Intelligent Object Detection and Interactive Surveillance

B.E. Phase I project report submitted in partial

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in

INFORMATION TECHNOLOGY

by

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CERTIFICATE

This is to certify that the B.E. project entitled **"Intelligent Object Detection and Interactive Surveillance"** is a bona fide work of "**Sushma Kumbhar" (EU1204038), "Akash Patel" (EU1204003)** and **"Heenal Patel" (EU1204021)** submitted to University of Mumbai in partial fulfilment of the requirement for the award of the degree of **"Bachelor of Engineering"** in **"Information Technology"** during the academic year 2023–2024.

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B.E. Project Report Approval

This project report entitled ***Intelligent Object Detection and Interactive Surveillance*** by ***Sushma Kumbhar, Akash Patel*** and ***Heenal Patel*** is approved for the degree of ***Bachelor of Engineering*** in ***Information Technology*** from ***University of Mumbai***.

Examiners

1.________________________________

2.________________________________

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in oursubmission. We understand that any violation of the above will be cause fordisciplinary action by the Institute and can also evoke penal action from thesources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date:

Abstract

The realm of security and surveillance has witnessed a transformative evolution in recent years, with cutting-edge technologies opening up new frontiers for ensuring safety and vigilance. In this major project, we present an intelligent security and surveillance system aimed at fortifying traditional surveillance cameras with advanced features to enhance their efficiency. This system leverages four key models, namely Object Detection, Face Detection, Face Recognition, and Motion Detection, to extract valuable information from video feeds and empower security personnel with actionable insights. Each of these models has been meticulously trained, and they collectively form the backbone of our innovative approach to security and surveillance.

The Object Detection model, which is based on YOLO (You Only Look Once) Nano, plays a pivotal role in recognizing objects within the camera's field of view. This capability equips our system to identify anomalies and potentially threatening objects, ensuring rapid response to security breaches. Face Detection and Face Recognition models, trained using FaceNet, serve as a second layer of defense by identifying individuals within the monitored area. The integration of these models aids in tracking known and unknown persons, especially during unconventional hours, effectively preventing unauthorized access. Complementing these features is our Motion Detection model, built on the Gaussian Mixture Model, which monitors and distinguishes between common and unusual motion patterns in the campus vicinity. The amalgamation of these models transforms conventional cameras into intelligent security tools, promising enhanced safety and peace of mind for the campus community.

Keywords- *Face Detection, Security, Surveillance, Motion Detection*

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List of Abbreviations

API	Application Programming Interface
OS	Operating System
YOLO	You Only Look Once
SJCEM	St. John College of Engineering and Management
WBS	Work Breakdown Structure
RAM	Random Access Memory
GMM	Gaussian Mixture Model

Chapter 1

Introduction

Security and surveillance have become indispensable components of modern-day living, ensuring the safety of individuals, assets, and communities. In a rapidly changing world, where threats and challenges are ever-evolving, the need for more intelligent and efficient security systems is paramount. Our major project aims to bridge this gap by introducing an Intelligent Security and Surveillance System that revolutionizes the capabilities of traditional surveillance cameras. By incorporating state-of-the-art models for Object Detection, Face Detection, Face Recognition, and Motion Detection, our system offers a comprehensive and proactive approach to security.

Traditional surveillance systems, while valuable, often fall short in addressing the dynamic nature of security threats. In response to these limitations, our project leverages cutting-edge technology to enhance the surveillance infrastructure. The Object Detection model, powered by YOLO Nano, identifies objects within the camera's field of view, providing a means to detect and respond to anomalous items. Concurrently, Face Detection and Face Recognition models, trained with FaceNet, facilitate the identification of individuals in real-time, enabling the system to discern between known and unknown persons, particularly during unusual hours. Furthermore, the Motion Detection model, grounded in the Gaussian Mixture Model, distinguishes common and uncommon motion patterns within the campus, offering yet another layer of security. This amalgamation of technologies promises to not only bolster security but also infuse a much-needed intelligence into conventional surveillance cameras, heralding a safer and more vigilant environment.

1.1 Motivation

The motivation behind our project is rooted in the growing need for advanced security and surveillance solutions in an increasingly complex and uncertain world. Traditional surveillance systems often struggle to keep pace with emerging threats and the evolving dynamics ofsecurity challenges. As such, our project is driven by the ambition to innovate and empower these systems with artificial intelligence to offer a more intelligent, proactive, and effective approach to security. We seek to bridge the gap between the limitations of conventionalsurveillance and the potential of cutting-edge technology, ultimately enhancing the safety and security of campuses and communities.

1.2 Problem Statement

The existing security and surveillance infrastructure, relying on traditional cameras, faces limitations in efficiently identifying and responding to emerging security threats. These limitations include the inability to recognize potentially dangerous objects, track individuals in real-time, especially during unusual hours, and distinguish between common and unusual motion patterns. Consequently, there is a pressing need for a comprehensive and intelligent security system that addresses these shortcomings. Our project aims to fill this void by introducing an advanced solution that combines Object Detection, Face Detection, Face Recognition, and Motion Detection models to empower traditional cameras with the capability to recognize anomalies, identify individuals, and detect unusual activities, thus enhancing overall security measures.

1.3 Objective

The objectives are as follows:

- Implement an Object Detection model based on YOLO Nas to identify and classify objects within the camera's field of view.
- Develop Face Detection and Face Recognition models using FaceNet to accurately track and identify individuals, both known and unknown.
- Create a Motion Detection model based on the Gaussian Mixture Model to distinguish common and unusual motion patterns in the monitored area.
- Integrate the four models into a unified Intelligent Security and Surveillance System to enhance the capabilities of traditional cameras.
- Enable real-time monitoring and proactive responses to security incidents by providing actionable insights and alerts to security personnel.

1.4 Scope

The scope of this project extends to the development and integration of advanced security and surveillance models, including Object Detection, Face Detection, Face Recognition, and Motion Detection, into existing surveillance systems. These models will be trained and fine-tuned to cater to specific security requirements within a campus or designated area. The system will offer real-time monitoring capabilities, providing actionable insights and alerts to security personnel, allowing them to respond promptly to potential security threats. The project aims to make traditional surveillance cameras more intelligent, versatile, and proactive in identifying anomalies, tracking individuals, and detecting unusual activities, ultimately enhancing the security measures in the designated area

Chapter 2

Review of Literature

Table 2.1 Literature Review

Sr.No.	Paper Title [Ref.]	Author Names	Conclusion	Research Gaps
1	A Real-time Border Surveillance System using Deep Learning and Edge Computing (Base Paper)	Dang-Khoa Luong-Huu,Tan-An Ngo,Huy-Tan Thai, Kim-Hung Le	Border Edge system, based on MobileNet architecture, provides real-time border surveillance, efficiently detecting unauthorized access for countering illegal cross-border activities.	Lack of specific methodologies for model pruning while maintaining accuracy. .
2	Object Detection using Machine Learning Technique	Praahas Amin, Anushree B. S., Bhavana B. Shetty, Kavya K., Likitha Shetty	It introduces a real-time object detection system employing YOLO algorithm, achieving efficient bounding box prediction and classification for images/videos, showcasing enhanced accuracy and speed.	Absence of validation plans for diverse indoor environments, especially in homes.
3	Real-time Object Detection using Deep Learning for helping People with Visual Impairments	M. Terreran, A. G. Tramontano, J. C. Lock, S. Ghidoni and N. Bellotto,	It assesses lightweight object detection models for real-time use in Electronic Travel Aids for visually impaired users, introducing the L-CAS Office dataset to validate models in real-world scenarios.	Absence of validation plans for diverse indoor environments, especially in homes.
4	The Object Detection Based on Deep Learning	Cong Tang, Yunsong Feng, Xing Yang, Chao Zheng, Yuanpu Zhou	The paper thoroughly dissects and compares deep learning-based object detection models like R-CNN,, Faster R-CNN, YOLO, and SSD.	It does not introduce new techniques, approaches, or experimental findings
5	Object Detection using Deep Learning	Pranita Jadhav, Vrushali Koli, Priyanka Shinde, Dr. M.M. Pawar	The paper focuses on explaining framework designs, model principles, and performance evaluations	it lacks a thorough exploration of innovative solutions to practical limitations and challenges.

6	Real-Time Object Detection with Yolo	Geethapriya. S, N. Duraimurugan, S.P. Chokkalingam	Implemented Yolo algorithm to detect object	it predicts fewer false positives in background areas.
7	Object Detection through Modified YOLO Neural Network	Tanvir Ahmad , Yinglong Ma , Muhammad Yahya, Belal Ahmad, Shah Nazir , Amin ul Haq	It modifies the YOLOv1 architecture, leading to enhanced detection performance.	It lacks a specific roadmap or detailed approach for creating a benchmark dataset
8	Object Recognition Using Deep Learning	Rohini Goel, Avinash Sharma, and Rajiv Kapoor	The paper presents a recent survey of deep learning for object recognition, comparing it favorably to traditional methods, and suggests potential future research directions.	It Lacks effectiveness of the Deep ResidualConv-Deconv Network with Adaptive Profiles (APs) and estimation profiles for robust
9	Small Objects Detection in Satellite Images Using Deep Learning	A. Mansour, W. M. Hussein and E. Said	Optimizing object size inhigh-resolution satellite images improves detection accuracy without significant processing time increase, emphasizing the importance of training quality and applicability across image types.	Challenges in applying the technique to various image types.
10	Real-Time Deep Learning- Based Object Detection Framework	William Tarimo, Moustafa M Sabra	Compared different Object detection algorithm	It has less accuracy
11	Object Detection in Deep Surveillance	Narina Thakur, Preeti Nagrath, Rachna Jain, Dharmender Saini, Nitika Sharma, D. Jude Hemanth	The research concludes that Yolov5 outperforms other models with a notable 61% precision and 44% F-measure.	The study lacks an in-depth examination of howthe proposed approach tackles challenges unique to high-end surveillance applications.
12	Intelligent monitoring of indoor surveillance video based on deep learning	Yun-Xia Liu, Yang Yang, Aijun Shi, Peng Jigang, Liu Haowe	Implemented monitoring system for home surveillance	The research lacks empirical validation andscalability assessment inreal-world surveillance scenarios.

13	Smart Surveillance and Tracking System using Resnet and Tesseract-OCR	C. Sonavane, P. Kulkarni, O. Podey and P. Rewane	Face and object detection, as well as vehicle number plate recognition,	Lack of empirical validation in diverse real-world environments.
14	Simulation of Object Detection Algorithms for Video Surveillance Applications	Mohana and H. V. Ravish Aradhya	The study finds that adjusting parameters in the Gaussian mixture model improves object detection. The Local Binary Pattern algorithm reduces false alarms and proves reliable for the dataset.	Finite changes in object detection
15	Real-Time Abnormal Object Detection for Video Surveillance in Smart Cities	Palash Yuvraj Ingle and Young-Gab Kim	The study introduces an MSD-CNN model for efficient detection of guns and knives in public areas through video surveillance.	Deploying the model on edge devices, enhancing real-time computation, and diversifying camera testing conditions.

Chapter 3

Requirements Gathering and Planning

3.1 Requirement Elicitation

3.1.1 Use Case Diagram

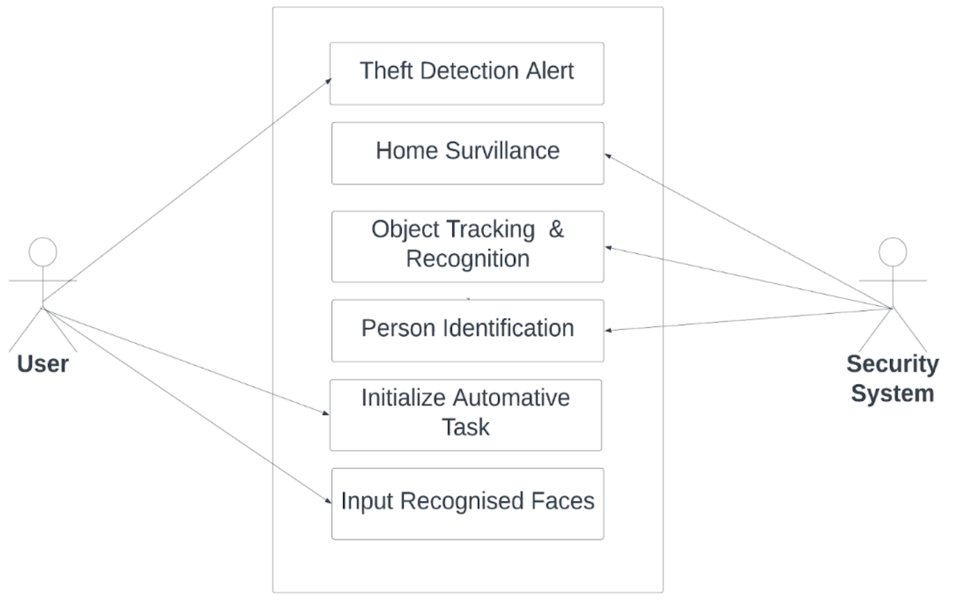

Fig 3.1.1 Use Case Diagram

3.1.2 Activity Diagram

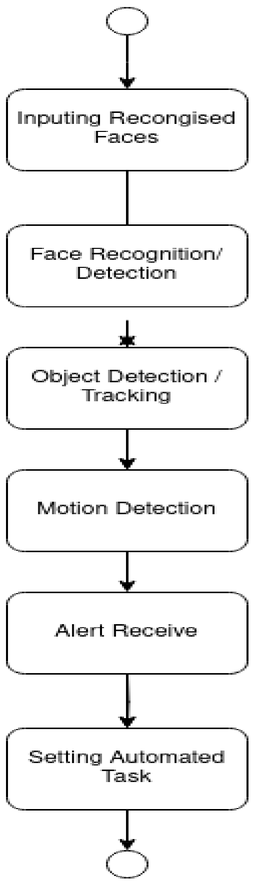

Fig 3.1.2 Activity Diagram

8

3.1.3 Sequence Diagram

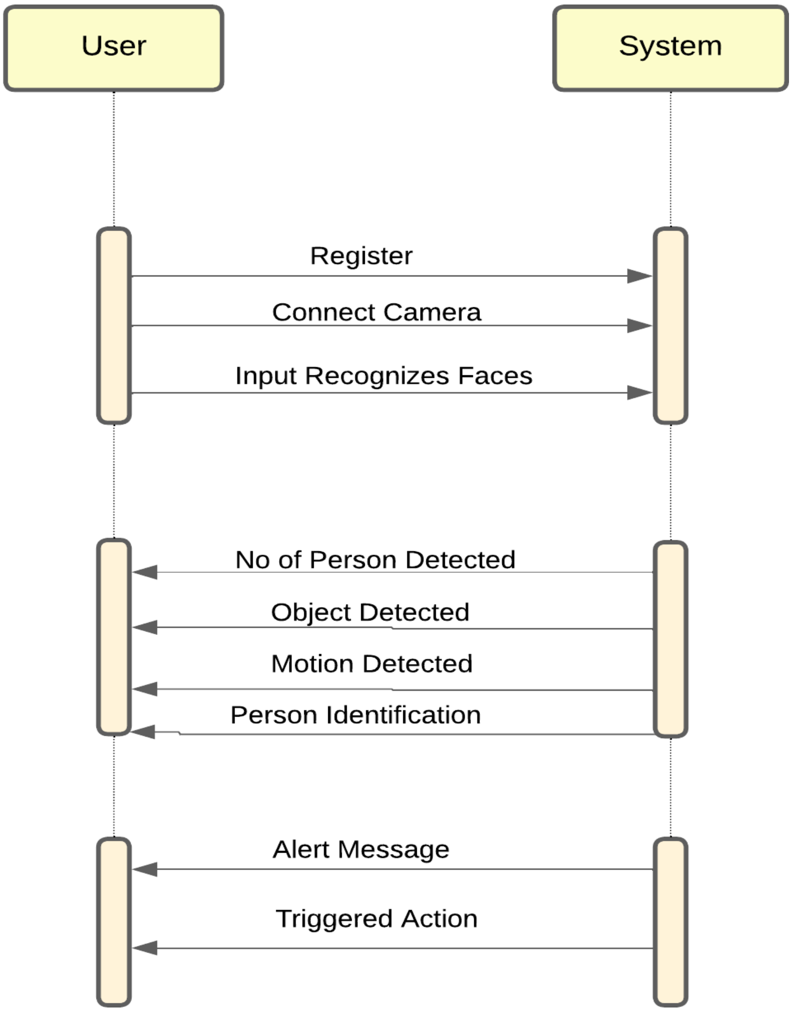

Fig. 3.1.3 Sequence Diagram

3.2 Dataflow Diagram (DFDs)

3.2.1 Level 0 DFD

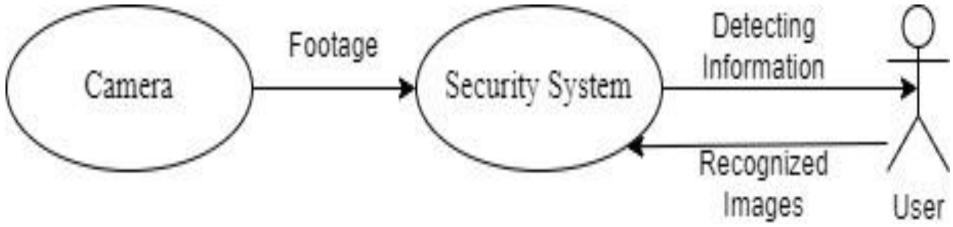

Table 3.2.1 Level 0 DFD

3.2.2 Level 1 DFD

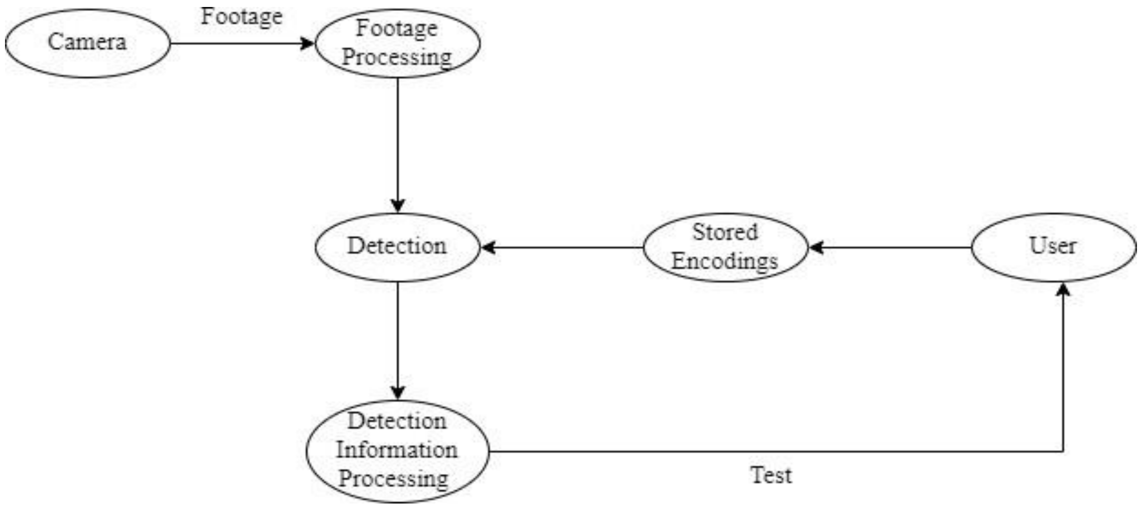

Table 3.2.1 Level 1 DFD

3.2.3 Level 2 DFD

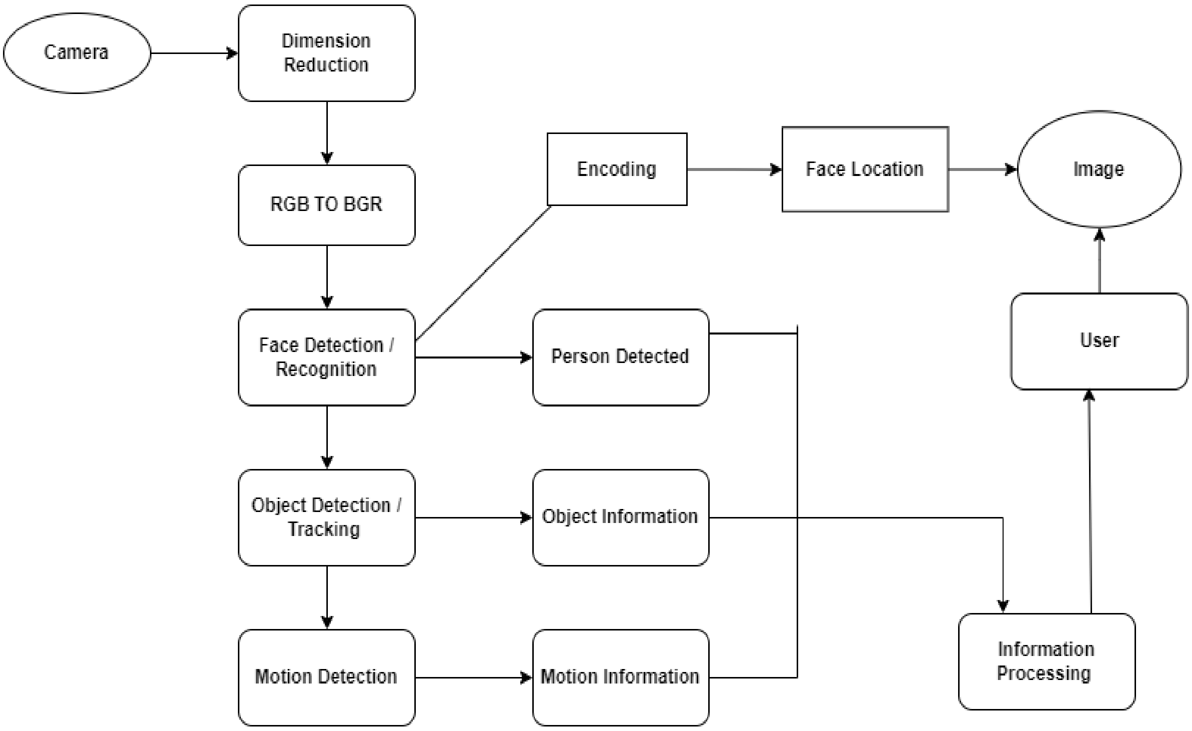

Figure 3.2.3 Level 2 DFD

3.3 Feasibility Study

3.3.1 Technical Feasibility

3.3.1.1 Hardware Requirements

1. Computer System
2. Intel i3 Processor or higher or Apple M1 Chip
3. 8GB RAM
4. Hard Disk 256GB

3.3.1.2 Software Requirements

1. Windows OS or MacOS
2. Visual Studio Code

3.4 Timeline / Gantt chart

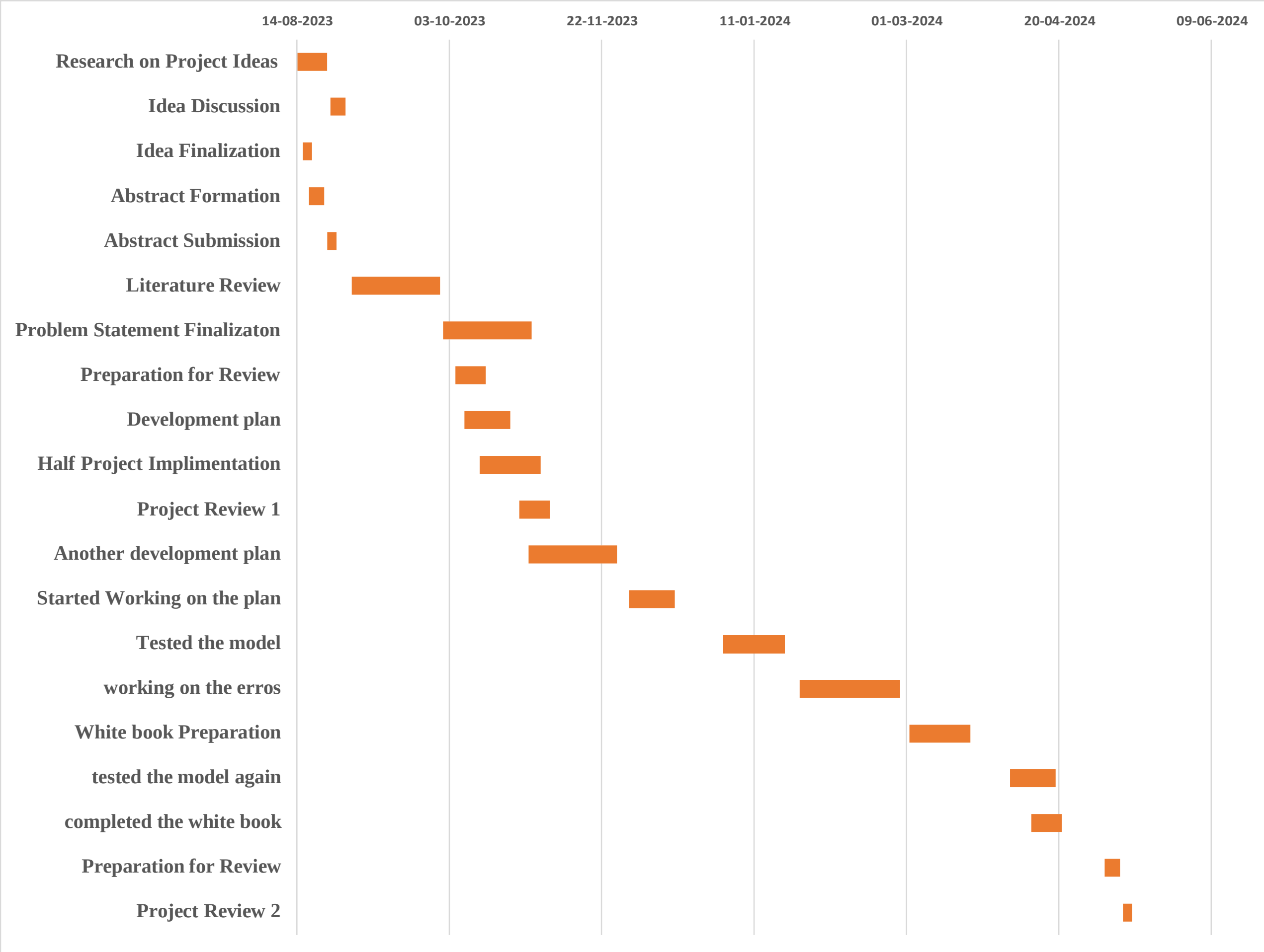

Fig 3.4 Gantt chart

3.5 Work Breakdown Structure (W.B.S) Chart

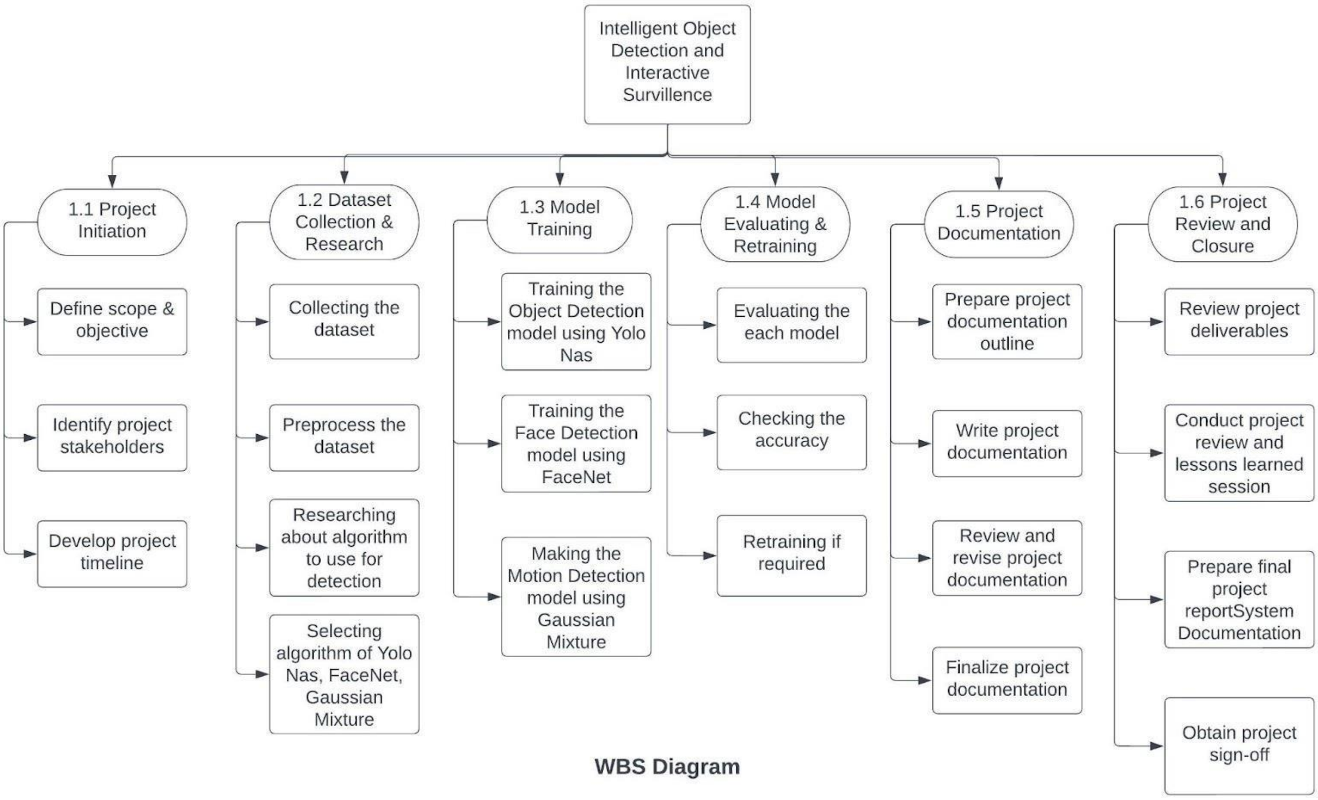

Fig 3.5 WBS Chart

Chapter 4

Report on Present Investigation

4.1 Proposed System

Our proposed advanced Security and Surveillance System addresses the limitations faced by traditional camera-based surveillance systems, ushering in a new era of security and surveillance. By leveraging state-of-the-art machine learning techniques, particularly object detection, this system offers intelligent, real-time security enhancements. The integration of object detection technology allows the system to differentiate between authorized and unauthorized individuals accurately. By combining this capability with robust facial recognition, we ensure precise identity verification and access control, thus minimizing false alarms and improving security. Additionally, the system's object detection features provide efficient motion detection, reducing false positives and enhancing reliability. Real-time data processing capabilities enable swift responses, while behavior analysis ensures early anomaly detection. Furthermore, the system optimizes resource usage, reducing energy consumption in commercial and public spaces. With seamless integration into existing security infrastructure, our advanced Security and Surveillance System not only rectifies the shortcomings of traditional systems but also paves the way for a safer and more secure environment, making it a game-changer in the field of security and surveillance.

4.1.1 Block Diagram of Proposed

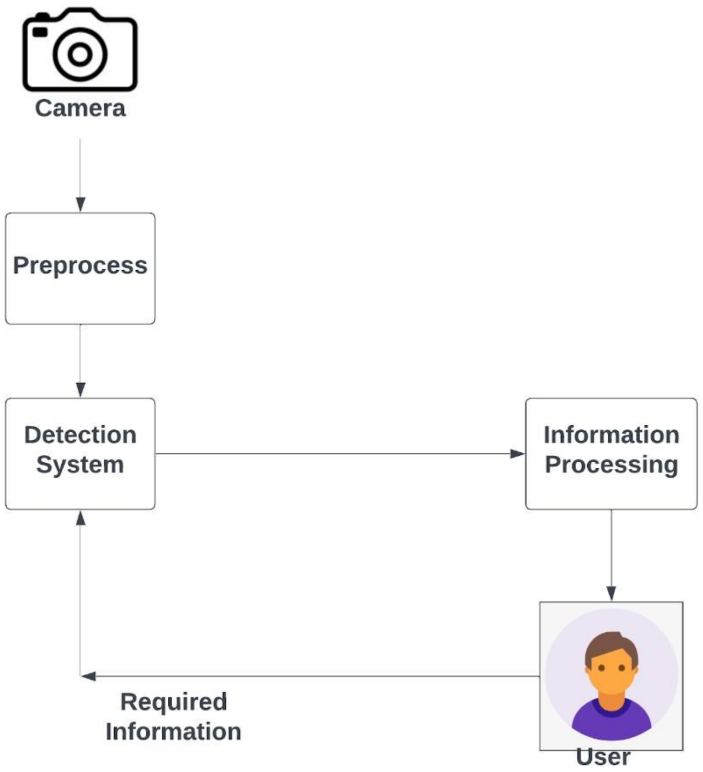

Fig 4.1.1 Block Diagram of Proposed System

4.2 Implementation

4.2.1 Algorithm / Flowchart

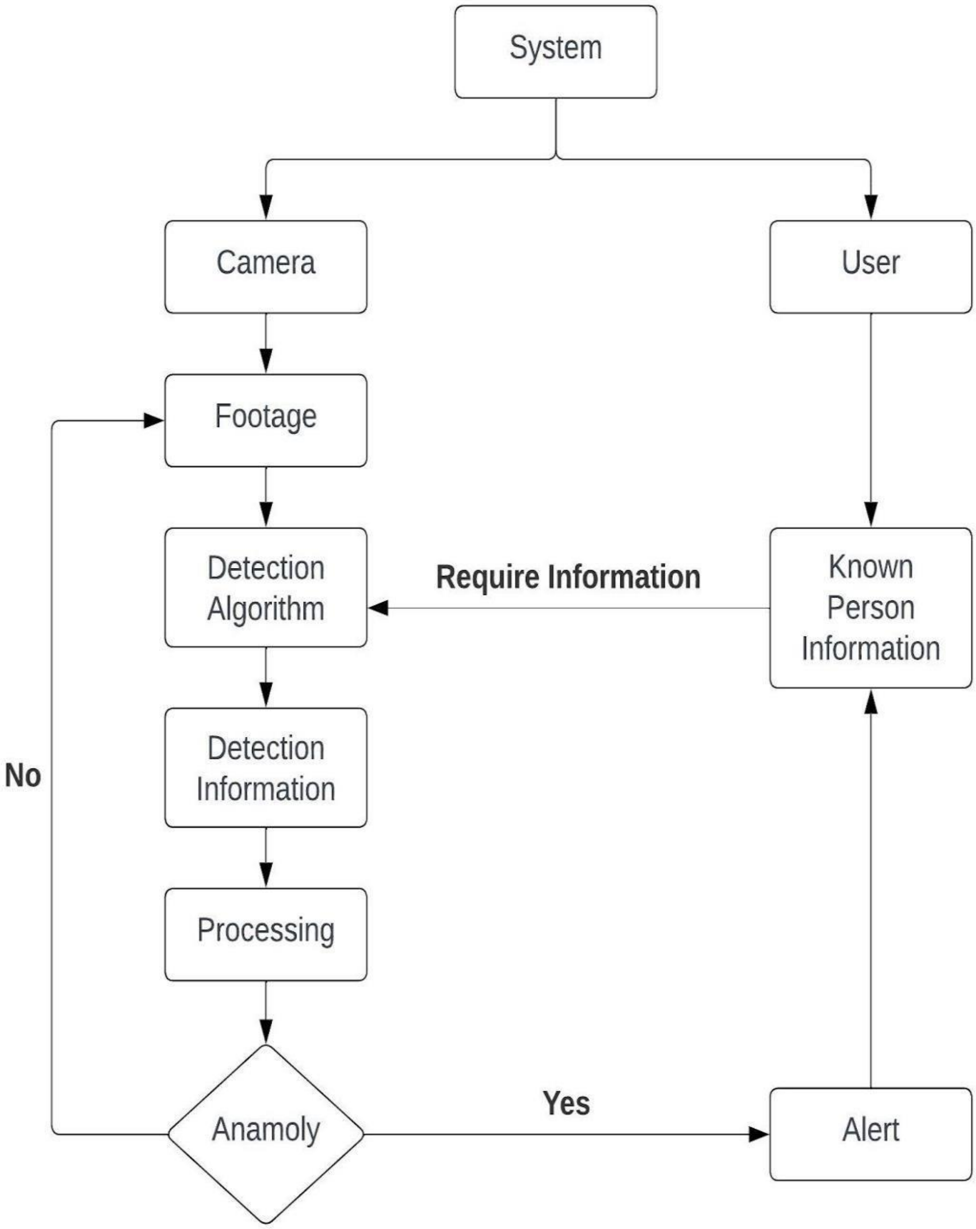

Fig 4.2.1 Flowchart

4.2.3 Pseudo Code

//Face Detection and Recognition

```
import cv2
import face_recognition

# Function for initializing known faces
def initialize_known_faces(known_faces):
    known_face_encodings = []
    known_face_names = []
    for name, file_path in known_faces.items():
        image_of_known_person = face_recognition.load_image_file(file_path)
        known_face_encodings.append(face_recognition.face_encodings(image_of_known_person)[0])
        known_face_names.append(name)

    return known_face_encodings, known_face_names

# Function for face detection
def detect_faces(frame):
    face_locations = face_recognition.face_locations(frame)
    return face_locations

# Function for face recognition
def recognize_faces(frame, known_face_encodings, known_face_names,face_locations):
    face_encodings = face_recognition.face_encodings(frame, face_locations)

    recognized_names = []
    for face_encoding in face_encodings:
        matches = face_recognition.compare_faces(known_face_encodings, face_encoding)
        name = "Unknown"

        if True in matches:
            first_match_index = matches.index(True)
            name = known_face_names[first_match_index]

        recognized_names.append(name)

    return recognized_names

# Function to process video with face detection and recognition
def process_video(video_path=None, known_faces={}):
    known_face_encodings, known_face_names = initialize_known_faces(known_faces)

    # Initialize video capture
    if video_path:
        cap = cv2.VideoCapture(video_path)
    else:
```

```
        cap = cv2.VideoCapture(0)  # Use the default camera

    while True:
        ret, frame = cap.read()

        if not ret:
            break

        face_locations = detect_faces(frame)
        recognized_names = recognize_faces(frame, known_face_encodings,
known_face_names,face_locations)

        for (top, right, bottom, left), name in zip(face_locations, recognized_names):
            cv2.rectangle(frame, (left, top), (right, bottom), (0, 255, 0), 3)
            font = cv2.FONT_HERSHEY_DUPLEX
            cv2.putText(frame, name, (left + 6, bottom - 6), font, 0.5, (255, 255, 255), 1)

        # Display the processed frame
        cv2.imshow('Face Recognition', frame)

        if cv2.waitKey(1) & 0xFF == ord('q'):
            break

    cap.release()
    cv2.destroyAllWindows()

# Usage example
if__name__== "__main__":
    # Define known faces and their image file paths
    known_faces = {
        "Akash": "MyPhoto.jpg",
        "Mummy": "mummy.jpg"
        # Add more known faces as needed
    }

    # Call the process_video function with the known faces
    process_video(video_path=None, known_faces=known_faces)
```

//Motion Detection

```
import cv2

# Initialize video capture (0 for default camera or specify video file path)
cap = cv2.VideoCapture(0)

# Define parameters for motion detection
threshold = 25  # Threshold for detecting motion
min_contour_area = 200 # Minimum contour area to consider as motion

# Initialize variables
```

```
previous_frame = None

while True:
    ret, frame = cap.read()

    if not ret:
        break

    # Convert the frame to grayscale for motion detection
    gray_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    gray_frame = cv2.GaussianBlur(gray_frame, (21, 21), 0)

    if previous_frame is None:
        previous_frame = gray_frame
        continue

    frame_diff = cv2.absdiff(previous_frame, gray_frame)
    _, thresholded = cv2.threshold(frame_diff, threshold, 255, cv2.THRESH_BINARY)
    thresholded = cv2.dilate(thresholded, None, iterations=2)

    contours, _ = cv2.findContours(thresholded, cv2.RETR_EXTERNAL,
cv2.CHAIN_APPROX_SIMPLE)

    for contour in contours:
        if cv2.contourArea(contour) > min_contour_area:
            (x, y, w, h) = cv2.boundingRect(contour)
            cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)

    cv2.imshow('Motion Detection', frame)

    key = cv2.waitKey(1)
    if key == ord('q'):
        break

    previous_frame = gray_frame

cap.release()
cv2.destroyAllWindows()
```

//Object Detection

```
import  torch
torch.__version__

import torch
torch.cuda.get_device_name(0)

from super_gradients.training import models

yolo_nas_l = models.get("yolo_nas_l", pretrained_weights="coco")
```

```
url =
"https://previews.123rf.com/images/freeograph/freeograph2011/freeograph201100150/158301822-group-of-friends-gathering-around-table-at-home.jpg"
yolo_nas_l.predict(url, conf=0.25).show()

import torch
device = 'cuda' if torch.cuda.is_available() else "cpu"

# Import the YouTubeVideo class from IPython.display
from IPython.display import YouTubeVideo

# Define the YouTube video ID
video_id = 'IMxDeACOWCE'  # Replace YOUR_VIDEO_ID with the actual video ID

# Create a YouTubeVideo object with the specified video ID
video = YouTubeVideo(video_id)

# Display the video
display(video)

%%capture

# Define the URL of the YouTube video
video_url = f'https://www.youtube.com/watch?v={video_id}'

# Download the video in mp4 format
!pip install -U "git+https://github.com/ytdl-org/youtube-dl.git"
!python -m youtube_dl -f 'bestvideo[ext=mp4]+bestaudio[ext=m4a]/mp4' "$video_url"

# Print a success message
print('Video downloaded successfully')


input_video_path = f"/content/Office Work Free Stock Video _ One1-{video_id}.mp4"
output_video_path = "detections.mp4"

device=0

yolo_nas_l.to(device).predict(input_video_path).save(output_video_path)
```

4.2.4 Screenshots of output with description

Following is the output of the object detection model which is able to detect any object in the images and videos. It will help to detect any object in the real time Footage in the camera.

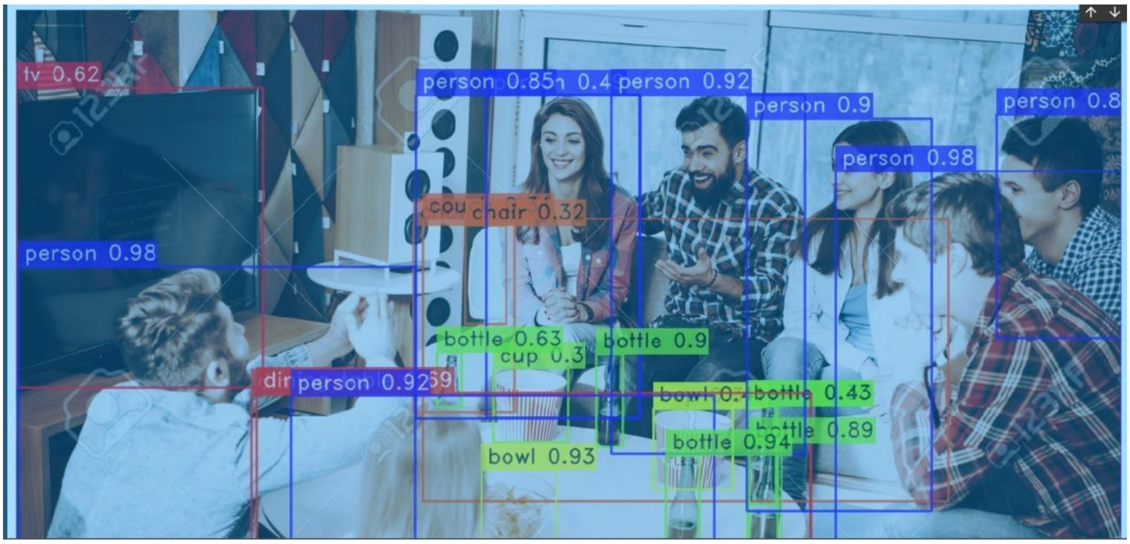

Figure 4.2.4(a)

Following is the 2 output of Face detection & Face Recognition model which is able to detect multiple faces of the person in real time footage. It will help to know about the identification of Person

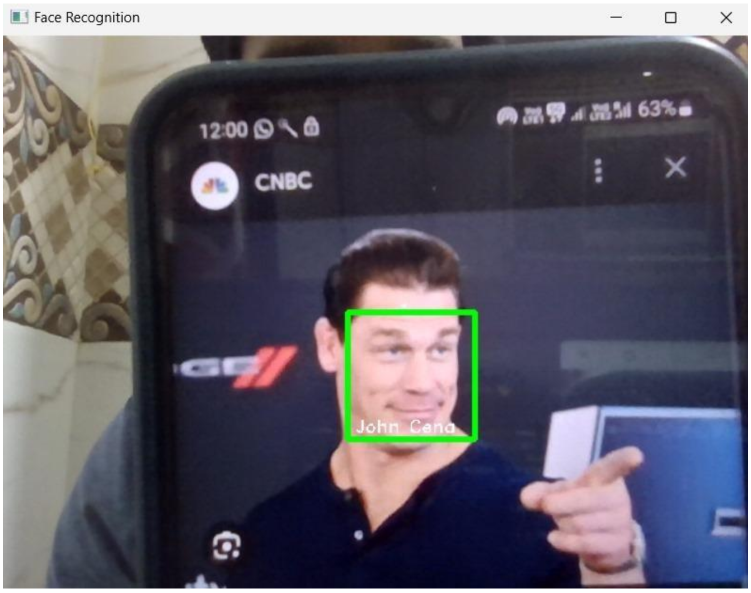

Figure 4.2.4(b)

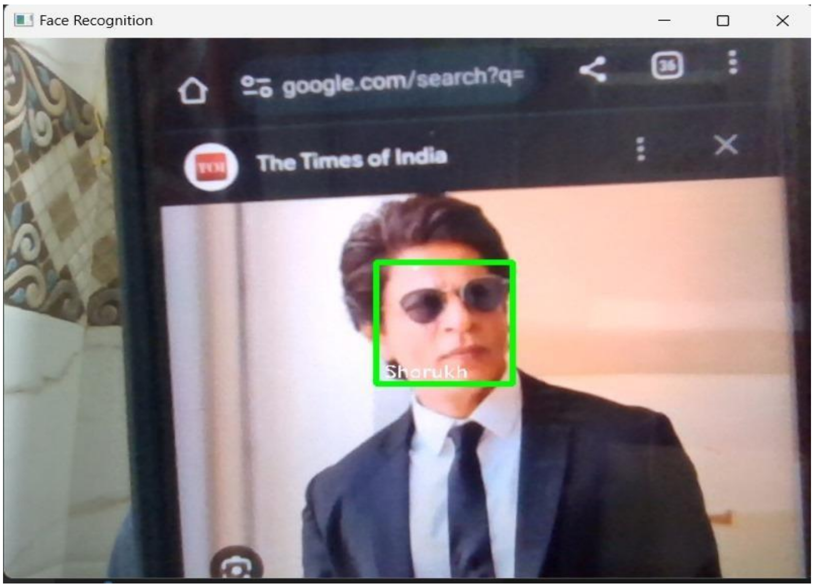

Figure 4.2.4(c)

Following is the output of Motion detection model which is able to detect the motion of any object in real time. It will help to detect any unusual activity based on some criteria

Figure 4.2.4(d)

Chapter 5

Technologies Used

Machine Learning

ML is a type of artificial intelligence that allows software applications to become more accurate at predicting outcomes without being explicitly programmed to do so.

Deep Learning

It is a type of machine learning and artificial intelligence (AI) that imitates the way humans gain certain types of knowledge.

Python

Python is a popular high-level programming language known for its simplicity, readability, and versatility. It is widely used in various fields, including web development, data analysis, scientific computing, artificial intelligence, and more. Python supports object-oriented, imperative, and functional programming paradigms and has a large ecosystem of libraries and frameworks that make it suitable for a wide range of applications. It's an interpreted language, which means that you can run Python code directly without the need for compilation.

Face Recognition (Library)

The Face recognition library is a sophisticated toolset designed for the accurate detection and analysis of human faces in images and videos. It harnesses advanced algorithms, particularly deep learning techniques, to identify facial features with precision. This allows for crucial functions like face detection, alignment, and recognition. The library further generates unique numerical representations, known as face embeddings, which serve as a basis for comparing and matching faces. This capability is fundamental for tasks such as identity verification and individual recognition. Additionally, the library's flexibility extends to custom model training, making it adaptable to specific use cases in diverse applications, including security, access control, and surveillance.

Chapter 6

Results and Discussion

Upon successful implementation and integration of our Intelligent Security and Surveillance System, the results demonstrate a significant improvement in security measures. The Object Detection model accurately identifies and classifies various objects within the camera's field of view, enabling the system to recognize potential anomalies swiftly. The Face Detection and Face Recognition models effectively track known individuals and flag unknown persons during unconventional hours, enhancing access control. Furthermore, the Motion Detection model adeptly distinguishes between common and unusual motion patterns, reducing false alarms. The real-time monitoring and proactive alerting capability empower security personnel to respond promptly to security incidents. The discussion emphasizes the system's potential for broader applications, including critical infrastructure protection and public safety, and highlights the need for ongoing refinement and scalability to meet evolving security challenges.

Chapter 7

Conclusion and Future Work

Our Intelligent Security and Surveillance System represents a significant leap in augmenting traditional surveillance infrastructure with artificial intelligence. The successful integration of Object Detection, Face Detection, Face Recognition, and Motion Detection models has shown promise in enhancing security measures within the designated area. The system's real-time monitoring and proactive alerting capabilities provide a robust defense against emerging threats. While our project marks a substantial step forward, ongoing refinement and scalability are crucial to adapt to the ever-evolving security landscape. This technology not only promises to bolster safety within a campus but also holds the potential for broader applications, emphasizing its relevance in addressing contemporary security challenges and the importance of continued research and development in this domain.

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