MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE GWALIOR

(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV, Bhopal)

NAAC Accredited with A++ Grade

Project Report

on

Bus Census System

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CENTRE FOR ARTIFICIAL INTELLIGENCE

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CERTIFICATE

This is certified that **Ashish Kumar Dwivedi** (0901AM211016) **Vivek Gaur** (0901AM211065) has submitted the project report titled **Bus Census System** under the mentorship of **Dr. Bhagat Singh Raghuwanshi**, in partial fulfilment of the requirement for the award of degree of Bachelor of Technology in **Artificial Intelligence and Machine Learning** from Madhav Institute of Technology and Science, Gwalior.

23/11/2023

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DECLARATION

I hereby declare that the work being presented in this project report, for the partial fulfilment of requirement for the award of the degree of Bachelor of Technology in **Artificial Intelligence and Machine Learning** at Madhav Institute of Technology & Science, Gwalior is an authenticated and original record of my work under the mentorship of **Dr. Bhagat Singh Raghuwanshi**, **Assistance Professor, Centre for Artificial Intelligence**.

I declare that I have not submitted the matter embodied in this report for the award of any degree or diploma anywhere else.

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ABSTRACT

Across various cities and regions in India, a pervasive issue looms large—a deceptive practice concerning bus ticketing, notably orchestrated by ticket collectors on government-operated buses. This fraudulent activity poses a significant threat to both public transportation revenue and the quality of services rendered. Unsuspecting passengers, enticed by marginal cost savings, unwittingly fall victim to this scam, resulting in substantial financial implications for the government. The ensuing financial constraints hinder the government's ability to upgrade and improve bus services, thereby compromising the overall travel experience for the commuting public.

To address this pressing challenge, an innovative solution leveraging the power of Artificial Intelligence (AI) and machine learning has been proposed. The methodology entails strategically placing cameras on buses for facial recognition purposes, utilizing advanced algorithms such as YOLO. The AI system meticulously records entry and exit times, associating them with unique identifiers stored in a comprehensive CSV file. By integrating this data with existing bus schedules, the system facilitates precise fare calculations, offering a mechanism for accurate revenue assessments. This comprehensive dataset, securely stored in a database, empowers authorities to scrutinize user behaviour patterns, identify irregularities, and optimize bus schedules based on authentic passenger demand.

This AI-centric approach not only effectively mitigates the ticket scam predicament but also ensures meticulous fare collection. The strategic implementation of this solution provides governmental entities with valuable insights for enhancing public transportation services. Ultimately, this transformative initiative aims to uplift the overall bus travel experience, aligning with the overarching goal of providing the commuting public with efficient, dependable, and improved transportation services.

Keyword: YOLO, Bus Census System, Artificial Intelligence, Ticket, Public Transportation.

सार:

भारत के विभिन्न शहरों और क्षेत्रों में लोग एक आच्छादित समस्या का सामना कर रहे हैं-सरकार द्वारा संचा लत बसों पर टिकटिंग से संबंधित एक धोखाधड़ी अभ्यास, जिसे खासकर टिकट संग्रहकों द्वारा निर्वहन कया जाता है। इस फर्जी गतिविधि ने सार्वजनिक परिवहन राजस्व और प्रदान की जाने वाली सेवाओं की गुणवत्ता के लए एक खतरा पैदा कया है। अनजाने मे यात्री, छोटे लागत के बचत के प्रेरणा से प्रेरित, इस धांधले का शकार बनते हैं, जिससे सरकार के लए वत्तीय परिणाम होते हैं। उपभोक्ताओं के लए सामान्य यातायात के लिए आर्थिक रूप से महत्वपूर्ण प्रतिबंध होने के कारण, सरकार की क्षमता में बस सेवाओं को अपग्रेड और सुधारने में कठिनाई आती है, जिससे यातायात के लए समग्र अनुभव पर कमी आती है।

इस चुनौती का सामना करने के लए, एक नवाचारी समाधान का सुझाव दिया गया है जो कृत्रिम बुद् धमत्ता (AI) और मशीन लर्निंग के शक्ति का उपयोग करता है। इस विधि में, बसों पर चेहरा पहचान के लए स्ट्रैटेजिक रूप से कैमरे लगाए गए हैं, YOLO जैसे उन्नत एल्गोरिदम का उपयोग करते हैं। AI सस्टम समझदारी से प्रवेश और निकास समय को रिकॉर्ड करता है, जो इसे एक व्यापक सीएसवी फ़ाइल में संग्रहित अद् वतीय पहचानकर्ताओं से जोड़ता है। इस डेटा को मौजूदा बस की अनुसू चयों के साथ इंटीग्रेट करके, सस्टम सटीक राजस्व मूल्यों की सु वधा प्रदान करता है, यह सटीक रूप से राजस्व मूल्यांकन के लए एक तंतुमय व्यवस्था प्रदान करता है। इस संपूर्ण डेटासेट को एक डेटाबेस में सुर क्षत रूप से संग्रहित करने से, प्राधिकृतियों को उपयोगकर्ता व्यवहार पैटर्न की जांच करने, अनिय मतताओं की पहचान करने, और पुनरायोजित यात्री मांग के आधार पर बस की अनुसू चयों को सुधारने की क्षमता प्राप्त होती है।

यह AI-केंद्रित दृष्टिकोण न केवल टिकट धांधले की समस्या को प्रभावी ढंग से समाधान करता है, बल्कि सुनिश्चित करता है कि लेन-देन सावधानीपूर्वक होता है। इस समाधान के रणनीतिक प्रयोग से सरकारी इकाइयों को सार्वजनिक परिवहन सेवाओं को सुधारने के लए मूल्यवान अंश मलते हैं। अंत में, यह परिवर्तनात्मक पहल सामान्य बस यातायात अनुभव को उन्नत, वश्वसनीय और सुधारित यातायात सेवाओं के साथ मेल करने का उद्देश्य रखता है।

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LIST OF ABBREVIATIONS

Abbreviation	Description
CNN	Convolutional neural network
deepSORT	Deep Simple Online Realtime Tracking
YOLO	You Only Look Once
NMS	Non-Maximum Suppression
IoU	Intersection Over Union
VGA	Video Graphics Array (here refers to 640 by 480 pixels resolution)
CUDA	Compute Unified Device Architecture
FPS	Frames per second

Chapter 1: Project Overview

1.1 Introduction:

Our project focuses on a common issue in many Indian cities—troublesome scams with bus tickets. Some people who collect tickets on government buses are up to no good, tricking folks into thinking they're saving a little money (like 10 or 20 rupees). Some passengers don't even know they need a ticket, so they end up paying without getting one.

This scam hurts the government because it gets less money than it should for running the buses. That means the government can't make the bus rides better for everyone. The goal of our project is to put a stop to this ticket scam. If we succeed, the government will have more money to make bus rides nicer. This way, people can enjoy better bus trips, and the government can provide improved services for everyone. Let's work together for a better travel experience for everyone!

1.2 **Objectives**:

Our main goal is to eliminate scams in society, whether they are intentional or accidental, as they result in reduced revenue for the government. We aim to develop a system capable of addressing such issues prevalent in society. This system will ultimately help the government generate more income, paving the way for affordable and enhanced public transportation services that are not only cost-effective but also more advanced and cleaner.

To achieve this objective, we will implement measures to identify and prevent scams related to public transport, ensuring that people are not tricked into paying more money than necessary. By creating a reliable system, we can contribute to the government's efforts to collect the rightful revenue from transportation services.

Additionally, our focus extends beyond just rectifying the immediate issue; we aspire to make public transport more accessible and attractive to the general population. This involves not only addressing scams but also making services more affordable, introducing new features to enhance the overall travel experience, and maintaining cleanliness standards.

In summary, our primary objective is to develop an effective system that eradicates scams associated with public transport, leading to increased government revenue. This, in turn, will enable the transformation of public transportation into a cost-effective, feature-rich, and clean mode of travel for the benefit of the entire community.

1.3 Scope:

The scope of our project encompasses a comprehensive approach to tackle the issue of scams related to bus tickets in Indian cities. The focus extends beyond mere identification and prevention; it involves the development of a robust system that addresses the root causes of these scams and contributes to the overall improvement of public transportation services. The scope is outlined in various dimensions:

1.3.1 Geographical Scope:

Initially, the project will be implemented in select Indian cities where the issue of bus ticket scams is prevalent.
The system's success in these cities will serve as a basis for potential expansion to other regions facing similar challenges.

1.3.2 Functional Scope:

The project will involve the development of a technological solution that identifies and prevents bus ticket scams.
Implementation of a secure and user-friendly interface for passengers to purchase tickets, reducing the chances of falling victim to scams.
Integration of a monitoring system to track and analyse ticket transactions, ensuring transparency and accountability.

1.3.3 Technical Scope:

Development of a mobile application or web platform for ticket purchase, incorporating secure payment gateways to eliminate the need for physical cash transactions.
Implementation of data analytics to identify patterns and anomalies in ticket sales, aiding in the detection of fraudulent activities.

Integration with existing government databases to cross-verify passenger information and enhance the overall accuracy of the system.

1.3.4 Financial Scope:

The project will require an initial investment for the development of the technological solution, including software development, user interface design, and integration with existing systems.
A sustainable financial model will be devised to cover ongoing maintenance costs and potential expansion to additional cities.

1.3.5 Regulatory and Legal Scope:

Collaboration with relevant government authorities to ensure alignment with existing transportation regulations and legal frameworks.
Implementation of measures to protect user privacy and comply with data protection laws.

1.3.6 Social Impact Scope:

Beyond addressing scams, the project aims to contribute to a positive social impact by making public transportation more affordable, accessible, and attractive to the general population.
Potential collaboration with local communities and advocacy groups to raise awareness about the benefits of the project.

1.3.7 Future Expansion Scope:

The project lays the groundwork for future expansion, not only in terms of geographical coverage but also by incorporating additional features to enhance the overall travel experience.
Exploration of partnerships with other stakeholders, such as transportation agencies and technology providers, for continuous improvement and innovation.

The scope of our project is comprehensive, aiming not only to eradicate bus ticket scams but also to contribute to the transformation of public transportation services, creating a positive impact on society and paving the way for future enhancements.

1.4 Project Features

Our Bus Census System boasts several key features designed to enhance its functionality and effectiveness in public transportation monitoring:

1.4.1 Face Recognition:

The system incorporates advanced face recognition capabilities, enabling the accurate identification and tracking of individuals within the public transport environment. This feature contributes to enhanced security and personalized services based on unique facial features.

1.4.2 Memory Management:

Efficient memory management is a crucial aspect of our system. Through the implementation of a Python dictionary, the system systematically records and recalls unique individual profiles. This feature ensures that passengers are distinctly identified and tracked over time, contributing to a comprehensive and organized database.

1.4.3 Data Collection:

The project includes a robust data collection mechanism, gathering essential information about passenger activities and interactions within the public transport system. This feature facilitates data-driven decision-making for authorities, enabling them to optimize routes, schedules, and resource allocation based on accurate and up-to-date information.

1.4.4 Real-Time Data Update:

Our system operates in real-time, providing instantaneous updates on passenger movements and activities. This feature ensures that transportation authorities have access to the most current information, allowing for prompt responses to security concerns, route optimization, and other dynamic aspects of public transportation management.

These features collectively contribute to the Bus Census System's capacity to revolutionize public transportation monitoring, offering a comprehensive solution that aligns with contemporary technological advancements and the evolving needs of transportation authorities and passengers alike.

1.5 Feasibility:

The feasibility of our project is assessed across various dimensions, considering technical, economic, legal, operational, and scheduling aspects.

1.5.1 Technical Feasibility:

Software Development: The technical feasibility revolves around the development of a robust software solution, which is technically achievable given the advancements in mobile application and web platform development.
Data Integration: The integration with existing government databases is feasible with proper collaboration and adherence to technical standards.
Data Analytics: Implementing data analytics for pattern recognition is technically viable, leveraging existing technologies and frameworks.

1.5.2 Economic Feasibility:

Initial Investment: While an initial investment is required for software development and system integration, the long-term economic benefits include increased government revenue and potential cost savings through efficient ticketing processes.
Sustainable Financial Model: Developing a sustainable financial model ensures ongoing maintenance and scalability without creating a burden on government resources.

1.5.3 Legal and Regulatory Feasibility:

Compliance: Collaboration with government authorities ensures compliance with existing transportation regulations and legal frameworks.
Privacy Protection: Implementing measures for user privacy protection aligns with data protection laws, contributing to legal feasibility.

1.5.4 Operational Feasibility:

User Adoption: Creating a user-friendly interface and conducting awareness campaigns will enhance user adoption, contributing to the operational feasibility.
Integration with Existing Systems: Collaborating with transportation agencies ensures a smooth integration with existing systems, minimizing operational disruptions.

1.5.5 Scheduling Feasibility:

Development Timeline: A realistic development timeline, including testing and refinement phases, is established to ensure the project's timely delivery.

Rollout Strategy: The phased rollout strategy allows for gradual implementation, reducing the impact on existing operations and facilitating adaptation.

1.5.6 Social Feasibility:

Community Engagement: Collaborating with local communities and advocacy groups enhances social feasibility, garnering support for the project's positive impact on public transportation.

User Benefits: The project's focus on making public transport more affordable and accessible contributes to its social feasibility by addressing the needs of the general population.

In summary, the feasibility analysis indicates that our project is technically, economically, legally, operationally, and socially viable. With proper planning, collaboration, and adherence to standards, the project is poised to effectively address the issue of bus ticket scams while contributing to the overall enhancement of public transportation services.

1.6 System requirement:

- **For video recording and sending to server**
    - **Hardware requirements**
        - Minimum 1 VGA camera
        - Intel Celeron or above CPU
        - Internet connectivity
    - **Software requirements**
        - Python
        - Open-cv
- **For Machine learning Task**
    - **Hardware requirements**
        - Intel i5 10gen or above
        - A CUDA Supported GPU
        - Internet Connectivity
        - Minimum RAM 16GB
    - **Software requirements**
        - Python

- Opencv
- Visual C++ Tools
- CUDA
- CUDA Drives
- deepSORT
- ultralytics
- YOLO

Chapter 2: Literature Review

The literature review provides a comprehensive overview of existing research, studies, and relevant information related to the issue of bus ticket scams in Indian cities and the broader context of public transportation. This review encompasses historical perspectives, challenges faced, existing solutions, and gaps in the current understanding.

2.1 Historical Context:

Historically, public transportation has been a vital component of urban infrastructure, facilitating the movement of people and contributing to economic development. However, the issue of scams related to bus tickets in Indian cities has been a persistent challenge. Early records indicate instances of fraudulent practices, with individuals exploiting gaps in ticketing systems to deceive passengers and evade rightful payments.

Over the years, the evolution of transportation systems has introduced new complexities, and the advent of technology has both facilitated and complicated the management of bus ticketing. Understanding the historical context provides insight into the persistence of scams and the necessity for innovative solutions.

2.2 Challenges in Public Transportation Ticketing:

Several challenges contribute to the perpetuation of bus ticket scams. These challenges include:

Manual Ticketing Systems: Reliance on manual ticketing processes creates opportunities for manipulation and fraud, as witnessed in various Indian cities.
Lack of User Awareness: Many passengers are unaware of the necessity of tickets, making them susceptible to scams where they unknowingly pay without receiving a valid ticket.
Limited Technology Integration: Insufficient integration of technology in ticketing systems hinders the ability to track and prevent fraudulent activities effectively.

2.3 Existing Solutions:

While the challenges persist, efforts have been made to address them through various solutions:

Digital Ticketing Platforms: Some cities have adopted digital platforms for ticketing, reducing the reliance on manual processes and increasing transparency.
Surveillance Systems: The deployment of surveillance systems on buses aims to deter fraudulent activities, although the effectiveness varies.
Public Awareness Campaigns: Initiatives to educate the public about the importance of valid tickets have been undertaken, but the impact is limited without technological support.

2.4 Gaps in Current Understanding:

Despite these efforts, there remain significant gaps in addressing the root causes of bus ticket scams:

Limited Technological Innovation: The full potential of technology in preventing scams has not been realized, and there is a need for more advanced systems.
Incomplete Integration: Many existing solutions operate in isolation, highlighting the need for comprehensive integration with government databases and other relevant systems.
Socioeconomic Factors: Understanding the socioeconomic factors contributing to ticket scams is crucial for developing targeted interventions and policy changes.

2.5 Relevance to Our Project:

Our project seeks to build upon the existing literature by developing a holistic and technologically advanced solution to eliminate bus ticket scams. By addressing historical challenges, incorporating technological innovations, and considering the socioeconomic context, we aim to contribute to the transformation of public transportation, ensuring fair revenue collection and an improved travel experience for all. The literature review informs the development of our project by providing valuable insights into the complexities of the issue and guiding the formulation of effective strategies for its resolution.

Chapter 3: Preliminary Design:

3.1 Video Recording Using OpenCV:

Our journey in developing the "Bus Census System" began by creating an open-source computer vision (OpenCV) application. We initiated the process by establishing a window with dimensions 640x480 and implemented screen recording. Our code systematically saves the video file at fixed intervals, laying the groundwork for our comprehensive bus monitoring system.

3.2 Creation of a Custom Human Detection Model:

Advancing to our second milestone, we engineered a human detection model utilizing OpenCV and Convolutional Neural Networks (CNN). Leveraging a dataset comprising human and non-human entities, our objective was to accurately identify humans. Although our initial model demonstrated an 80% accuracy rate, it exhibited slower processing speeds. Subsequently, we transitioned to YOLO (You Only Look Once) for improved efficiency.

3.3 Human Detection Using YOLO v5:

In this phase, we seamlessly integrated YOLO v5 with the assistance of the Ultralytics library and OpenCV. Customizing YOLO's feature parameters specifically for human detection, we used the power of GPU computing through CUDA computing, enhancing the model's performance and precision.

Fig 1. YOLO Sample Output

3.4 Non-Maximum Suppression (NMS)

Non-Maximum Suppression (NMS) is a technique used in numerous computer vision tasks. It is a class of algorithms to select one entity (e.g., bounding boxes) out of many overlapping entities. We can choose the selection criteria to arrive at the desired results. The criteria are most commonly some forms of probability number and some form of overlap measure (e.g., Intersection over Union).

Fig 2. NMS working Demonstration

IoU in mathematical terms can be represented by the following expression,

Intersection Over Union (IoU) = (Target ∩ Prediction) / (Target U Prediction)

In our case using BBoxes, it can be modified to,

IOU(Box1, Box2) = Intersection_Size(Box1, Box2) / Union_Size(Box1, Box2)

Consider the the two BBoxes in the following figure,

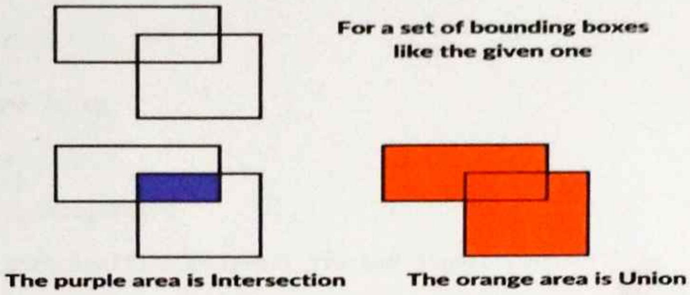

Fig 3. Behind NMS Algorithm

Their union area is the orange area, and their intersection area is the purple area. So the IoU(Intersection over Union) can be calculated by dividing the purple area by the orange area.

3.5 DeepSORT Algorithm

DeepSORT, short for "Deep Simple Online and Realtime Tracking," is an algorithm designed for multiple object tracking (MOT) in video streams. It builds upon the SORT (Simple Online and Realtime Tracking) algorithm by integrating deep learning features for improved tracking accuracy, especially in challenging scenarios with occlusions and appearance changes.
DeepSORT employs deep learning techniques to extract more robust and discriminative features for object representation. Convolutional Neural Networks (CNNs) are often used to learn features from the appearance of objects in each frame. These learned features help improve the tracking accuracy, especially in challenging scenarios with occlusions and changes in appearance.
DeepSORT is designed to be scalable, allowing it to handle tracking in real-time even in scenarios with a large number of objects.

3.6 Final Model:

The culmination of our efforts resulted in the development of the final model. Combining YOLO v5, OpenCV, deepSORT (Deep Simple Online and Realtime Tracking), and NMS (Non-Maximum Suppression), we implemented a sophisticated system. To maintain a comprehensive record, we crafted a Python dictionary to uniquely identify individuals and store their distinct features. This final model represents a robust and efficient solution for monitoring and analysing human activity within the context of our Bus Census System.

Our Code for model is:

```
import cv2
import numpy as np
import sys
import time
import torch
import face_recognition

from deep_sort_realtime.deepsort_tracker import DeepSort

class YoloDetector():

    def __init__(self, model_name):
        self.model = self.load_model(model_name)
        self.classes = self.model.names
        self.device = 'cuda' if torch.cuda.is_available() else 'cpu'

    def load_model(self, model_name):
        if model_name:
            model = torch.hub.load('ultralytics/yolov5', 'custom',
path=model_name, force_reload=True)
        else:
            model = torch.hub.load('ultralytics/yolov5', 'yolov5n',
pretrained=True)
        return model

    def score_frame(self, frame):
        self.model.to(self.device)
        downscale_factor = 2
        width = int(frame.shape[1] / downscale_factor)
        height = int(frame.shape[0] / downscale_factor)
        frame = cv2.resize(frame, (width, height))
        results = self.model(frame)
        labels, cord = results.xyxyn[0][:, -1], results.xyxyn[0][:, :-1]
        return labels, cord

    def class_to_label(self, x):
        return self.classes[int(x)]

    def plot_boxes(self, results, frame, height, width,
confidence_threshold=0.3):
```

```
        labels, cord = results
        detections = []
        n = len(labels)
        x_shape, y_shape = width, height
        for i in range(n):
            row = cord[i]
            if row[4] >= confidence_threshold:
                x1, y1, x2, y2 = int(row[0]*x_shape),
int(row[1]*y_shape), int(row[2]*x_shape), int(row[3]*y_shape)
                if self.class_to_label(labels[i]) == 'person':
                    x_center = x1 + (x2 - x1)
                    y_center = y1 + ((y2 - y1) / 2)
                    tlwh = np.asarray([x1, y1, int(x2-x1), int(y2-y1)],
dtype=np.float32)
                    confidence = float(row[4].item())
                    feature = 'person'
                    detections.append(([x1, y1, int(x2-x1), int(y2-y1)],
row[4].item(), 'person'))
        return frame, detections

# Create a dictionary to maintain mapping between face encodings and
person IDs
face_encodings_dict = {}

cap = cv2.VideoCapture(0)
cap.set(cv2.CAP_PROP_FRAME_WIDTH, 480)
cap.set(cv2.CAP_PROP_FRAME_HEIGHT, 360)

detector = YoloDetector(model_name=None)

object_tracker = DeepSort(max_age=5,
                          n_init=2,
                          nms_max_overlap=1.0,
                          max_cosine_distance=0.3,
                          nn_budget=None,
                          override_track_class=None,
                          embedder="mobilenet",
                          half=True,
                          bgr=True,
                          embedder_gpu=True,
                          embedder_model_name=None,
                          embedder_wts=None,
                          polygon=False,
                          today=None)

while cap.isOpened():
    success, img = cap.read()

    start = time.perf_counter()

    results = detector.score_frame(img)
    img, detections = detector.plot_boxes(results, img,
height=img.shape[0], width=img.shape[1], confidence_threshold=0.5)

    tracks = object_tracker.update_tracks(detections, frame=img)

    for track in tracks:
```

```
        if not track.is_confirmed():
            continue
        track_id = track.track_id
        ltrb = track.to_ltrb()

        bbox = ltrb

        # Extract the person's face region from the bounding box
        x1, y1, x2, y2 = map(int, bbox)
        face_image = img[y1:y2, x1:x2]

        # Encode the face
        face_encodings = face_recognition.face_encodings(face_image)

        if len(face_encodings) > 0:
            face_encoding = face_encodings[0]  # Use the first face
found

            # Check if the face encoding already exists in the
dictionary
            found_id = None
            for id, known_encoding in face_encodings_dict.items():
                match = face_recognition.compare_faces([known_encoding],
face_encoding)
                if match[0]:
                    found_id = id
                    break

            # If the face encoding is found, assign the same ID
            if found_id is not None:
                assigned_person_id = found_id
            else:
                # If not found, generate a new person ID
                assigned_person_id = len(face_encodings_dict) + 1
                face_encodings_dict[assigned_person_id] = face_encoding

            cv2.rectangle(img, (int(bbox[0]), int(bbox[1])),
(int(bbox[2]), int(bbox[3])), (0, 0, 255), 2)
            cv2.putText(img, "ID: " + str(assigned_person_id),
(int(bbox[0]), int(bbox[1] - 10)), cv2.FONT_HERSHEY_SIMPLEX,
                        0.9, (0, 255, 0), 2)

    end = time.perf_counter()
    totalTime = end - start
    fps = 1 / totalTime

    cv2.putText(img, f'FPS: {int(fps)}', (20, 70),
cv2.FONT_HERSHEY_SIMPLEX, 1.5, (0, 255, 0), 2)
    cv2.imshow('img', img)

    if cv2.waitKey(1) & 0xFF == 27:
        break

# Release and destroy all windows before termination
cap.release()
cv2.destroyAllWindows()
```

Chapter 4: Final Analysis and Design

4.1 Results

Fig4. Input video Frame

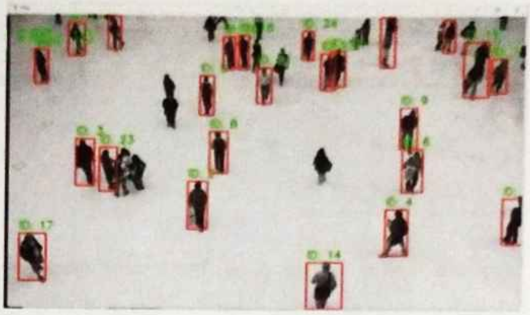

Fig5. Output video Frame

4.2 Result Analysis

On looking at the results of our Bus Census System, two important things stood out.

1. **Unique IDs for Every Person:**

We made sure that each person gets their very own special ID. This was possible because we used a clever algorithm called a deepSORT, with the help of the python dictionary. This dictionary remembers each person and deepSORT gives them a unique ID. So, every passenger or person is recognized individually.

2. **One Box for Each Person:**

To keep things clear and neat, we made sure that each person gets just one box around them. This was made possible by using something called the NMS (Non-Maximum Suppression) Algorithm. It's like making sure there's only one box for each person, so things don't get confusing.

These two aspects help the system work smoothly, ensuring that each person is recognized uniquely and that there's a clear box around them, making it easy to keep track of individuals in the Bus Census System.

4.3 Application

The Bus Census System, fortified by a sophisticated amalgamation of OpenCV, YOLOv5, deepSORT, and NMS, serves as a groundbreaking application with multifaceted implications. Primarily designed for enhancing public transportation surveillance, its versatile applications extend to various domains.

4.3.1 Public Transport Security:

The system's real-time human detection capabilities significantly elevate public transport security. By leveraging YOLOv5 and deepSORT, it provides swift and accurate identification of individuals, enhancing overall passenger safety. Suspicious activities and unauthorized access can be promptly identified and addressed, contributing to a more secure commuting environment.

4.3.2 Revenue Protection:

The Bus Census System aids in curbing revenue loss resulting from ticket scams. With its capacity to uniquely identify and track passengers, the system ensures that each individual pays the rightful fare. By integrating NMS for precise data processing, the system becomes an invaluable tool in safeguarding government revenue and optimizing public transportation finances.

4.3.3 Crowd Management:

In densely populated urban areas, efficient crowd management is paramount. The system's human detection capabilities, powered by YOLO5, allow for real-time monitoring of passenger density. Transport authorities can utilize this data to optimize bus routes, deploy additional services during peak hours, and enhance overall transit efficiency.

4.3.4 Contactless Passenger Experience:

With its foundation in OpenCV, the system facilitates a contactless passenger experience. Automated ticket verification and tracking eliminate the need for physical tickets, promoting a seamless and hygienic public transport experience. Passengers can board buses swiftly, reducing congestion and improving the overall efficiency of the transportation system.

4.3.5 Data-Driven Decision-Making:

The comprehensive Python dictionary holding unique person IDs and features empowers transportation authorities with valuable data. This data can be harnessed for data-driven decision-making, including route optimization, resource allocation, and long-term planning to enhance the overall effectiveness and sustainability of public transportation systems.

In essence, the Bus Census System emerges as a transformative solution, redefining the landscape of public transportation by amalgamating cutting-edge technologies for enhanced security, revenue protection, crowd management, and data-driven decision-making.

4.4 Problems faced

Our journey in developing the Bus Census System was not without challenges, and we encountered several hurdles that required innovative solutions for successful implementation.

4.4.1 System Requirement Issues:

One significant challenge arose from system requirements. To overcome this, we introduced a second device with enhanced specifications. This ensured that our system had the necessary resources to operate smoothly and efficiently.

4.4.2 Visual C++ Tool Support and Space Constraints:

The Visual C++ tool demanded substantial space, posing a challenge. To address this, we strategically managed other files on our system, creating sufficient space to accommodate Visual C++ without compromising the overall functionality.

4.4.3 Multiple Unstable Bounding Boxes on Single Human:

An issue emerged concerning the appearance of multiple unstable bounding boxes around a single human. To rectify this, we implemented the Non-Maximum Suppression (NMS) algorithm, enhancing the precision of bounding box identification and eliminating instability.

4.4.4 Python Version Compatibility:

Ensuring compatibility between different Python versions was crucial for seamless integration. We resolved this challenge by installing a specific Python version that harmonized with the other components, establishing a cohesive and interoperable system.

4.4.5 CUDA Compatibility:

Cuda compatibility became a focal point for optimization. To address this, we installed a specific Python version that aligned with CUDA requirements. This strategic adjustment ensured smooth communication between our system and GPU, maximizing computational power.

4.4.6 Frames Per Second (FPS) Drop:

Encountering a drop in Frames Per Second (FPS) presented performance challenges. Our solution involved leveraging CUDA to harness the computing power of our GPU. This not only resolved the FPS drop issue but also enhanced the overall efficiency of our system.

In navigating these challenges, our team demonstrated adaptability and problem-solving prowess, ensuring the successful development of the Bus Census System. Each problem encountered became an opportunity for improvement, resulting in a robust and effective solution for public transportation monitoring.

4.5 Limitations

Despite the successes and innovations achieved in developing the Bus Census System, it's essential to acknowledge its limitations, recognizing areas where improvements could enhance its overall performance.

4.5.1 Low Light Situations:

One notable limitation is the system's difficulty in operating effectively in low-light conditions. The technology relies on clear visibility, and in situations with inadequate lighting, its capacity to accurately detect and identify individuals may be compromised. This limitation implies that the system may not perform optimally during nighttime or in poorly lit environments.

4.5.2 System Requirement Challenges:

The Bus Census System has specific requirements for the devices it operates on. Unfortunately, these requirements can be demanding, necessitating devices with larger storage capacities and specific technical specifications. This limitation may pose challenges for users with devices that do not meet these criteria, potentially hindering widespread accessibility.

4.5.3 High Internet Connectivity:

Another limitation lies in the system's dependency on a robust internet connection. For seamless real-time data processing and communication, a consistently high-speed internet connection is required. In regions with limited internet access or unreliable connectivity, the system may experience disruptions, affecting its reliability and performance.

4.5.4 Prone to Physical Damage:

The physical durability of the system represents a limitation. Given that the system may be implemented in public transport vehicles, it becomes susceptible to physical damage due to various factors such as accidents, vibrations, or tampering. Ensuring the robustness and resilience of the system components is crucial to mitigate the risk of malfunctions caused by physical damage.

While these limitations highlight areas for consideration, they also present opportunities for future enhancements. Addressing these challenges could involve refining the system's sensitivity to low light, optimizing its compatibility with a broader range of devices, exploring offline capabilities, and reinforcing its physical resilience. Recognizing and addressing these limitations will contribute to the continual improvement and effectiveness of the Bus Census System in various operational scenarios.

4.6 Conclusion

The Bus Census System project represents a significant achievement in enhancing public transportation monitoring and security. Through the collaborative integration of YOLOv5, OpenCV, deepSORT, and NMS algorithms, we successfully developed a sophisticated and efficient system for tracking and analysing human activity within the context of public transport.

The utilization of YOLOv5 facilitated real-time detection and classification of individuals, while the integration of deepSORT ensured the smooth tracking of these detected individuals over time. NMS played a crucial role in refining the system's output by addressing the challenge of multiple bounding boxes around a single person, enhancing the precision and clarity of the visual data.

One notable feature of our system is the creation of a Python dictionary that uniquely identifies individuals based on their features. This not only contributes to accurate tracking but also provides a foundation for future enhancements and personalized services within the public transportation framework.

Despite the project's successes, certain limitations such as sensitivity to low-light conditions, specific system requirements, internet connectivity dependencies, and vulnerability to physical damage have been identified. Recognizing these limitations opens avenues for further refinements and developments in subsequent iterations of the Bus Census System.

In conclusion, our project lays the groundwork for a more secure, efficient, and data-driven public transportation system. The robustness of the final model, combined with ongoing efforts to address identified limitations, positions the Bus Census System as a valuable tool for authorities seeking to optimize public transport services and enhance passenger safety.

References

1. Github Repository of Yolo v5

2. Lewert, Jessica. "Human Detection for Flood Rescue: Application of YOLOv5 Algorithm and DeepSort Object Tracking." PhD diss., Georgia Institute of Technology, 2021.

3. Gai, Yuqiao, Weiyang He, and Zilong Zhou. "Pedestrian target tracking based on DeepSORT with YOLOv5." 2021 2nd International Conference on Computer Engineering and Intelligent Control (ICCEIC). IEEE, 2021.

4. Wang, Yuhan, and Han Yang. "Multi-target pedestrian tracking based on yolov5 and deepsort." In 2022 IEEE Asia-Pacific Conference on Image Processing, Electronics and Computers (IPEC), pp. 508-514. IEEE, 2022.

5. X. You, D. Li and M. Zhang, "A Top-View Multiple People Tracking System based on Newest YOLOv5 and DeepSort Using Depth Data," 2022 IEEE International Conference on Artificial Intelligence and Computer Applications (ICAICA), Dalian, China, 2022, pp. 91-96, doi: 10.1109/ICAICA54878.2022.9844474.

6. Bouraya, Sara, and Abdessamad Belangour. "Approaches to Video Real time Multi-Object Tracking and Object Detection: A survey." In 2021 12th International Symposium on Image and Signal Processing and Analysis (ISPA), pp. 145-151. IEEE, 2021.