust system capable of efficiently detecting and recognizing people in various real-time video surveillance scenarios as shown in Figure 3.1.

3.2 People Detection with YOLO:

To ensure real-time object detection, we opt for a pre-trained YOLO model, such as YOLOv7 or YOLOv8, known for their effectiveness in this regard. Model selection and deployment can be facilitated using tools like Darknet or frameworks like TensorFlow. The integration of YOLO with OpenCV enables the capture of video streams from CCTV cameras. YOLO processes these streams, providing bounding boxes and confi-

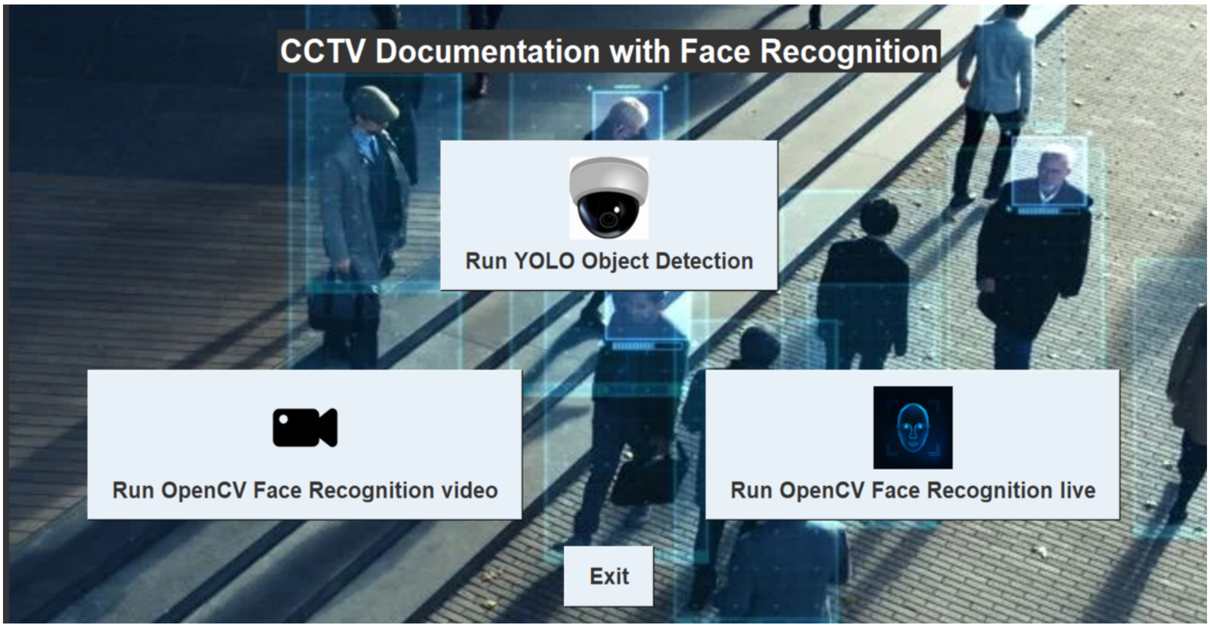


Figure 3.1: System Design

dence scores for detected people in each frame. This seamless integration of YOLO and OpenCV forms a crucial component of our system, facilitating real-time monitoring and detection of objects within video feeds.

3.3 Face Recognition

If the system includes the identification of individuals, a separate face recognition model becomes necessary. This typically involves training a model on a dataset containing faces of the individuals to be recognized. Tools such as OpenCV or dlib can facilitate this process. Once YOLO detects a person within a frame, OpenCV is employed to crop the face region from that frame. Subsequently, the cropped face image is fed into the face recognition model for identification purposes. This seamless integration of YOLO, OpenCV, and the face recognition model enables the system to accurately identify individuals in real-time video surveillance scenarios, enhancing its overall functionality and utility as shown in Figure 3.2.

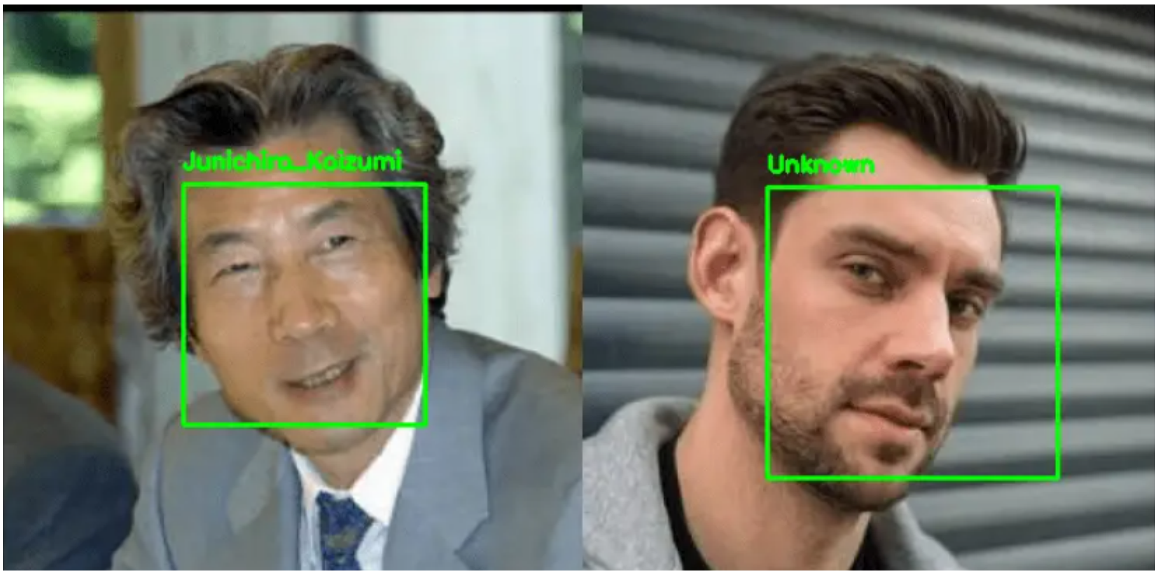


Figure 3.2: opencv face detection

3.4 Entry/Exit Tracking and Logging:

The system maintains counters to effectively track the number of people entering and exiting the monitored area. It achieves this by analyzing the movement of bounding boxes detected by YOLO. When a person enters the monitored area (indicated by a bounding box moving from left to right), the entry counter is incremented. Conversely, when a person exits (signified by a bounding box moving from right to left), the exit counter is incremented accordingly. To enhance visualization and comprehension, OpenCV functionalities are leveraged to draw virtual lines directly onto the video frame, delineating entry and exit zones. This comprehensive approach ensures accurate monitoring and tracking of individuals within the surveillance area, facilitating efficient management and analysis of foot traffic in real-time scenarios.

3.5 Database and Logging:

To store timestamps and identified faces, a suitable database is selected, such as an Excel sheet or an SQL database. When a recognized face is detected, the system logs the timestamp along with the person's information retrieved from the database into the chosen storage system. This integration enables the system to maintain a comprehensive record of identified individuals and their corresponding timestamps, facilitating subsequent analysis or retrieval of pertinent information as needed as shown in Figure 3.3 and 3.4.

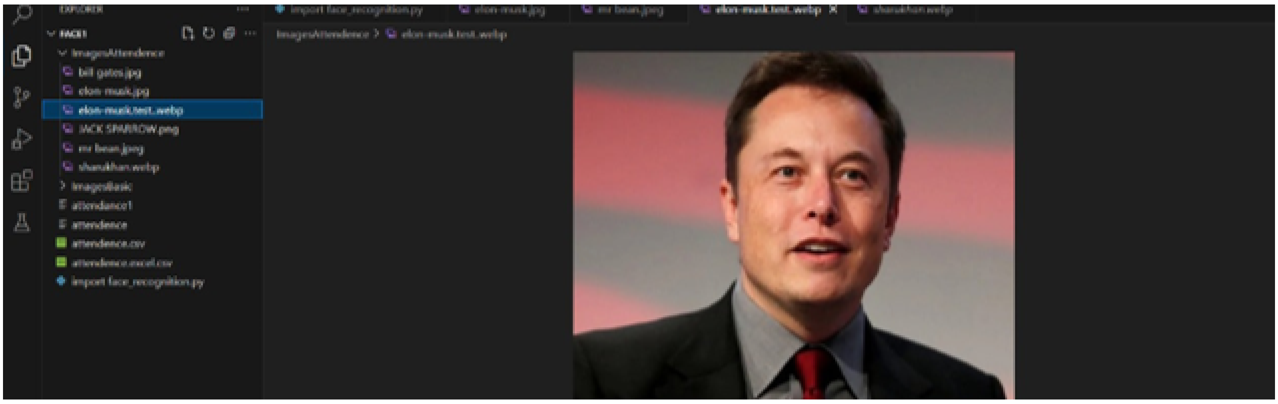


Figure 3.3: database for face recognition

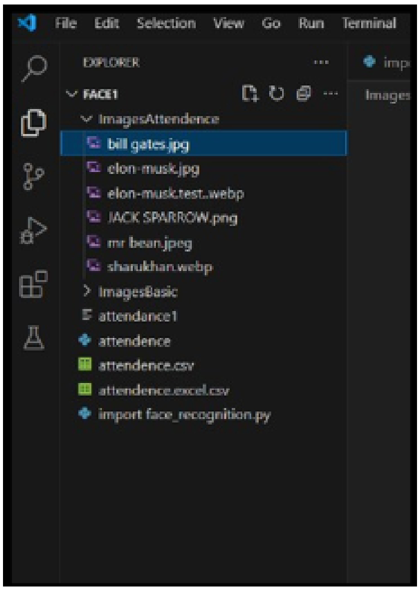


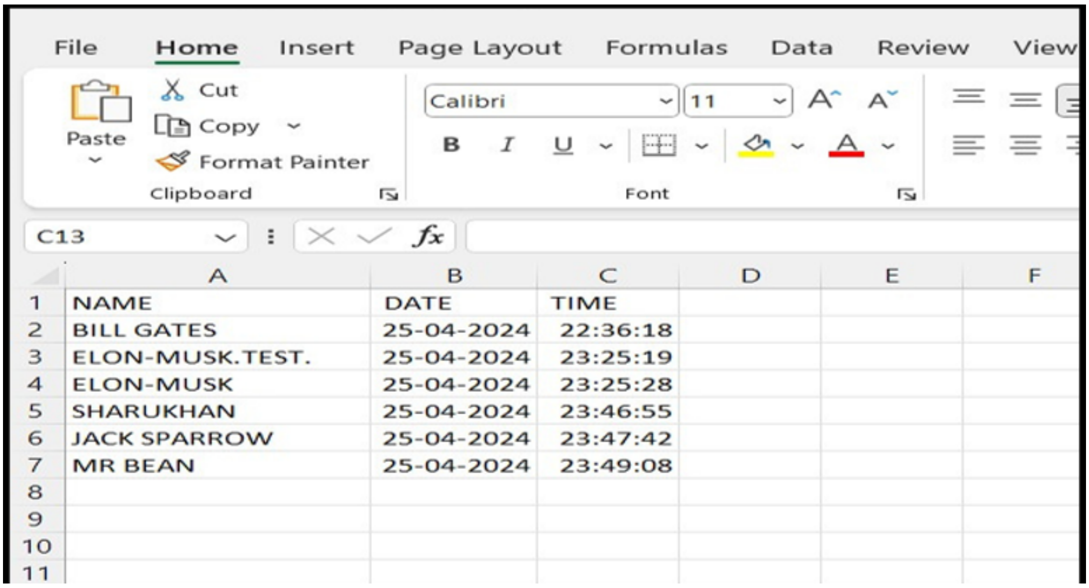
Figure 3.4: database for face recognition 2

3.6 Development and Testing:

The system development process involves utilizing Python along with libraries such as OpenCV, NumPy, and relevant deep learning frameworks, depending on the chosen YOLO and face recognition model. By leveraging these tools and frameworks, we can efficiently implement the functionalities required for real-time object detection, tracking, and face recognition within the surveillance system. Subsequently, the system undergoes rigorous testing using sample video recordings featuring diverse scenarios, including variations in lighting conditions and occlusions. This testing phase aims to evaluate the system's performance under real-world conditions, ensuring its reliability and effectiveness across different environments and potential challenges. Through iterative testing and refinement, we strive to optimize the system's performance and enhance its capability to accurately detect, track, and identify objects and individuals in real-time video streams.

3.7 Optimization and Deployment:

Based on the results obtained from testing, the system undergoes optimization to enhance efficiency. Techniques may include the utilization of lighter YOLO models or optimizing code for faster processing. By implementing these optimizations, the system aims to achieve improved performance without compromising accuracy. Subsequently, the system is deployed on the target hardware platform, typically a computer connected to the CCTV camera. During deployment, thorough testing is conducted to ensure the system runs smoothly in real-time, effectively fulfilling its intended purpose of monitoring and surveillance. This process involves verifying that the system operates seamlessly within the constraints of the target hardware platform, guaranteeing reliable performance in various real-world scenarios.face recognition output as shown in Figure 3.5



	A	B	C	D	E	F
1	NAME	DATE	TIME			
2	BILL GATES	25-04-2024	22:36:18			
3	ELON-MUSK.TEST.	25-04-2024	23:25:19			
4	ELON-MUSK	25-04-2024	23:25:28			
5	SHARUKHAN	25-04-2024	23:46:55			
6	JACK SPARROW	25-04-2024	23:47:42			
7	MR BEAN	25-04-2024	23:49:08			
8						
9						
10						
11						

Figure 3.5: face recognition output

Chapter 4

Experiment and Results

4.1 Non Real-time System

4.1.1 YOLO Object Detection and OpenCV Face Recognition

In our project, we integrated YOLO (You Only Look Once) for object detection and OpenCV (Open Source Computer Vision Library) for face recognition to develop a robust non-real-time surveillance system. YOLO is a state-of-the-art deep learning model known for its speed and accuracy in detecting objects in images and video streams. OpenCV, on the other hand, is a powerful library widely used for various computer vision tasks, including face detection and recognition.

To train the YOLO model, we utilized a diverse dataset consisting of footage from various environments such as campuses, markets, and public places. This dataset included scenarios with different lighting conditions, crowd densities, and background clutter. We

Figure 4.1: In and Out Output

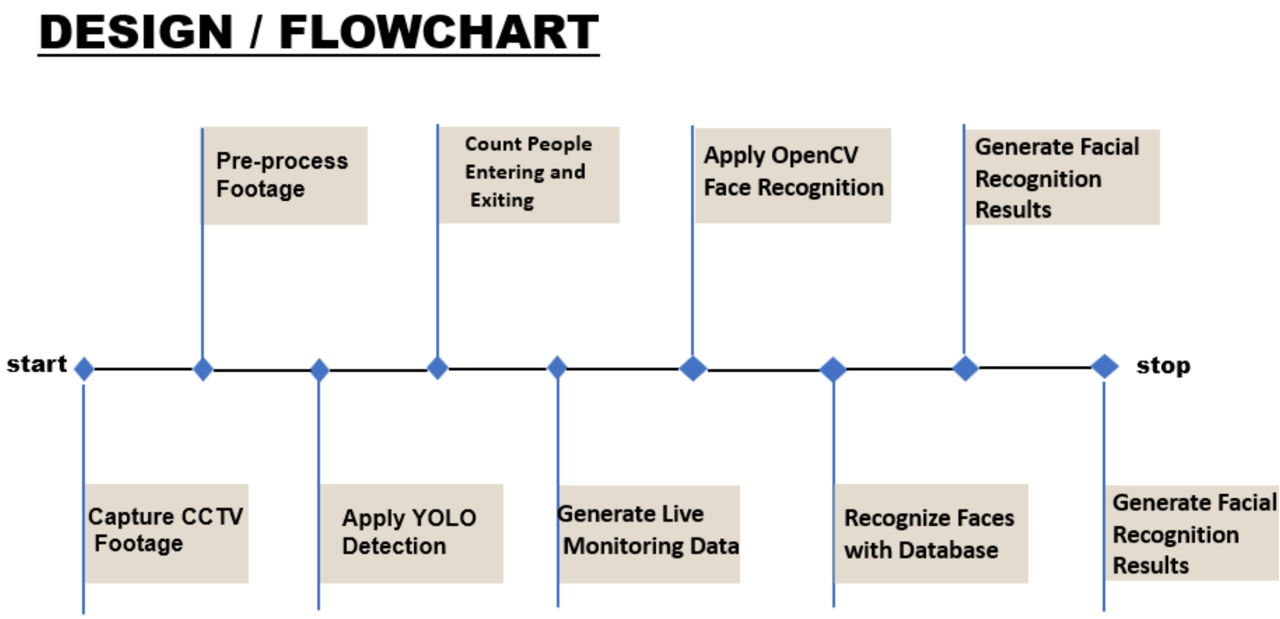


Figure 4.2: flowchart

fine-tuned the YOLO model to accurately detect and count the number of people entering and exiting a location in real-time as shown Figure 4.1 and performance measures as shown in Figure 4.4 and result analysis of yolo models are shown in Figure 4.5 which clearly describes the performance of YOLOV8.

Simultaneously, we employed OpenCV to create a database of individuals for face recognition. This database contained images of individuals along with their corresponding identities. We used OpenCV's facial recognition algorithms to match faces detected in the video footage with the images stored in the database. This allowed us to identify individuals present in the scene and associate them with their respective identities.

By integrating YOLO's object detection capabilities with OpenCV's face recognition technology, we developed a comprehensive surveillance system capable of providing detailed insights into crowd dynamics and individual presence in non-real-time scenarios. This integration streamlined the process of data collection and analysis, enhancing the efficiency and effectiveness of surveillance operations.

4.1.2 Data Collection and Footage Analysis

One of the key advantages of our system is its ability to ease the collection of data from video footage. YOLO's real-time object detection capabilities enable automatic count-

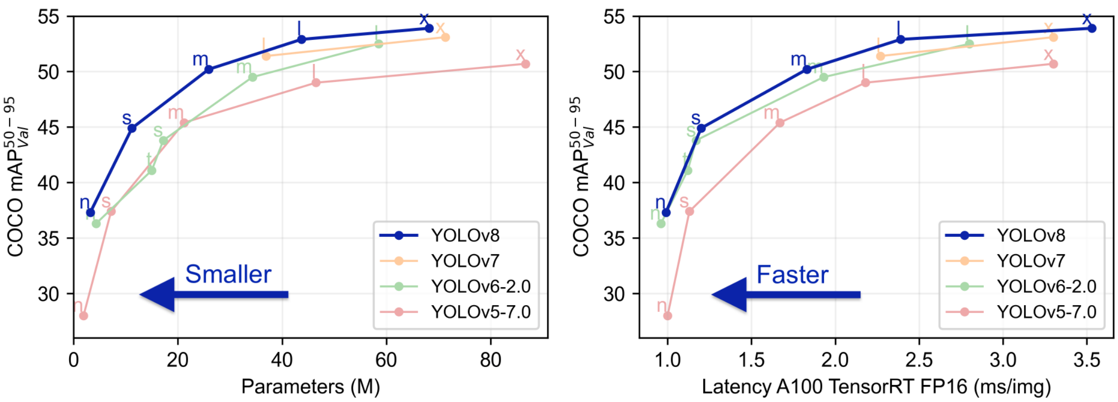


Figure 4.3: result analysis of YOLO

ing of people entering and exiting a location, eliminating the need for manual counting. This significantly reduces the time and effort required for data collection, especially in environments with high foot traffic.

Furthermore, OpenCV's face recognition algorithms facilitate the identification of individuals in the footage, providing valuable information about their presence and movements. By associating detected faces with identities stored in the database, our system enables detailed analysis of individual behavior and interactions within the crowd.

Through extensive testing and analysis of recorded video footage, we validated the accuracy and reliability of our system in non-real-time scenarios. The combination of YOLO's object detection and OpenCV's face recognition capabilities yielded precise results, enabling us to gather actionable insights from the collected data.

4.2 Real-time System

4.2.1 Integration with Live CCTV Feeds

Building upon the success of our non-real-time system, we extended our project to support real-time monitoring using live CCTV feeds. By integrating YOLO and OpenCV into existing CCTV systems, we enabled instant analysis of crowd dynamics and individual presence in real-time.

YOLO's efficient object detection algorithms operate seamlessly with live video streams, providing continuous updates on the number of people entering and exiting the monitored area. This real-time counting capability enhances situational awareness and facilitates timely decision-making in response to changing conditions.

Simultaneously, OpenCV's facial recognition module processes live footage, identifying individuals and matching them with their identities in the database. This enables security personnel to quickly identify known individuals and respond appropriately to security threats or incidents. As shown in Figure 4.3 it provide above 91 percentage accuracy and the result analysis of Opencv as shown in Figure 4.6.

By integrating YOLO and OpenCV into live CCTV systems, our project offers a comprehensive solution for real-time surveillance and monitoring. The combination of these technologies provides enhanced security measures and situational awareness, making it ideal for applications in public safety, transportation, and crowd management.

Figure 4.4: accuracy graph of open cv

4.2.2 Live Results and Situational Awareness

One of the key features of our real-time system is its ability to provide live results and situational awareness to users. YOLO's object detection algorithms continuously monitor the live video feed, updating the count of people entering and exiting the area in real-time. This information is displayed on a user interface, allowing operators to track crowd movements and identify potential security risks.

Meanwhile, OpenCV's facial recognition module processes live footage, identifying

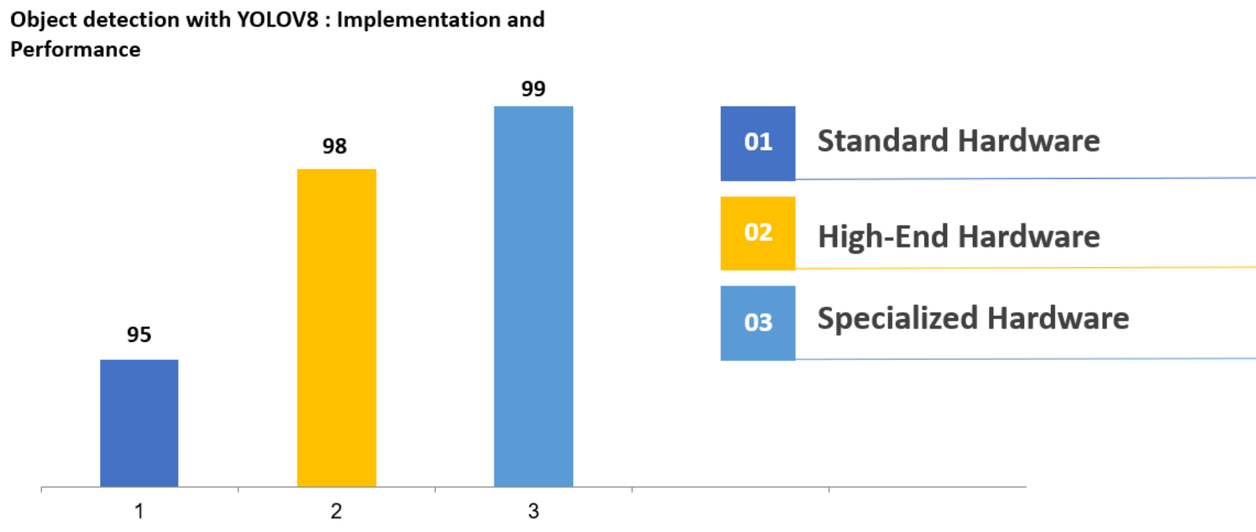


Figure 4.5: result analysis

individuals and displaying their identities on the user interface. This enables security personnel to quickly identify known individuals and monitor their movements within the monitored area.

By providing live results and situational awareness, our system empowers users to respond effectively to emerging situations and security threats. The combination of YOLO's object detection and OpenCV's face recognition capabilities enhances security measures and enables proactive decision-making in real-time scenarios.

4.3 Objectives

The primary objectives of our project are as follows:

4.3.1 Data Collection:

Gather data on individuals present during specific events or situations, including their identities and movements.

4.3.2 Crowd Monitoring:

Monitor the number of people entering and exiting a location in real-time, providing accurate counts and updates.

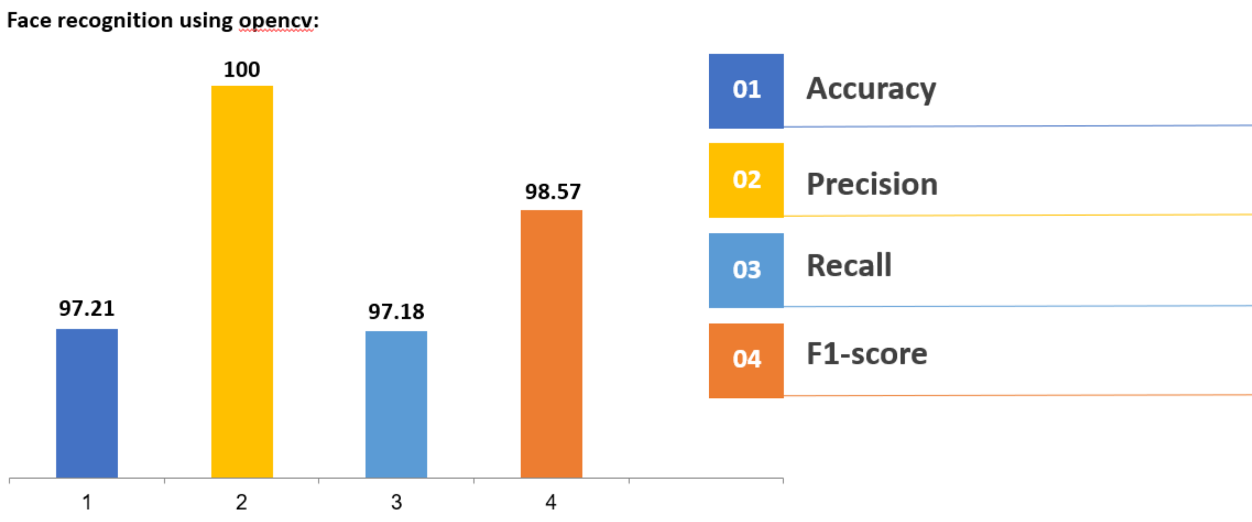


Figure 4.6: result analysis

4.3.3 Individual Identification:

Identify individuals present in the footage using facial recognition technology, associating them with their respective identities.

4.3.4 Situational Awareness:

Provide live results and situational awareness to users, enabling proactive decision-making and response to security threats or incidents.

By achieving these objectives, our project aims to enhance security measures, improve crowd management, and facilitate data-driven decision-making in various environments.

4.4 Methodology

Our methodology for implementing the project involved several key steps:

4.4.1 Dataset Collection:

Gather diverse datasets for training YOLO and creating the OpenCV face recognition database. The datasets include footage from different environments and scenarios to ensure robust performance.

4.4.2 Model Training:

Train the YOLO model on the collected datasets to accurately detect and count people in various scenarios. Fine-tune the model to achieve high accuracy and real-time performance.

4.4.3 Database Creation:

Use OpenCV to create a database of individuals for face recognition. Collect images of individuals along with their corresponding identities and store them in the database.

4.4.4 System Integration:

Integrate YOLO and OpenCV into a unified surveillance system capable of real-time monitoring and analysis. Ensure seamless communication between the two components for efficient data processing.

4.4.5 Testing and Evaluation:

Conduct extensive testing and evaluation of the system using recorded and live video footage. Validate the accuracy, reliability, and performance of the system in different scenarios.

4.4.6 Results Analysis:

Analyze the results obtained from the system to assess its effectiveness in achieving the project objectives. Compare the performance of the system against predefined metrics and benchmarks.

By following this methodology, we were able to successfully implement our project and achieve our objectives of data collection, crowd monitoring, individual identification, and situational awareness.

4.5 Conclusion

In conclusion, our project demonstrates the effectiveness of integrating YOLO object detection and OpenCV face recognition technologies for non-real-time and real-time surveillance applications. By leveraging the strengths of these two technologies, we developed a comprehensive surveillance system capable of gathering data, monitoring crowds, identifying individuals, and providing real-time situational awareness.

The successful implementation of our project offers significant benefits in terms of enhanced security, improved crowd management, and proactive decision-making. By providing accurate and timely information to security personnel and decision-makers, our system empowers them to respond effectively to security threats and incidents, ultimately enhancing safety and security in various environments.

Overall, our project showcases the potential of combining advanced computer vision technologies to address real-world challenges and improve security and safety in today's dynamic and evolving environments.

Chapter 5

Conclusion

In conclusion, the integration of CCTV documentation with advanced face recognition capabilities represents a transformative advancement in the realm of security and surveillance across diverse settings. This comprehensive solution not only addresses the shortcomings of traditional surveillance systems but also unlocks a myriad of possibilities for enhancing security measures. By automating counting processes and seamlessly integrating facial recognition technology, the proposed system significantly improves surveillance efficiency and accuracy. Moreover, the system's ability to swiftly identify individuals of interest or potential threats enhances the proactive monitoring capabilities of authorities, enabling them to respond effectively to security threats in real-time. The incorporation of real-time insights further strengthens the system's efficacy by providing actionable intelligence for timely decision-making. Beyond its functionality, the system's user-friendly interface and versatility underscore its potential for widespread adoption and application in various environments, ranging from public spaces like campuses and markets to commercial areas. Overall, the integration of CCTV documentation with advanced face recognition capabilities heralds a new era in surveillance technology, promising enhanced security and surveillance capabilities with far-reaching implications for public safety and security.

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