A

Industrial-Oriented

Mini Project On

USING EXISTING CCTV NETWORK FOR CROWD MANAGEMENT, CRIME PREVENTION AND WORK MONITORING USING AI & ML

(Submitted in partial fulfilment of the requirements for the award of Degree)

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

By

P.Arun	(227R1A05B1)
R.Shirisha	(227R1A05B5)
P.Geethika	(227R1A05A9)

Under the Guidance of

MD ASMA

(Assistant Professor)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CMR TECHNICAL CAMPUS

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Kandlakoya (V), Medchal Road, Hyderabad-501401.

April, 2025.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the project entitled "**A USING EXISTING CCTV NETWORK FOR CROW MANAGEMENT, CRIME PREVENTION AND WORK MONITORING USING ML & AI**" being submitted by **P.Arun (227R1A05B1), R.Shirisha (227R1A05B5) & P.Geethika (227R1A05A9)** in partial fulfilment of the requirements for the award of the degree of B.Tech in Computer Science and Engineering to the Jawaharlal Nehru Technological University Hyderabad, during the year 2024-25.

The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

MD.Asma
Assistant Professor
INTERNAL GUIDE

Dr. Nuthanakanti Bhaskar
HOD

Dr. A. Raji Reddy
DIRECTOR

Signature of External Examiner

Submitted for viva voice Examination held on ____________________

ACKNOWLEDGEMENT

We take this opportunity to express our gratitude to the people who have been instrumental in the successful completion of this project, we take this opportunity to express our profound gratitude and deep regard to our guide **MD Asma,** Assistant Professor for her exemplary guidance, monitoring and constant encouragement throughout the project work. The blessing, help and guidance given by her shall carry us a long way in the journey of life on which we are about to embark.

We take this opportunity to extend our heartfelt appreciation to the Project Review Committee (PRC) Coordinators— **B Sekhar, and S Hari Hara Nadha Sai**—for their unwavering support, insightful guidance, and valuable inputs, which played a crucial role in steering this project through its various stages.

Our sincere appreciation also goes to **Dr. Nuthanakanti Bhaskar**, Head, for his encouragement and continuous support in ensuring the successful completion of our project.

We are deeply grateful to **Dr. A. Raji Reddy**, Director, for his cooperation throughout the course of this project. Additionally, we extend our profound gratitude to Sri. **Ch. Gopal Reddy**, Chairman, Smt. **C. Vasantha Latha**, Secretary and Sri. **C. Abhinav Reddy**, Vice-Chairman, for fostering an excellent infrastructure and a conducive learning environment that greatly contributed to our progress.

We also acknowledge and appreciate the guidance and assistance provided by the faculty and staff of **CMR Technical Campus**, whose contributions have been invaluable in bringing this project to fruition.

Lastly, we sincerely thank our families for their unwavering support and encouragement. We also extend our gratitude to the teaching and non-teaching staff of CMR Technical Campus for their guidance and assistance. Their contributions, along with the support of everyone who helped directly or indirectly, have been invaluable in the successful completion of this project.

P. Arun (217R1A05B1)
R. Shirisha (227R1A05B5)
P. Geethika (227R1A05A9)

VISION AND MISSION

INSTITUTE VISION:

To Impart quality education in serene atmosphere thus strive for excellence in Technology and Research.

INSTITUTE MISSION:

1. To create state of art facilities for effective Teaching- Learning Process.
2. Pursue and Disseminate Knowledge based research to meet the needs of Industry & Society.
3. Infuse Professional, Ethical and Societal values among Learning Community.

DEPARTMENT VISION:

To provide quality education and a conducive learning environment in computer engineering that foster critical thinking, creativity, and practical problem-solving skills.

DEPARTMENT MISSION:

1. To educate the students in fundamental principles of computing and induce the skills needed to solve practical problems.
2. To provide State-of-the-art computing laboratory facilities to promote industry institute interaction to enhance student’s practical knowledge.
3. To inculcate self-learning abilities, team spirit, and professional ethics among the students to serve society.

ABSTRACT

In the constantly evolving realm of urban security, the incorporation of machine learning (ML) technologies into existing Closed-Circuit Television (CCTV) networks emerges as a game-changing solution. Inspired by real- world challenges where traditional surveillance methods often falter, our project sets out to redefine urban safety through innovative technological interventions. Our approach harness the potential of ML, involving the YOLOv8 (YOU ONLY LOOK ONCE) algorithm, to conduct real-time analysis of video feeds, swiftly identifying suspicious activities, anomalies, crowd congestion, weapons, and known criminal faces. By seamlessly integrating ML- generated insights with conventional surveillance techniques, we aim to elevate the public safety, enhance law enforcement efficiency, prevent crimes, and streamline operational processes. Additionally, our system leverages crime prevention efforts. Moreover, we incorporated a work monitoring module, for tracking employee presence, work utilization, and non-violent scenarios to optimize workplace safety. This initiative marks a significant milestone in urban security, laying the groundwork for safer and smarter cities in the future.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

1. INTRODUCTION

1. INTRODUCTION

In the dynamic landscape of urban security, this project stands at the forefront, leveraging the power of machine learning (ML) technologies to revolutionize existing Closed-Circuit Television (CCTV) networks. By leveraging the state-of-theart algorithms like YOLOv8 (You Only Look Once), the project focuses on three critical aspects: crowd management, crime prevention, and work monitoring. The crowd management module enables real-time video analysis and crowd density estimation, allowing for the identification of overcrowding situations and facilitating efficient deployment of crowd control measures. The crime prevention module employs ML algorithms to detects violent behaviour and nonviolent behaviour, and identifies potentially dangerous weapons such as pistols and knifes .The Work monitoring module optimizes workplace safety by tracking employee presence, workplace utilization, and non-violent scenarios. By integrating ML techniques with existing CCTV networks, this initiative redefines urban security and sets a new standard for proactive crowd control, crime prevention, and operational efficiency.

The integration of Machine learning (ML) techniques with Closed-Circuit Television (CCTV) networks has gained significant attention in recent years, with numerous studies exploring the potential of ML algorithms for enhancing urban security. Among these studies, the yolo (You Only Look Once) algorithm has emerged as a promising solution for real-time video analysis and object detection. In the context of urban security, YOLO has been used for various applications, including crowd management, crime prevention and work monitoring. For instance, a study Wang et al (2022) integrated yolo with criminal face recognition to detect and identify wanted individuals from a database of known offenders, further enhancing crime prevention efforts. In addition to crowd management and crime prevention, YOLO has been used for work monitoring applications.

1.1 PROJECT PURPOSE

In the constantly evolving realm of urban security, the incorporation of machine learning (ML) technologies into existing Closed-Circuit Television (CCTV) networks emerges as a game changing solution. Inspired by real- world challenges where traditional surveillance methods often falter; our project sets out to redefine urban safety through innovative technological interventions. Our approach harnesses the potential of ML, involving the YOLOv8 (YOU ONLY LOOK ONCE) algorithm, to conduct real-time analysis of video feeds, swiftly identifying suspicious activities, anomalies, crowd congestion, weapons, and known criminal faces. By seamlessly integrating ML- generated insights with conventional surveillance techniques, we aim to elevate the public safety, enhance law enforcement efficiency, prevent crimes, and streamline operational processes. Additionally, our system leverages further crime prevention efforts. Moreover, we incorporated a work monitoring module, for tracking employee presence, work utilization, and non-violent scenarios to optimize workplace safety. This initiative marks a significant milestone in urban security, laying the groundwork for safer and smarter cities in the future

1.2 PROJECT FEATURES

The system seamlessly integrates state-of-the-art AI models into existing CCTV networks to deliver real-time crowd management, weapon detection, and criminal face recognition. Leveraging YOLOv8, it accurately detects and counts individuals in both image and video feeds, while concurrently identifying firearms and knives. Beyond real-time detection of people and weapons, the system also includes automated crowd density estimation and threshold-based alerting to preemptively manage overcapacity scenarios. Its modular design allows independent training and updating of each AI component—YOLOv8 for object detection, models can be fine-tuned and swapped without disrupting the overall pipeline. The Tkinter GUI not only overlays live bounding boxes and counts but also logs every event with timestamps, enabling post-event analysis and audit trails. Performance monitoring is built in: users can view training curves within the same interface and export logs for external review. The solution supports batch processing of archived footage, making it useful for forensic investigations, while its lightweight footprint ensures it can be deployed on edge devices or scaled up to cloud-based clusters.

2. LITERATURE SURVEY

1.LITERATURE SURVEY

Crowd management is crucial for countries and organizations as it can lead to severe consequences or serious safety concerns. Most of the existing research focus on addressing limited crowd management issues, namely crowd counting, density estimation, localization, and behaviour monitoring. Furthermore, the generated incidents' alerts are mostly not interpretable and remediable. Therefore, there is no comprehensive solution that addresses all these issues. This research proposes a comprehensive intelligence-based crowd management framework that employs anomaly rules to monitor, predict, and detect crowd accidents and help in providing quick response. The suggested crowd intelligence framework addresses all crowd management issues.

The use case chosen for this framework is the management of crowds of pilgrims in Umrah Holy event. The proposed framework is then implemented and evaluated with respect to efficiency, scalability, interpretability, irremediability, and the number of false positive, true positive, and false negative alerts. In addition, the suggested framework is compared with other recent related work in terms of supporting crowd management issues. The design of the proposed framework and implementation are then fine-tuned in light of the evaluation results. The results and findings of this research can be extended to manage crowds at any event.

Security is the biggest concern in today's world which needs to be addressed to save people from critical threats. We need to detect these threats at the earliest to protect people and take required actions. Security cameras are used almost everywhere now ranging from our home to shopping malls to banks. Currently, not many surveillance cameras have an automatic weapon detection system but with the advancement in technologies, it can be easily equipped. This will help the people in charge concerned to take the appropriate actions and thus prevent crimes. Deep learning techniques are used widely to detect objects as the traditional methods of object detection have their own limitations in certain situations.

One such algorithm – Mask RCNN is implemented in this work to detect guns from surveillance video images. Gaussian deblur technique is used to enhance the features of handgun for efficient detection especially in blurred images. The experiment results show that the performance of the model increased with pre-processing.

With the extraordinary growth in images and video data sets, there is a mind-boggling want for programmed understanding and evaluation of data with the assistance of smart frameworks, since physically it is a long way off. Individuals, unlike robots, have a limited capacity to distinguish unexpected expressions. As a result, the programmed face proximity frame- work is important in face identification, appearance recognition, head-present evaluation, human-PC cooperation, and other applications. Software that uses facial recognition for face detection and identification is regarded as biometric.

This study converts the mathematical aspects of a person’s face into a face print, which is then stored in a database to verify an individual’s identification. A deep learning system compares a digital image or an image taken quickly to a previously stored image (which is saved in the database). The face has a significant function in interpersonal communication for identifying oneself. Face recognition technology determines the size and placement of a human face in a digital picture. Facial recognition software has a wide range of uses in the consumer market and in the security and surveillance sectors. The COVID pandemic has brought facial recognition into greater focus lately than ever before.

Face detection and recognition play a vital part in security systems that people need to interact with without making physical contact. The pattern of online exam proctoring is employing face detection and recognition. Facial recognition is used in the airline sector to enable rapid, accurate identification and verification at every stage of the passenger trip. In this research, we focused on image quality because it is the major drawback in existing algorithms and used OPEN CV, Face Recognition, and designed algorithms using libraries in python. This study discusses a method for facial recognition along with its implementation and applications.

Classification is a well-known supervised learning technique in data mining. It is used to extract meaningful information from large datasets and can be effectively used for predicting unknown classes. In this research, classification is applied to a crime dataset to predict ‘Crime Category’ for different states of the United States of America. The crime dataset used in this research is real in nature, it was collected from socio-economic data from 1990 US Census, law enforcement data from the 1990 US LEMAS survey, and crime data from the 1995 FBI UCR.

This paper compares the two different classification algorithms namely, Naïve Bayesian and Decision Tree for predicting ‘Crime Category’ for different states in USA. The results from the experiment showed that, Decision Tree algorithm out performed Naïve Bayesian algorithm and achieved 83.9519% Accuracy in predicting ‘Crime Category’ for different states of USA.

Data mining is a way to extract knowledge out of usually large data sets; in other words, it is an approach to discover hidden relationships among data by using artificial intelligence methods. The wide range of data mining applications has made it an important field of research. Criminology is one of the most important fields for applying data mining. Criminology is a process that aims to identify crime characteristics. Actually, crime analysis includes exploring and detecting crimes and their relationships with criminals. The high volume of crime datasets and also the complexity of relationships between these kinds of data have made criminology an appropriate field for applying data mining techniques.

The knowledge that is gained from data mining approaches is a very useful tool which can help and support police forces. An approach based on data mining techniques is discussed in this paper to extract important entities from police narrative reports which are written in plain text. By using this approach, crime data can be automatically entered into a database, in law enforcement agencies. We have also applied a SOM clustering method in the scope of crime analysis and finally we will use the clustering results in order to perform crime matching process.

2.1 DEFINITION OF PROBLEM STATEMENT

In modern urban environments, ensuring public safety, managing large crowds, and monitoring workplace activities have become increasingly complex and critical tasks. Traditional CCTV surveillance systems, which rely on manual monitoring and outdated detection algorithms, are no longer sufficient to handle these challenges effectively. These systems often suffer from delayed responses, limited accuracy in crowded or dynamic scenes, and lack the intelligence needed for detecting weapons, identifying criminal behavior, or monitoring workforce efficiency.

This project aims to address these limitations by leveraging existing CCTV infrastructure and integrating advanced models such as YOLOv8 for object detection, to enable real-time crowd analysis, crime prevention, and workplace monitoring with improved accuracy, speed, and reliability.

2.2 EXISTING SYSTEM

In existing technique manual human efforts required to monitor crowd in the public area but propose algorithm will detect all moving persons and then count them as crowd. This application will work on any CCTV videos where moving crowds exists. The current surveillance system relies on YOLOv4 for real-time object detection within CCTV networks, but it has limitations including dependency on predefined class, reduced accuracy in crowded scenes and reliance manual monitoring, leading to errors and delayed responses. To overcome these challenges and improve urban surveillance, an enhanced system integrating advanced AI & ML techniques in necessary. By leveraging cutting-edge algorithms like deep learning and ensemble methods, the system can adopt to emerge threats, handle complex scenarios like crowd density estimation, and automate monitoring processes for quicker detection and response .

Limitations of Existing System

- **Manual Monitoring Dependency**

The current system relies heavily on human operators to monitor CCTV footage, which is time-consuming, error-prone, and inefficient, especially in high-crowd-density areas.

- **Use of Outdated YOLOv4 Algorithm**

The existing system uses YOLOv4, which, while powerful, has lower performance compared to more recent versions like YOLOv8. It struggles with precision and recall in complex scenarios such as dense crowds or small object detection.

- **Accuracy Issues in Crowded Environments**

The object detection model used in the existing system shows reduced accuracy when detecting individuals in highly crowded scenes, leading to underestimation or misidentification of people.

- **Limited Real-Time Response**

The existing solution often experiences delays in response time, which is critical in emergency scenarios like violent behavior or weapon detection.

- **No Integrated Weapon Detection or Criminal Recognition**

There is no integration with weapon detection models or facial recognition systems for identifying known criminals, which limits the system's ability to proactively prevent crime.

- **Lack of Scalability & Intelligence**

The system does not incorporate adaptive AI/ML techniques to learn from new threats or scenarios, making it less scalable for evolving urban security needs.

2.3 PROPOSED SYSTEM

In this project you are asking to manage crowd using advance AI and ML algorithms so we are implementing YoloV8 algorithm which is more advance than any other algorithms exist today. This algorithm will detect only available peoples in the current frame of CCTV footage and then count them, if number of crowds increases then there is a chance of crime and system will alert authorities to take necessary action.

Advantages of the Proposed System:

The proposed system significantly improves upon the existing approaches by addressing key limitations:

- Utilizes YOLOv8 for improved object detection accuracy and speed
- Accurately detects and counts individuals in real-time from CCTV footage
- Identifies overcrowding situations for effective crowd management
- Detects weapons like guns and knives for crime prevention
- Integrates facial recognition to identify known criminals
- Reduces manual surveillance efforts with automated monitoring
- Enhances workplace safety by tracking employee presence and activities
- Provides real-time alerts for quick response to threats or anomalies
- Decreases execution time with optimized ML models
- Offers a user-friendly GUI for easy interaction and control
- Supports both image and video inputs for flexible monitoring
- Improves precision and recall through advanced model training
- Visualizes model performance with training graphs for better insights
- Can be deployed using existing CCTV infrastructure, reducing setup costs
- Easily scalable for different environments like malls, offices, or public events
- Minimizes human error in surveillance and threat detection

2.4 OBJECTIVES

- To integrate advanced AI and ML algorithms into existing CCTV surveillance systems
- To detect and count individuals in real-time for effective crowd management
- To identify overcrowded areas and generate alerts to prevent potential hazards
- To detect weapons such as knives and guns for timely crime prevention
- To recognize known criminals using facial recognition from a pre-defined database
- To monitor employee presence and activities for improved workplace safety
- To reduce dependency on manual surveillance and improve system accuracy
- To provide real-time alerts and notifications for quick response to threats
- To ensure scalability and adaptability across different environments
- To visualize model performance using training graphs for better system tuning
- To enable batch processing of archived footage for forensic investigations
- To support multi-camera synchronization and cross-camera tracking
- To optimize resource usage for deployment on edge devices and cloud environments
- To facilitate periodic model retraining with new, real-world data for continuous improvement
- To allow seamless integration with existing security and emergency response infrastructures
- To implement predictive analytics for early threat forecasting and resource allocation

2.5 HARDWARE & SOFTWARE REQUIREMENTS

2.5.1 HARDWARE REQUIREMENTS:

Hardware interfaces specifies the logical characteristics of each interface between the software product and the hardware components of the system. The following are some hardware requirements,

2.5.1.1	Processor	:	Intel Core i3
2.5.1.2	Hard disk	:	500GB.
2.5.1.3	RAM	:	4GB.
2.5.1.4	Speed	:	1.1 GHZ

2.5.2 SOFTWARE REQUIREMENTS:

Software Requirements specifies the logical characteristics of each interface and software components of the system. The following are some software requirements,

2.5.2.1	Operating system	:	Windows 10
2.5.2.2	Language	:	Python

3. SYSTEM ARCHITECTURE & DESIGN

3. SYSTEM ARCHITECTURE & DESIGN

The system architecture is designed to integrate AI and ML models into an existing CCTV network for real-time crowd and weapon detection. The pipeline begins with image or video input from CCTV, followed by preprocessing steps like frame extraction and resizing. The processed data is passed through the YOLOv8 object detection model, which identifies people and weapons. Based on this output, the Crowd Management Module counts individuals and raises alerts for overcrowding, while the Crime Prevention Module detects weapons like guns or knives. The results are displayed via a user-friendly Tkinter-based GUI, and the entire system is launched through a single run.py script, ensuring seamless execution.

3.1 PROJECT ARCHITECTURE

The system processes CCTV feeds using AI models for crowd and weapon detection, generating alerts and displaying results through a Tkinter GUI.

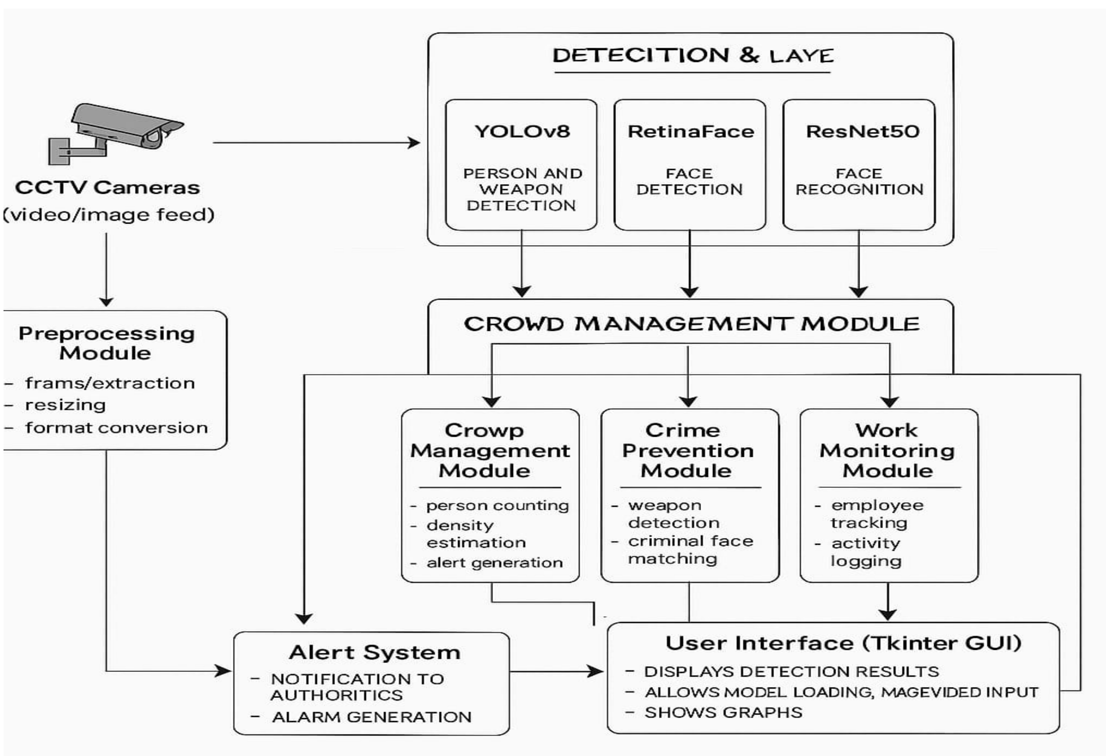

Figure 3.1: Project Architecture of Using Existing CCTV Network for Crowd Management, Crime Prevention &work Monitoring using AI & ML

3.2 DESCRIPTION

The architecture represents an intelligent surveillance system that leverages existing CCTV infrastructure and integrates AI/ML models for real-time analysis and decision-making. It begins with CCTV cameras capturing video or image feeds, which are then sent to the Preprocessing Module for frame extraction, resizing, and format conversion to prepare the data for analysis. The processed input is passed to the Detection Layer, where three specialized models operate: YOLOv8 detects both persons and weapons.

The outputs from these models feed into the **Crowd Management Module**, which is divided into two functional sub-modules:

- **Crowd Management Module**: Handles person counting, crowd density estimation, and generates alerts when thresholds are exceeded.
- **Crime Prevention Module**: Detects the presence of weapons and matches detected faces against a database of known criminals.

Detection results are displayed in a user-friendly **Tkinter GUI**, which allows model selection, manual input (images/videos), and visualization through graphs. If any critical event is detected—such as a weapon or overcrowding—the **Alert System** is triggered to send notifications to authorities and raise alarms, ensuring timely intervention. This integrated architecture supports public safety, operational efficiency, and proactive incident response.

3.3 DATA FLOW DIAGRAM

Data flow diagrams illustrate how data is processed by a system in terms of inputs and outputs. Data flow diagrams can be used to provide a clear representation of any business function. The technique starts with an overall picture of the business and continues by analysing each of the functional areas of interest. This analysis can be carried out in precisely the level of detail required. The technique exploits a method called top-down expansion to conduct the analysis in a targeted way.

As the name suggests, Data Flow Diagram (DFD) is an illustration that explicates the passage of information in a process. A DFD can be easily drawn using simple symbols. Additionally, complicated processes can be easily automated by creating DFDs using easy-to-use, free downloadable diagramming tools. A DFD is a model for constructing and analysing information processes. DFD illustrates the flow of information in a process depending upon the inputs and outputs. A DFD can also be referred to as a Process Model. A DFD demonstrates business or technical process with the support of the outside data saved, plus the data flowing from the process to another and the end results.

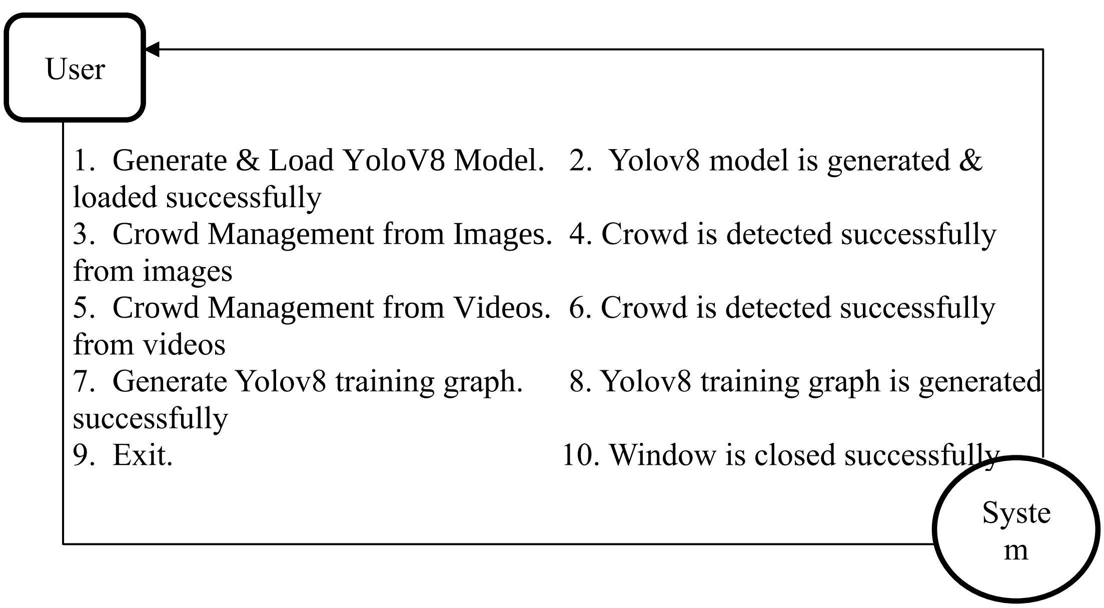

Figure 3.2 : Project Architecture of Using Existing CCTV Network for Crowd Management, Crime Prevention &work Monitoring using AI & ML

This Data Flow Diagram (DFD) represents the flow of data in your AI-based CCTV surveillance system for crowd management and crime prevention.

Description:

- **Input (CCTV Cameras):**

  The system begins with real-time input from CCTV cameras capturing video/image feeds.

- **Preprocessing Module**:

  This module processes the raw video/images by extracting frames, resizing them, and converting formats to prepare the data for analysis.

- **Detection Layer**:

  - YOLOv8 handles person and weapon detection.
  - RetinaFace detects faces.
  - ResNet50 is used for face recognition.

- **Crowd Management Module**:

  - Crowd Management: Person counting, crowd density estimation, and alert generation.
  - Crime Prevention: Detects weapons and matches faces with criminal databases.
  - Work Monitoring: Tracks employee behavior and logs activities.

- **User Interface (GUI)**:

  Built using Tkinter, displays results from the models, allows users to upload images/videos, visualizes outputs through graphs and tables.

4. IMPLEMENTATION

IMPLEMENTATION

The implementation phase of a project involves executing the planned strategies and tasks. It requires meticulous coordination, resource allocation, and monitoring to ensure that objectives are met efficiently. Effective implementation is crucial for achieving project goals and delivering expected outcomes within the set timeline and budget constraints.

4.1 ALGORITHMS USED

YOU ONLY LOOK ONCE(YOLOv8):

YOLOv8 is the latest version of the YOLO (YOU ONLY LOOK ONCE) object detection algorithm, developed by Ultralytics. The state-of-the-art YOLOv8 (YOU ONLY LOOK ONCE) object detection model is employed as the core component for various tasks including crowd management, violence detection, weapon detection and work monitoring. In crowd management scenarios, it can detect and track individuals, estimate crowd density. For violence detection, it can recognize aggressive actions, fights or suspicious behaviour and for weapon detection, yolov8 can be trained to identify firearms, knives enhancing security measures. In work monitoring, the algorithm can track worker movements and detects potential safety violations. It takes an input image or video frame and divides it into a grid of cells. For each cell, the algorithm predicts a set of bounding boxes and confidence scores for object present within that cell, along with the class probabilities for each bounding box. The final output is a set of bounding boxes with their corresponding class labels and confidence scores. YOLOv8 incorporates several improvements over previous versions, such as backbone network for feature extraction, optimized anchor box, advanced data augmentation technique.

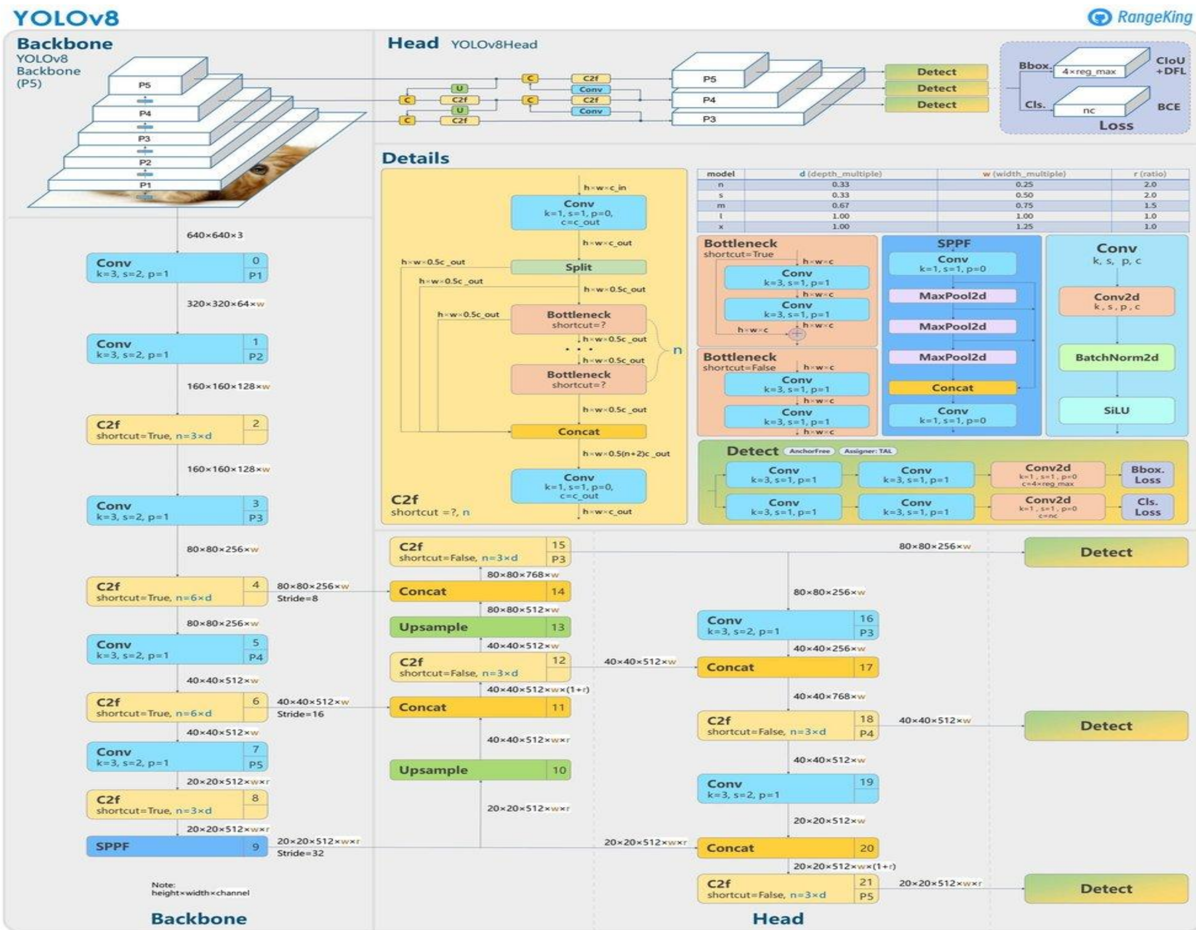

Figure 4.1 : YOLOV8 Architecture

ADVANTAGES OF YOU ONLY LOOK ONCE(YOLOv8):

- Provides real-time object detection with high speed and accuracy
- Detects small, occluded, or overlapping objects effectively
- Lightweight model suitable for deployment on low-resource devices
- Offers improved bounding box precision
- Supports transfer learning for customized detection tasks
- Capable of object detection, classification, and segmentation
- Easy to integrate with various platforms and applications
- Backed by strong community support and regular updates

4.2 SAMPLE CODE

```
import cv2
import tkinter as tk
from tkinter import filedialog
from ultralytics import YOLO
from PIL import Image, ImageTk
from matplotlib.backends.backend_tkagg
import FigureCanvasTkAgg
from matplotlib.figure import Figure
# Initialize models as None
crowd_model = None
weapon_model = None
# Setup GUI
root = tk.Tk()
root.title("Crowd & Weapon Detection")
root.geometry("1000x720")
root.configure(bg="#e6f2ff")  # Light blue background
canvas = tk.Canvas(root, width=700, height=500, bg="white")
canvas.pack(pady=10)
# Status label
status_label = tk.Label(root, text="", font=("Arial", 12), bg="#e6f2ff")
status_label.pack(pady=5)
canvas_image_id = None
canvas_close_button = None
# Graph setup
fig = Figure(figsize=(5, 2), dpi=100)
ax = fig.add_subplot(111)
canvas_fig = None  # Will be initialized only on View Graph
```

```
def load_crowd_model():
    global crowd_model
    try:
        crowd_model = YOLO("yolov8_model/best.pt")
        status_label.config(text="Crowd Model Loaded ✅", fg="green")
    except Exception as e:
        status_label.config(text=f"Error: {e}", fg="red")
def load_weapon_model():
    global weapon_model
    try:
        weapon_model = YOLO("weapon_model/best.pt")
        status_label.config(text="Weapon Model Loaded ✅", fg="green")
    except Exception as e:
        status_label.config(text=f"Error: {e}", fg="red")
def show_image(img):
    global canvas_image_id,  canvas_close_button
    img_rgb = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    img_pil = Image.fromarray(img_rgb).resize((700, 500))
    img_tk = ImageTk.PhotoImage(image=img_pil)
    canvas_image_id = canvas.create_image(0, 0, anchor=tk.NW,
    image=img_tk)
    canvas.image = img_tk
    # Add X button to close image
    if canvas_close_button:
        canvas.delete(canvas_close_button)
```

```
 canvas_close_button = canvas.create_text(680, 20, text="❌",
   font=("Arial", 20), fill="red", activefill="darkred")
  canvas.tag_bind(canvas_close_button,
"<Button-1>", lambda e: clear_canvas())
  # function for  clearing
def clear_canvas():
   global canvas_image_id, canvas_close_button
   if canvas_image_id:
      canvas.delete(canvas_image_id)
      canvas_image_id = None
   if canvas_close_button:
      canvas.delete(canvas_close_button)
      canvas_close_button = None
   canvas.image = None

#function for detect objection
def detect_objects(img):
   person_count = 0
   weapon_count = 0
   if crowd_model:
      results_crowd = crowd_model(img)[0]
      for box in results_crowd.boxes:
         x1, y1, x2, y2 = map(int,box.xyxy[0])
         cls = int(box.cls[0])
         label = crowd_model.names[cls]
         if label.lower() == "person":
            person_count += 1
         cv2.rectangle(img, (x1, y1), (x2, y2), (255, 0, 0), 2)
```

```
cv2.putText(img, label, (x1, y1 - 10),
  cv2.FONT_HERSHEY_SIMPLEX, 0.9,  (255, 0, 0), 2)
    if weapon_model:
        results_weapon = weapon_model(img)[0]
        for box in results_weapon.boxes:
            x1, y1, x2, y2 = map(int,box.xyxy[0])
            cls = int(box.cls[0])
            label = weapon_model.names[cls]
        weapon_count += 1
            cv2.rectangle(img, (x1, y1), (x2, y2), (0, 0, 255), 2)
            cv2.putText(img, label, (x1, y1 - 10),
           cv2.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0, 255), 2)
    return img, person_count, weapon_count
# function for uploading image
def open_image():
    file_path = filedialog.askopenfilename(initialdir="images",
    filetypes=[("Image files", "*.jpg *.png *.jpeg")])
    if file_path:
        img = cv2.imread(file_path)
        if img is None:
            status_label.config(text="Failed to read image", fg="red")
            return
        detected_img, _, _ = detect_objects(img)
        show_image(detected_img)
# function for uploading video
def open_video():
    file_path = filedialog.askopenfilename(initialdir="video",
    filetypes=[("Video files", "*.mp4 *.avi")])
```

```
  if not file_path:
        status_label.config(text="Video selection cancelled.", fg="orange")
        return
    cap = cv2.VideoCapture(file_path)
    if not cap.isOpened():
        status_label.config(text="Unable to open video file.", fg="red")
        return
    while cap.isOpened():
        ret, frame = cap.read()
        if not ret:
            break  # If frame is not successfully read, exit the loop
# Detect objects and draw bounding boxes on the frame
        detected_frame, _, _ = detect_objects(frame)
        # Show the frame with bounding boxes
        show_image(detected_frame)
        # Update the GUI for each frame
        root.update()
    cap.release()  # Release the video capture object when done
def graph():
    graph_img = cv2.imread('yolov8_model/results.png')
    graph_img = cv2.resize(graph_img, (800, 600))
    cv2.imshow("YOLO Training Graph", graph_img)
    cv2.waitKey(0)
# Button Layout
btn_frame = tk.Frame(root, bg="#e6f2ff")
btn_frame.pack(pady=10)
tk.Button(btn_frame, text="Load Crowd Model",
command=load_crowd_model).grid(row=0, column=0, padx=8)
```

```
tk.Button(btn_frame, text="Load Weapon Model",
command=load_weapon_model).grid(row=0, column=1, padx=8)
tk.Button(btn_frame, text="Upload Image",
command=open_image).grid(row=0,
column=2, padx=8)
tk.Button(btn_frame, text="Upload Video",
command=open_video).grid(row=0,
column=3, padx=8)
tk.Button(btn_frame, text="View Graph", command=graph)
.grid(row=0, column=4, padx=8)
root.mainloop()
```

5. RESULTS & DISCUSSION

RESULTS & DISCUSSION

The following screenshots showcase the results of our project, highlighting key features and functionalities. These visual representations provide a clear overview of how the system performs under various conditions, demonstrating its effectiveness and user interface. The screenshots serve as a visual aid to support the project's technical and operational achievements.

5.1 GUI/Main Interface :

In below screen, click on 'Generate & Load YoloV8 Model' button to load Yolo8 algorithm .

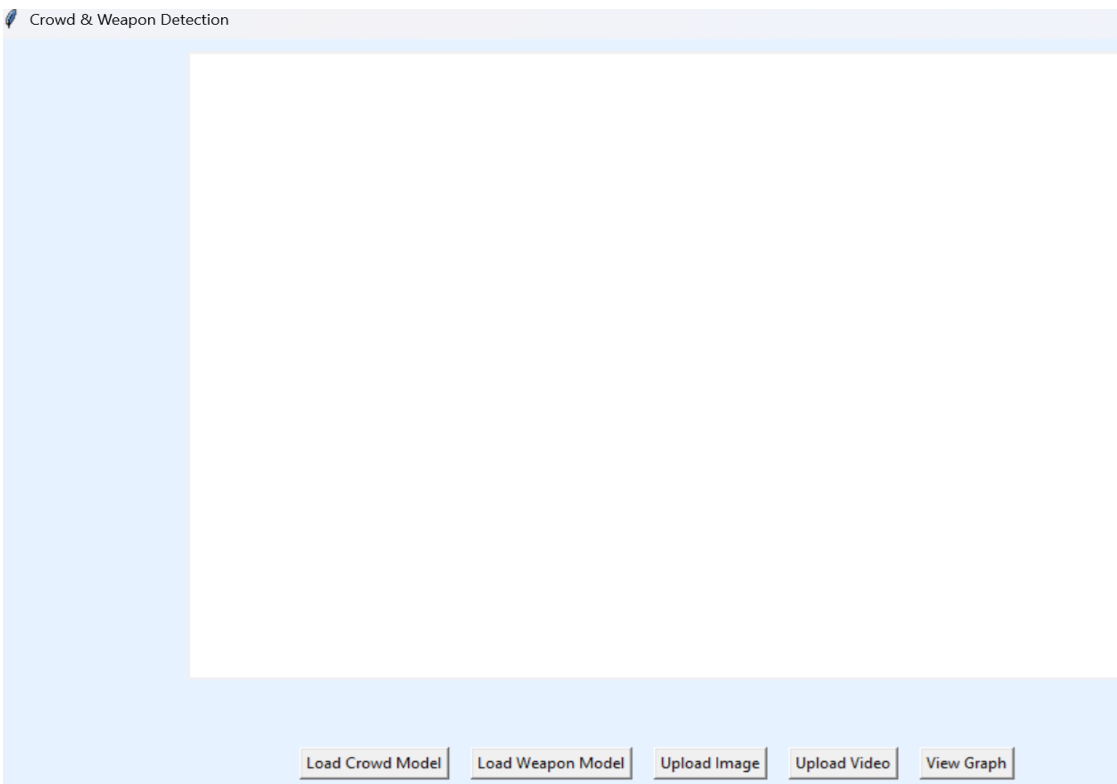

Figure 5.1 : GUI/Main Interface of Using Existing CCTV Network for Crowd Management, Crime Prevention &work Monitoring using AI & ML

5.2 Loaded Sample Image :

In below screen model loaded and now click on ‘Crowd Management from Images’ button to upload image and get output

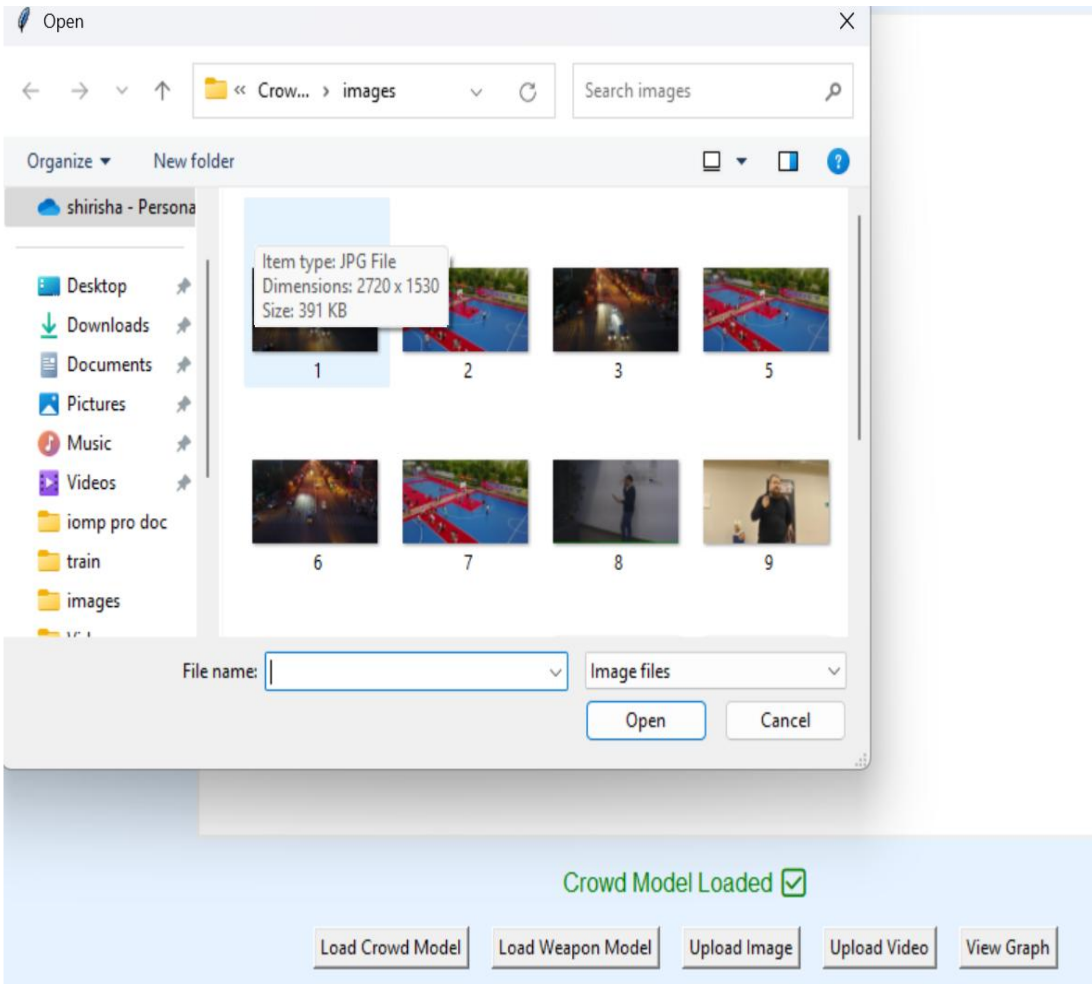

Figure 5.2 : Loaded sample image of Using Existing CCTV Network for Crowd Management, Crime Prevention &work Monitoring using AI & ML

In above screen selecting and uploading image and then click on ‘Open’ button to get below output

5.3 Detect Crowd :

In below screen we can see all detected crowd objects and then each crowd person is marked with their appearance count and similarly you can upload video also

Figure 5.3 : Detected crowd objects and then each crowd person is marked with their appearance count

5.4 Upload And Test Videos Of Any Moving Crowds:

In below screen, by playing video we can see all detected crowd peoples and then in red colour we can see current frame crowd count and similarly you can upload and test videos of any moving crowds. Now click on 'YoloV8 Training Graph' button to get below graph

Figure 5.4 : All detected crowd peoples and then in red colour we can see current frame crowd count of a uploaded video.

5.5 DETECT WEAPON

In below screen we can see all detected weapon objects for an uploaded image or an video. Here the weapon is detected as pistol with a bounded box and label

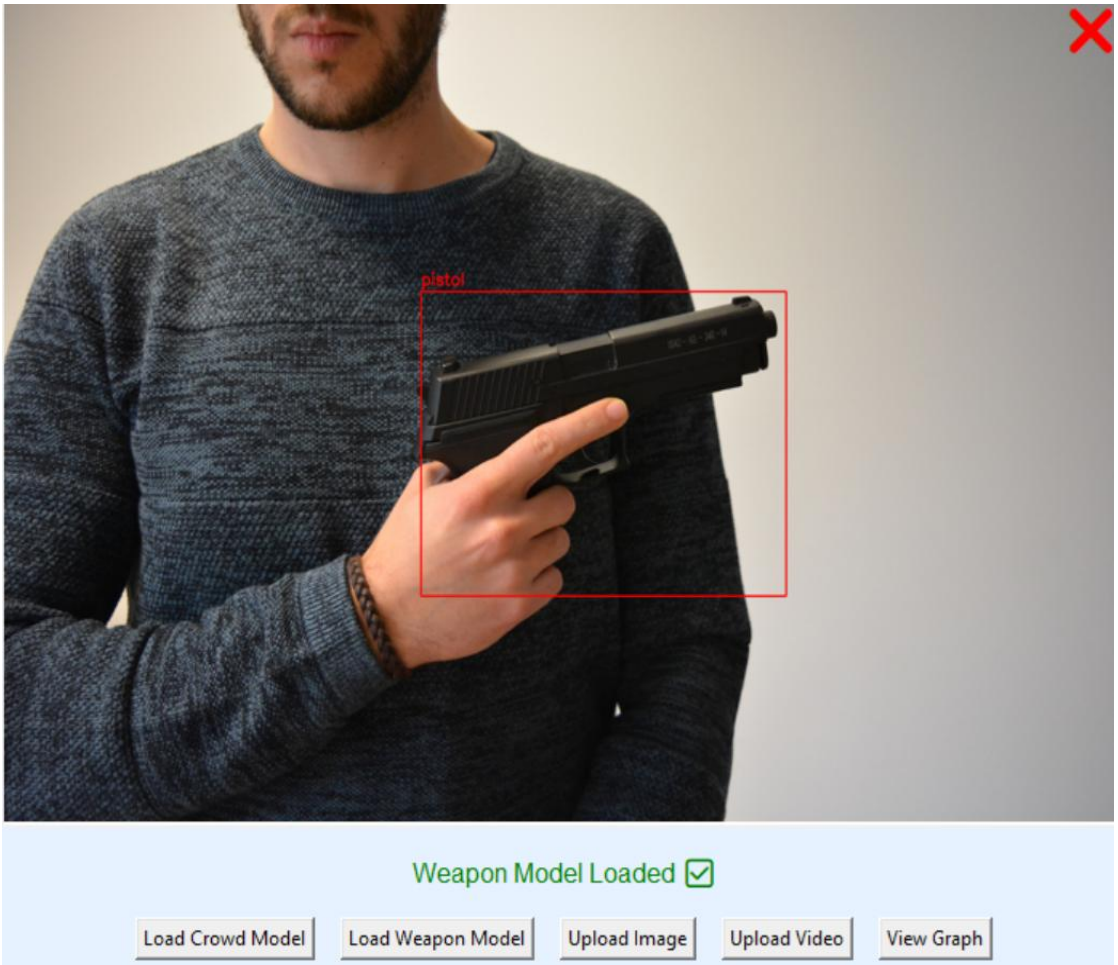

Figure 5.5 : Detected weapon objects with a bounded box and weapon label as pistol

5.6 DISPLAY WEAPON IN IMAGE

In below screen we can see all detected weapon objects for an uploaded image or an video. Here the weapon is detected as Knife with a bounded box and label

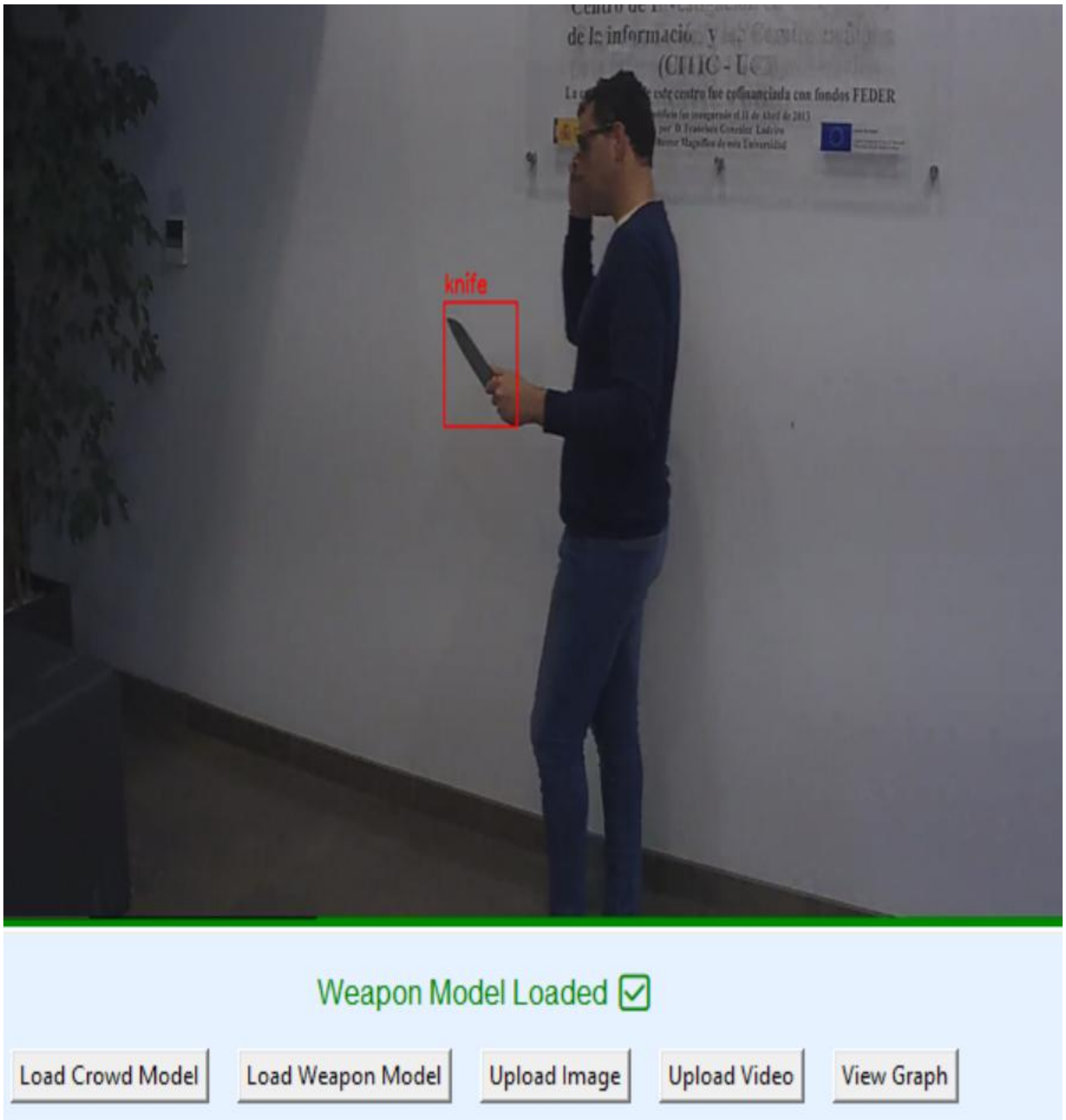

Figure 5.6 : Detected weapon objects with a bounded box and weapon label as Knife

5.7 Display of Training Graph :

Now click on 'YoloV8 Training Graph' button to get below graph. In above graph x-axis represents training epochs from 0 to 40 and y-axis represents Recall, Precision and loss in different graphs. In above graphs we can see loss values continuously decrease with each training epoch and reached closer to 0 and precision, recall continuously increase with each epoch and reached closer to 1.

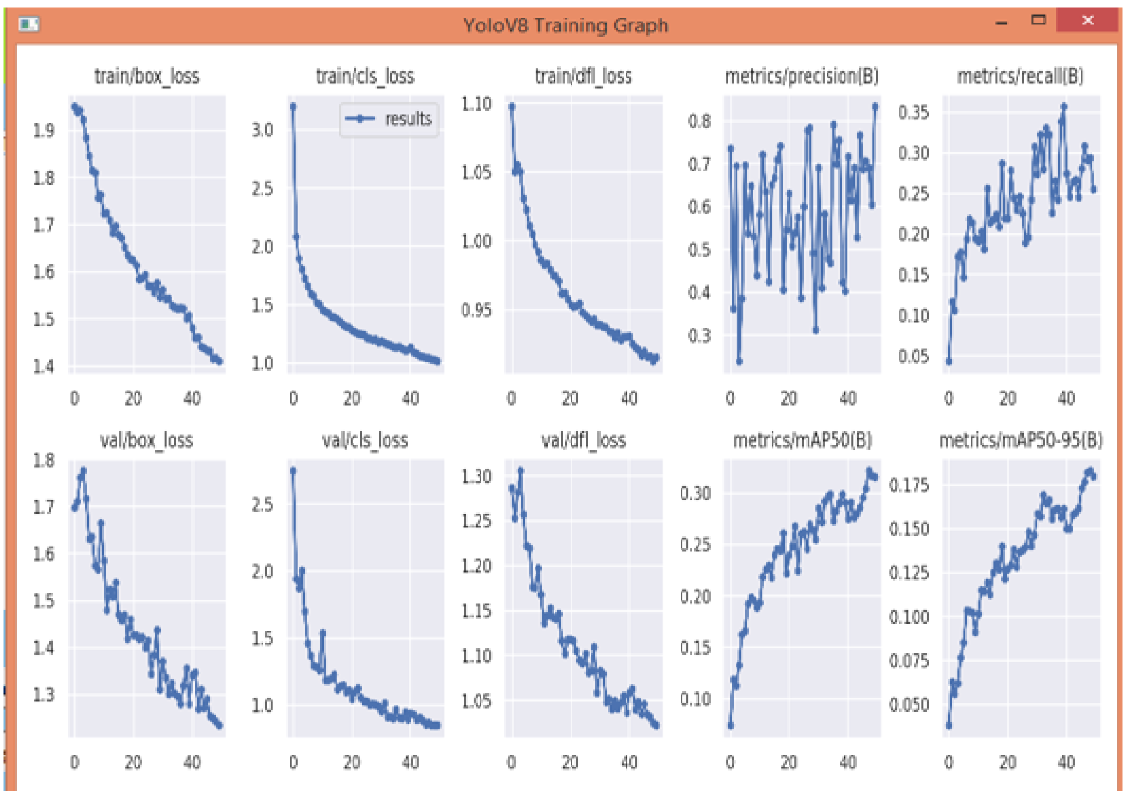

Figure 5.7 : Display of Training Graph of Using Existing CCTV Network for Crowd Management, Crime Prevention &work Monitoring using AI & ML

6. VALIDATION

VALIDATION

The validation of this project relies on a systematic multi-stage testing process designed to ensure the reliability, accuracy, and efficiency of person detection, weapon identification, and crowd behavior analysis using advanced AI models. The system undergoes rigorous evaluation through dataset-based testing, performance metrics assessment, and real-time simulation to confirm its capability in handling dynamic and complex surveillance scenarios.

To ensure robustness, each module of the system was tested independently through unit testing and then validated collectively via integration testing. The real-time performance was evaluated by simulating various scenarios such as low-light environments, overlapping crowds, and partially visible weapons. The system consistently demonstrated reliable detection and timely alerts. Feedback from simulated deployments helped fine-tune thresholds for crowd density and weapon sensitivity, ensuring minimal false alarms. This thorough validation confirms the system's readiness for real-world deployment across diverse surveillance environments.

6.1 INTRODUCTION

The initial phase of validation involves preparing a high-quality dataset, incorporating CCTV video feeds with annotated persons, weapons, and faces. The data is split into training and testing sets (commonly in an 80-20 ratio), with the training set used to fine-tune models such as YOLOv8 for object and weapon detection. To avoid overfitting and improve generalization, K-fold cross-validation is performed across the dataset, ensuring robust model behavior across different data splits.

The system's performance is assessed using standard evaluation metrics like accuracy, precision, recall, F1-score, and mean Average Precision (mAP). The confusion matrix helps visualize misclassifications in person and weapon detection, guiding iterative model refinement. The effectiveness of YOLOv8 is compared with previous detection architectures, validating that it offers improved detection speed the and higher accuracy in crowded scenes and with small or concealed objects like weapons.

In the final validation stage, real-time testing is conducted using live or simulated CCTV footage to evaluate the end-to-end system under practical conditions. This includes GUI interaction, alert system response, and accurate output display. Feedback from these real-world tests is used for continuous improvements, ensuring that the system performs reliably in high-stakes environments such as public spaces, workplaces, or sensitive zones. The validation framework confirms that the project is scalable, responsive, and dependable for real-time crowd monitoring and security alerting.

6.2 TEST CASES

TABLE 6.2.1 FUNCTIONAL TESTING

Test Case Id	Test Case Name	Test Case Desc.	Test Steps			Test Case Status	Test Priorit-y
			Step	Expected	Actual		
01	Generate & Load YoloV8 Model	Test whether YoloV8 Model is loaded or not into the system	If the YoloV8 Model may not load	We cannot do further operations	If YoloV8 Model loaded we will do further operations	High	High
02	Crowd Managem-ent and weapon detection from Images	Test whether the image is uploaded or not to detect the crowd	If the image may not upload	We cannot do further operations	we can detect the crowd using image	High	High
03	Crowd Managem-ent and weapon detection from Videos	Test whether the video is uploaded or not to detect the crowd	If the video may not upload	We cannot do further operations	we can detect the crowd using video	High	High
04	YoloV8 Training Graph	Test YoloV8 Training Graph generated or not	If the YoloV8 Training Graph may not generate.	We cannot check performance details YoloV8	We can check the performance details YoloV8 algorithm	High	High

7. CONCLUSION & FUTURE ASPECTS

7. CONCLUSION & FUTURE ASPECTS

In conclusion, the project has successfully achieved its objectives, showcasing significant progress and outcomes. The implementation and execution phases were meticulously planned and executed, leading to substantial improvements and insights. Looking ahead, the future aspects of the project hold immense potential. Future developments will focus on expanding the scope, integrating new technologies, and enhancing sustainability. These advancements will not only strengthen the existing framework but also open new avenues for growth and innovation, ensuring the project remains relevant and impactful in the long term. This strategic approach will drive continuous improvement and success.

7.1 PROJECT CONCLUSION

In this research, a system is presented, integrated advanced machine learning techniques with existing CCTV networks. The framework leverages YOLOv8 state-of-the-art algorithm for object detection, Retina Face for face detection and ResNet50 for face recognition. The Crowd Management module enables realtime video analysis, crowd density estimation, and identification of overcrowding situations, facilitating efficient deployment of crowd control measures. The crime prevention module to detect violent behaviour and identifies weapons such as pistols and knives, and integrated criminal face recognition to identify wanted individuals from a database. The work monitoring module optimizes workplace safety by tracking employee presence and work utilization. As future work, conducting comprehensive research to identify and evaluate the most suitable models and techniques for collecting and processing multimodal data sources, including video feeds, audio signals, and sensor data enhancing the system's intelligence-based security and monitoring capabilities and exploring online threats.

7.2FUTURE ASPECTS

In the future, this system can be extended to support audio analysis and infrared sensor integration for detecting abnormal sounds or heat signatures in restricted areas. The AI models can be further trained with larger, real-world datasets to improve accuracy in complex environments. Additionally, cloud integration and real-time alerting via mobile apps or dashboards can enhance remote monitoring capabilities. Scalability to multi-camera networks and the inclusion of predictive analytics can also help in forecasting potential threats before they occur, making urban surveillance smarter and more proactive.

The system can be adapted for crowd sentiment analysis using posture and facial expressions. Integration with emergency response systems can help in automating dispatches in high-risk situations. Anomaly detection algorithms can be employed to identify suspicious behavior beyond predefined rules. Support for multilingual voice alerts and region-specific settings can make the system more adaptive. Furthermore, collaboration with law enforcement databases can enable real-time criminal verification across regions.

8. BIBLIOGRAPHY

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8.2 GITHUB LINK

https://github.com/geeths431/using-existing-cctvnetwork-for-crowd-management-crome-prevention-and-work-monitoring-using-AI-ML