Enhancing Safety in Public Spaces: Advanced Object Detection and Anomaly Monitoring using Surveillance Footage

Submitted in partial fulfillment of the requirements
of the course **Innovative Product Development (IPD) IV**

Year 3, Sem VI Computer Engineering

By

Yuvraj Rasal	**60004210196**
Aditya Dighe	**60004210212**
Mohit Dhatrak	**60004210214**
Aradhya Sakalley	**60004210253**

Guides:

Pankaj Sonawane
Assistant Professor

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

University of Mumbai
2023-2024

CERTIFICATE

This is to certify that the project entitled **“Enhancing Safety in Public Spaces: Advanced Object Detection and Anomaly Monitoring using Surveillance Footage”** is a bonafide work of **“Yuvraj Rasal (60004210196), Aditya Dighe (60004210212), Mohit Dhatrak (60004210214), Aradhya Sakalley (60004210253)”** submitted as a project work for the course **Innovative Product Development (IPD) IV, Year 3, Semester VI, B.Tech Computer Engineering**

(Pankaj Sonawane)
Internal Guide1/Guide2

Dr. Meera Narvekar
Head of Department

Dr. Hari Vasudevan
Principal

IPD Project Report Approval for BTech Semester VI

This project report entitled **Enhancing Safety in Public Spaces: Advanced Object Detection and Anomaly Monitoring using Surveillance Footage** by **Yuvraj Rasal, Aditya Dighe, Mohit Dhatrak, and Aradhya Sakalley** is approved for the Innovative Product Development (IPD) IV examination **of Year 3, Semester VI, B.Tech Computer Engineering**

Examiners

1.--

2.--

Date:

Place:

Declaration

I/We declare that this written submission represents my/our ideas in my/our own words and where others' ideas or words have been included, I/We have adequately cited and referenced the original sources. I/We also declare that I/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 my/our submission. I/We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Yuvraj Rasal (60004210196)

Aditya Dighe (60004210212)

Mohit Dhatrak (60004210214)

Aradhya Sakalley (60004210253)

Date:

Abstract

Our project, originally tailored for enhancing safety within the confines of the Indian Railways, has undergone a significant evolution, expanding its scope to tackle security challenges prevalent in a myriad of public spaces. This transformation reflects our commitment to not only revolutionizing railway safety but also to addressing broader societal needs for heightened security measures. Through the integration of cutting-edge technology such as Advanced Object Detection and Anomaly Monitoring, our endeavor seeks to optimize safety protocols across diverse environments, transcending the boundaries of railway stations. Leveraging YOLO V8 for real-time object detection and Roboflow for meticulous dataset annotation, our system ensures swift and accurate identification of potential threats, underscoring our dedication to precision and efficacy in safeguarding public spaces. Moreover, by introducing innovative features like person counting and abandoned object detection, we aim to proactively mitigate security risks, thereby setting a new benchmark for comprehensive security solutions that prioritize both efficiency and safety.

Contents

1. INTRODUCTION **1**
2. NEED OF THE PRODUCT **1**
2.1. Explain in detail why the product is needed? 1
2.2. If an extension of existing, then explain the drawbacks of the existing 3
2.3. Applications of the product 3
3. SURVEY **4**
3.1. Field survey 4
3.2. Literature survey 11
3.3. Outcome of survey 11
4. PROBLEM FORMULATION **12**
4.1. Problem Formulation 12
4.2. Product objectives 12
4.3. Novelty 13
4.4. Scope of the project 14
5. PROPOSED DESIGN **14**
5.1. Proposed model 14
5.2. Database design (DFDs, CFDs, ER diagrams) 15
5.3. Use cases 17
6. IMPLEMENTATION **18**
6.1. GUI design (Screenshots of GUI) 18
6.2. Modules implementation (Pseudocode/algorithm of the model) 21
7. EXPERIMENTATION & RESULTS **24**
7.1. Datasets / Tables 24
7.2. Test cases (or Hypothesis) 27
7.3. Parameter tuning experiments (if any) 32
7.4. Results 33
8. CONCLUSION **34**
9. REFERENCES / BIBLIOGRAPHY **34**
10. APPENDIX **35**
1. Technical paper 35
2. Patent filing (if any) 35

List of Figures

Figure No.	Figure Caption	Page No.
1	CCTV surveillance and crime index graph	9
2	CCTV camera surveillance in India	10
3	Product architecture	14
4	ER diagram	15
5	Graphical User Interface Implementation	18-21
6	YOLO architecture	22-23

List of Tables

Table No.	Table Title	Page No.
1	Entity description table	16

List of Abbreviations

Sr. No.	Abbreviation	Expanded form
1	DSS	Decision Support System
2	YOLO	You Only Look Once
3	CNN	Convolutional Neural Network
4	CCTV	Closed Circuit Television

ENHANCING SAFETY IN PUBLIC SPACES: ADVANCED OBJECT DETECTION AND ANOMALY MONITORING USING SURVEILLANCE FOOTAGE

1. INTRODUCTION

In response to the changing security landscape and challenges faced by Indian Railways, our research project focuses on improving security at railway stations by implementing advanced object detection and anomaly monitoring. Our approach addresses problems ranging from intrusions to real-time identification of abandoned objects and attempts to overcome the limitations of current surveillance systems. By integrating YOLO V8 for object detection, and supplemented by Roboflow's precise dataset annotation, our system is designed to optimize efficiency and accuracy. This report describes our approach and highlights the integration of cutting-edge technologies and innovative features such as people counting and abandoned object detection to usher in a new era of station safety.

2. NEED OF THE PRODUCT

2.1. Explain in detail why the product is needed?

The need for a CCTV surveillance system with suspicious activity detection using CNN arises from the increasing importance of security and the desire to enhance monitoring capabilities in various environments. Here are some reasons why such a product is valuable:

1. Enhanced security: By integrating CNN-based suspicious activity detection into a CCTV surveillance system, you can improve security measures by automatically identifying and flagging potentially suspicious behaviors or events. This can help prevent crimes, mitigate risks, and enhance overall safety.

2. Real-time monitoring: Traditional manual monitoring of CCTV footage can be time-consuming and prone to human error. By employing CNN algorithms, the system can automatically analyze video streams in real-time, allowing for swift detection and response to suspicious activities, minimizing the need for constant human vigilance.

3. Scalability and coverage: A CNN-based surveillance system can be deployed in various environments, such as public spaces, transportation hubs, commercial buildings, or residential areas. This scalability enables comprehensive coverage, allowing for effective monitoring of a large area with multiple cameras.

4. Rapid response and intervention: When suspicious activities are detected, the system can immediately alert security personnel or authorities, enabling faster response times and intervention. This can help prevent incidents from escalating and potentially aid in capturing perpetrators.

5. Efficient resource allocation: By automating the detection of suspicious activities, the system can reduce the burden on security personnel, allowing them to focus on critical tasks and investigations. This can optimize resource allocation and increase the overall efficiency of security operations.

6. Forensic analysis and evidence: In the event of an incident or crime, the CCTV surveillance system can provide valuable video evidence for forensic analysis and investigations. The suspicious activity detection capability can aid in identifying key moments or events leading up to an incident, assisting law enforcement agencies in their work.

Overall, a CCTV surveillance system with suspicious activity detection using CNN can significantly improve security measures, enhance monitoring capabilities, and contribute to maintaining public safety in a wide range of environments.

2.2. If an extension of existing, then explain the drawbacks of the existing

Drawbacks of current one - Models like OpenPose, PoseNet give out the keypoint coordinates of the people in the image/video in real time. But just obtaining the keypoints of the people without any background or surrounding objects information is not enough to decide if an activity is suspicious.
So, we use a CNN approach in our system instead of using a keypoints based approach.

2.3. Applications of the product

1. Develop a CCTV surveillance system that incorporates CNN-based suspicious activity detection to enhance security measures and monitoring capabilities.

2. Create an automated system that reduces reliance on manual monitoring, minimizing human error and improving efficiency in identifying suspicious activities.

3. Implement real-time analysis of video footage using CNN algorithms to enable proactive response measures and timely intervention in the event of security threats.

4. Improve accuracy and reliability of suspicious activity detection, minimizing false positives and false negatives through continuous model training and refinement.

5. Ensure scalability of the product, allowing it to be deployed in various environments and easily integrated with existing CCTV surveillance infrastructure.

6. Provide a user-friendly interface for configuring and managing the system, allowing security personnel to monitor and review flagged activities efficiently.

3. SURVEY

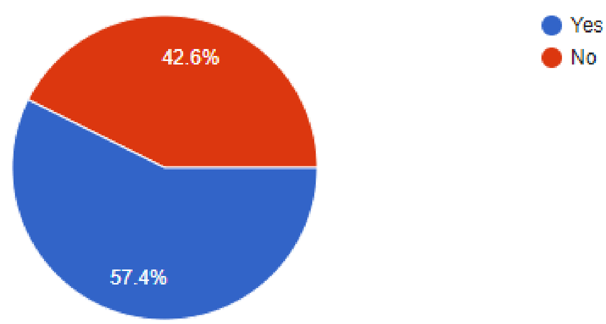
3.1. Field survey

Google form survey: https://forms.gle/nuvp7pPKBzVfefDB7

Are you familiar with the current security surveillance systems at Mumbai railway stations?

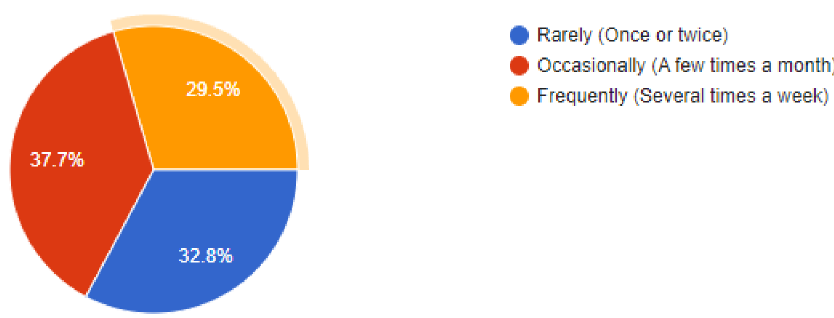
Western Railways installs 2,729 high-resolution cameras across 30 Mumbai suburban stations

61 responses



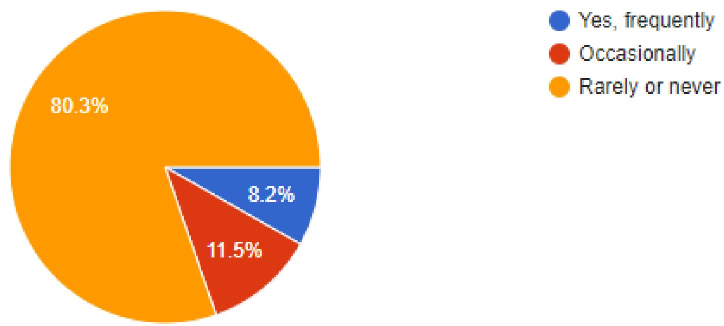
How often do you witness abandoned/unattended objects on railway platforms?

61 responses



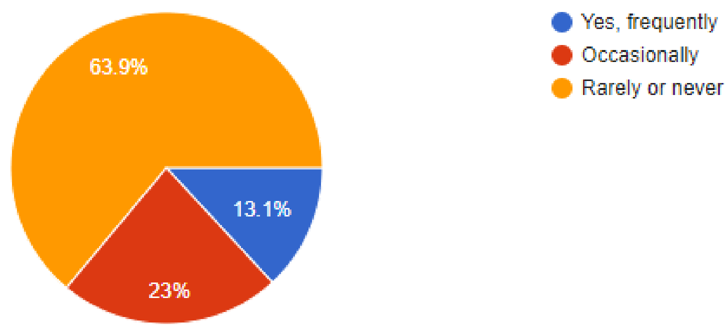
Have you reported or have witnessed others reporting abandoned/unattended objects when observed?

61 responses



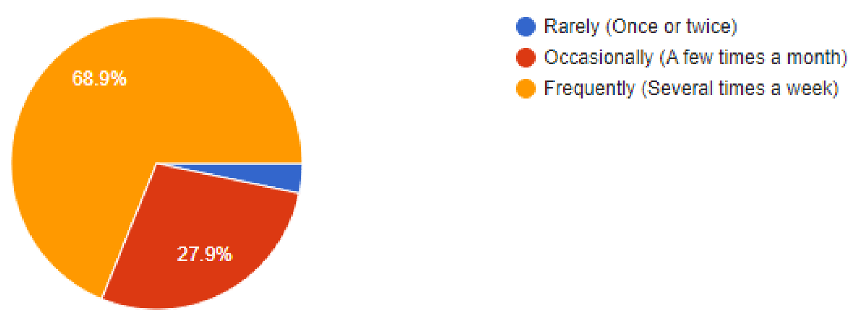
Are actions promptly taken upon reporting such unattended luggage and objects?

61 responses



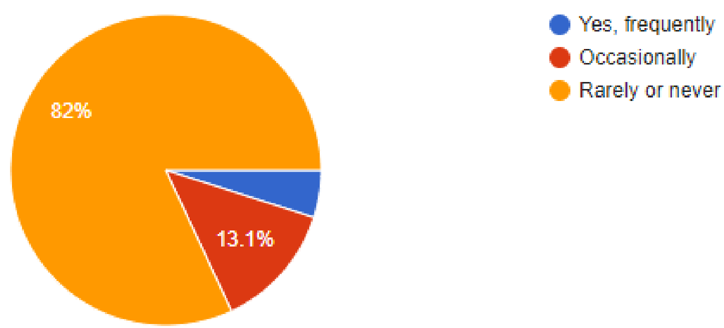
How often do you observe incidents of trespassing (crossing railway tracks)?

61 responses



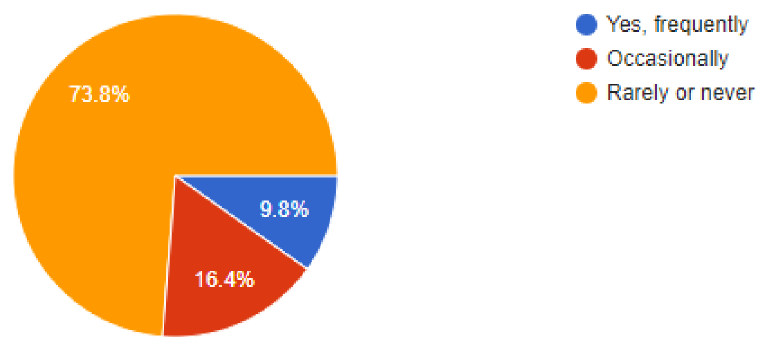
Have you reported or have witnessed others reporting incidents of trespassing on railway tracks?

61 responses



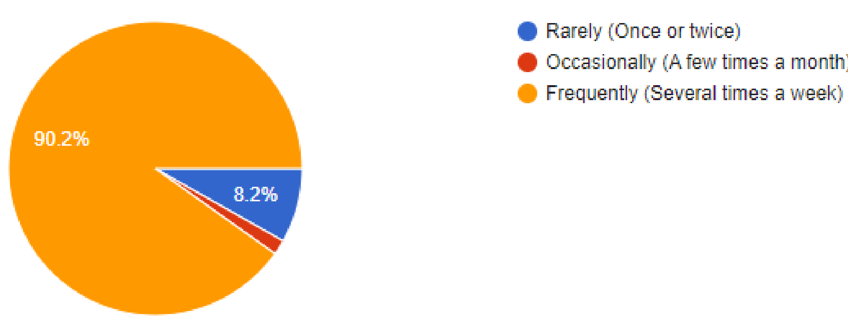
Are prompt actions taken upon receiving reports of trespassing incidents?

61 responses



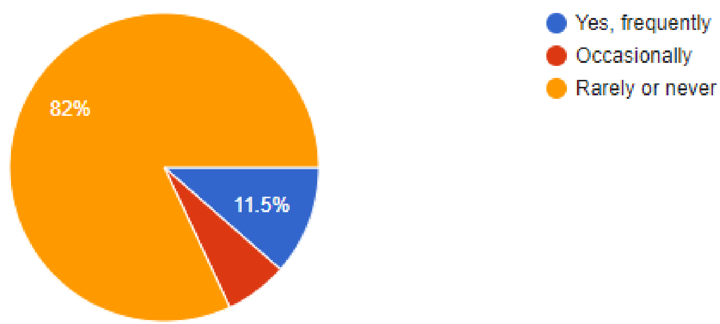
How frequently do you notice overcrowding at train stations?

61 responses



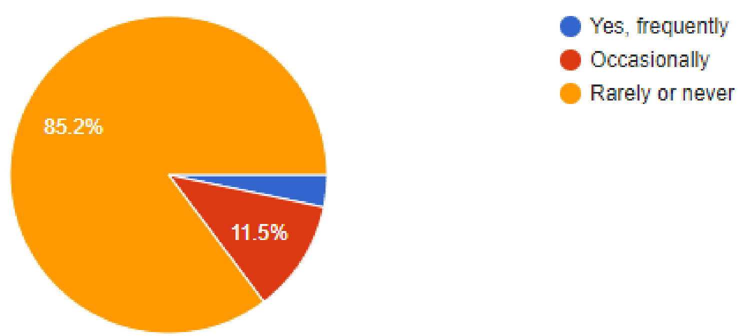
Have you reported or have witnessed others reporting incidents of overcrowding?

61 responses



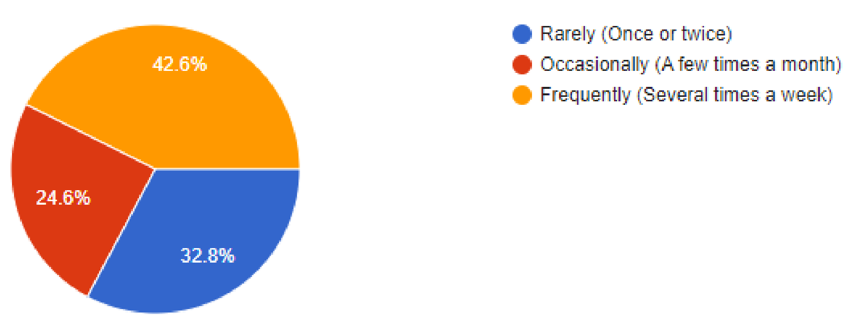
Are prompt actions taken upon receiving reports of overcrowding?

61 responses



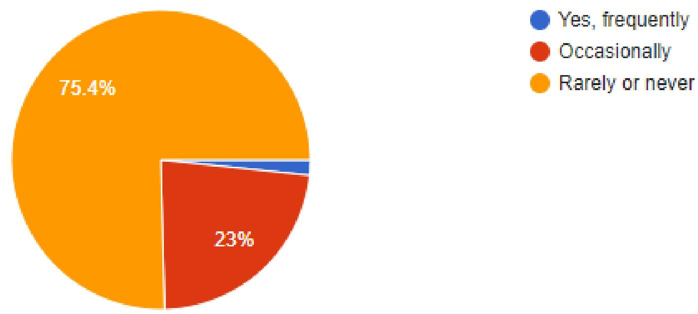
How frequently do you observe maintenance of a safe distance from the train on platforms?

61 responses



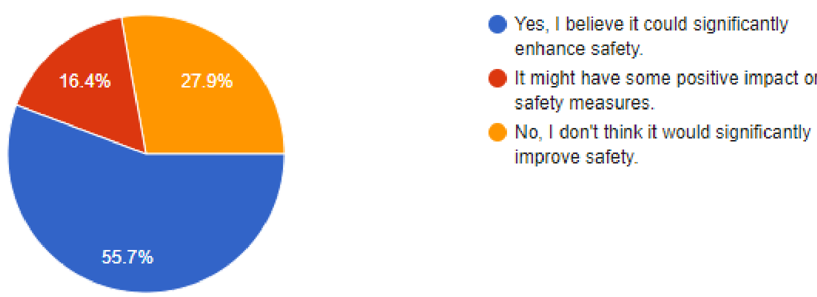
Are measures taken by the officials to ensure maintenance of safe distance from trains?

61 responses



Do you believe implementing advanced object detection technology to replace manual monitoring of CCTV camera footage could significantly improve safety measures at railway stations?

61 responses



Analysis of Survey Responses:

Observations:

- Abandoned Objects and Trespassing: Frequently observed.
- Reporting Frequency: Rare, despite frequent observations.

Key Insights:

- Significant disparity between observed incidents and reported cases.
- Potential underreporting issue, indicating a gap in reporting behavior.
- Lack of awareness or perceived barriers might hinder reporting.

Action Points:

- Implement awareness campaigns emphasizing the importance of reporting.
- Simplify reporting procedures and enhance accessibility to reporting channels.
- Evaluate and improve existing surveillance systems for better incident monitoring.
- Address safety concerns or barriers preventing individuals from reporting.

Considerations:

- Assess policy effectiveness regarding incident reporting.
- Explore advanced technologies for better incident detection and reporting.
- This concise analysis highlights the underreporting issue observed in the survey responses and proposes actionable steps to address this gap in reporting for improved safety and security.

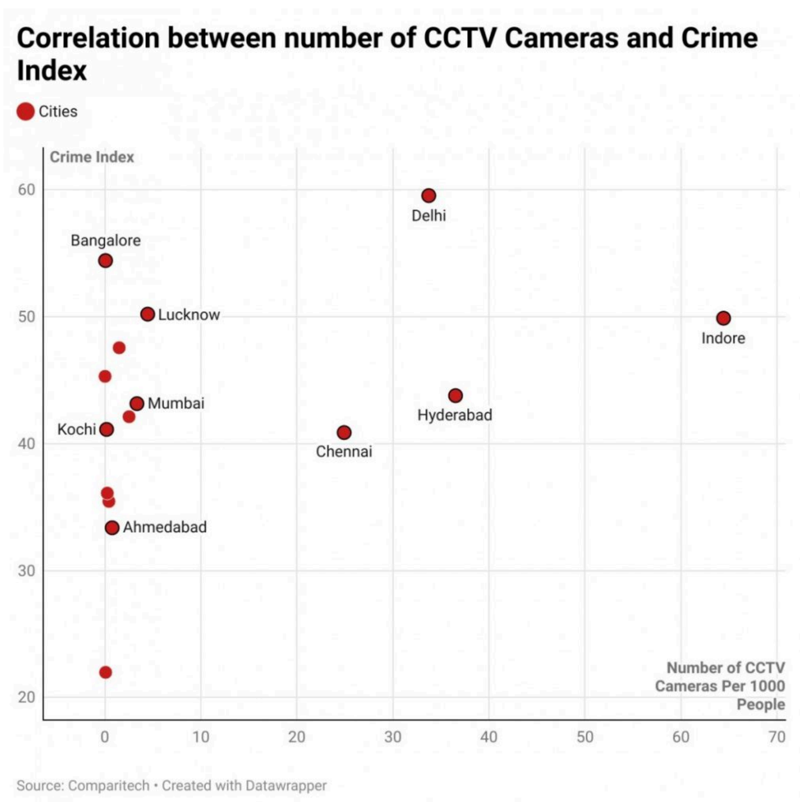
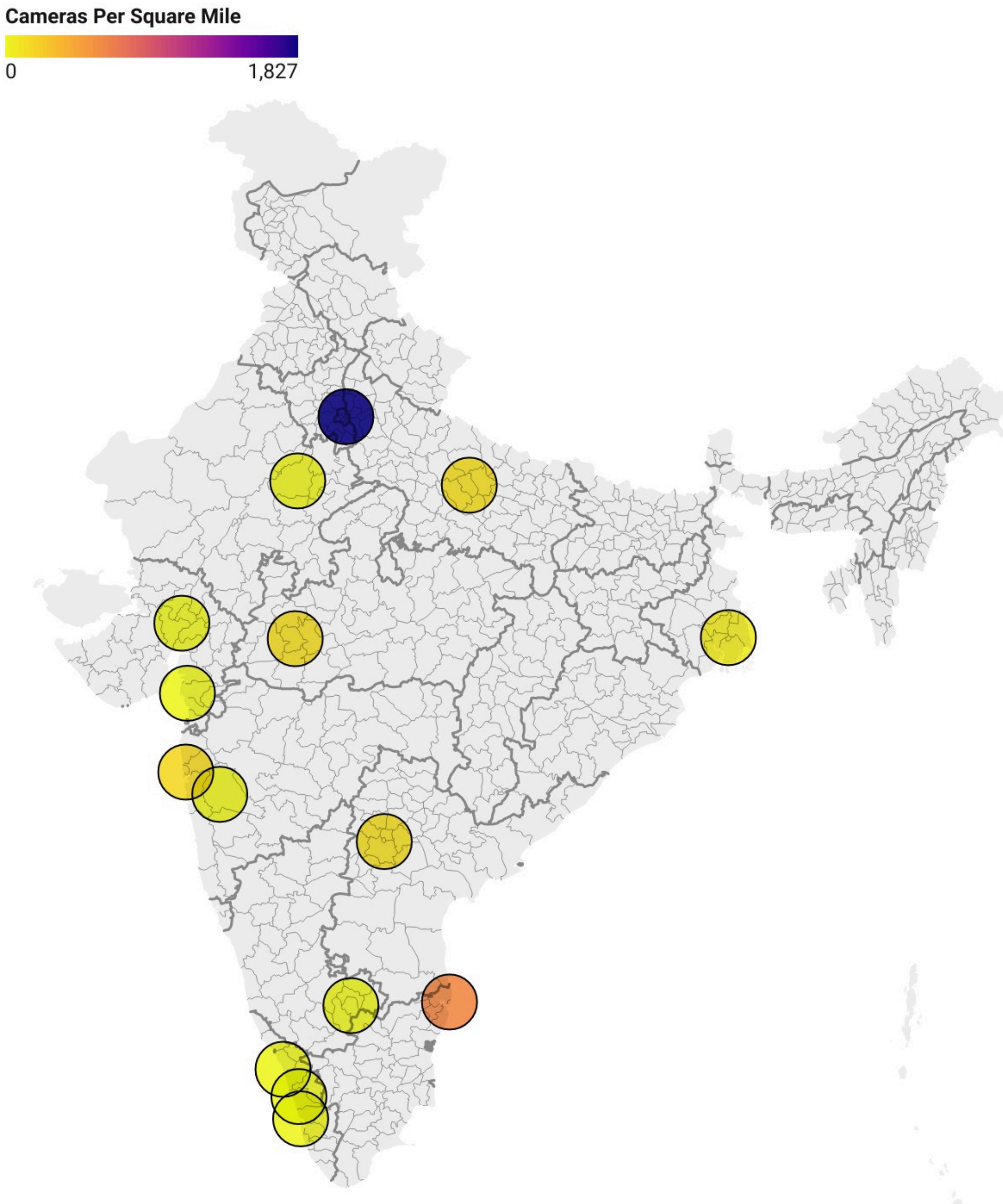


Figure - Correlation between the number of CCTV cameras & crime index

CCTV Camera Surveillance in India

The geographical mapping shows the 15 most surveilled cities in India. New Delhi, Hyderabad, Chennai, and Indore are the primary locations of surveillance with the most number of CCTV Cameras.



Source: Comparitech • Created with Datawrapper

Figure - CCTV camera surveillance in India

3.2. Literature survey

The rising number of CCTV cameras in India is a cause of grave concern. Figure 1 shows that around 1.54 million cameras are spread among India's top 15 cities. New Delhi (5,51,500), Hyderabad (3,75,000), Chennai (2,80,000), and Indore (2,00,600) have the most surveillance cameras in the country. It is worth noting that almost 91.1% of CCTV cameras installed in the country are present only in these four cities. Figure 2 shows the correlation between CCTV cameras per 1,000 people and crime index in India. It reveals that high surveillance rates do not always result in lower crime indices. Cities like New Delhi, Indore, Hyderabad, and Chennai, which are the focal spots of CCTV surveillance in India, rank high on the crime index. Meanwhile, cities with fewer cameras like Bangalore, Kolkata, and Kochi have lower crime indices. Surfshark's January 2020 report found that increased camera numbers do not correlate with the crime index globally. According to the California Research Bureau's study on video surveillance and biometric technologies of US law enforcement agencies, there is limited evidence that CCTV cameras reduce crime rates in our society.

3.3. Outcome of survey

From the data, we can see that there is no correlation between number of CCTV times and crime rate. Only installing CCTV cameras isn't the solution. It needs to be properly monitored as well. But monitoring the footage of so many cameras all the time is not possible. So we need a system that would help us identify suspicious activities and share alerts and timestamp of the surveillance video. This would make it easier for authorities or security agencies to take quick action, helping reduce the chances of mishaps or crimes.

4. PROBLEM FORMULATION

4.1. Problem Formulation

The inefficiency of manual monitoring in CCTV surveillance poses significant challenges in detecting and responding to suspicious activities effectively. The reliance on human vigilance alone often leads to delays and potential errors in identifying and addressing security threats. There is a need to develop a solution that integrates CNN-based suspicious activity detection into CCTV surveillance systems, reducing dependence on manual monitoring and enabling automated real-time analysis of video footage. This solution should address the limitations of manual monitoring, improve response times, and enhance the overall efficiency and accuracy of detecting suspicious activities, ultimately ensuring a higher level of security and safety in monitored environments.

4.2. Product objectives

1. Develop a CCTV surveillance system that incorporates CNN-based suspicious activity detection to enhance security measures and monitoring capabilities.

2. Create an automated system that reduces reliance on manual monitoring, minimizing human error and improving efficiency in identifying suspicious activities.

3. Implement real-time analysis of video footage using CNN algorithms to enable proactive response measures and timely intervention in the event of security threats.

4. Improve accuracy and reliability of suspicious activity detection, minimizing false positives and false negatives through continuous model training and refinement.

5. Ensure scalability of the product, allowing it to be deployed in various environments and easily integrated with existing CCTV surveillance infrastructure.

6. Provide a user-friendly interface for configuring and managing the system, allowing security personnel to monitor and review flagged activities efficiently.

4.3. Novelty

The implementation of a CCTV surveillance system with suspicious activity detection using Convolutional Neural Networks (CNN) introduces a novel approach to enhancing security measures. By integrating CNN algorithms into existing CCTV infrastructure, the system automates the analysis of video footage, reducing reliance on manual monitoring. In real-time, the system can detect suspicious activities as they occur, enabling proactive response measures and enhancing overall security. The solution is adaptable and scalable, making it suitable for various environments and applications, from small-scale deployments to large-scale implementations. Continuous learning mechanisms ensure that the system improves over time by retraining the CNN model with new data, enabling it to adapt to evolving threats and enhance accuracy. Additionally, the system can be seamlessly integrated with existing infrastructure, minimizing the need for extensive hardware changes. Privacy considerations are also addressed, ensuring compliance with regulations and protecting personal information captured by the CCTV system. Overall, the implementation of this system brings a novel and efficient approach to surveillance, enhancing security and safety in monitored environments.

4.4. Scope of the project

The scale and range of the project can vary based on available resources, technical constraints, and specific domain requirements. It can span from small-scale deployments to large-scale implementations covering multiple locations or even entire cities. Factors such as camera density, computational resources, dataset size, predefined activities, environmental constraints, and privacy considerations can influence the extent of completion for the project. Careful consideration of these factors is necessary to ensure a feasible and effective implementation within the desired domain or application.

5. PROPOSED DESIGN

5.1. Proposed model

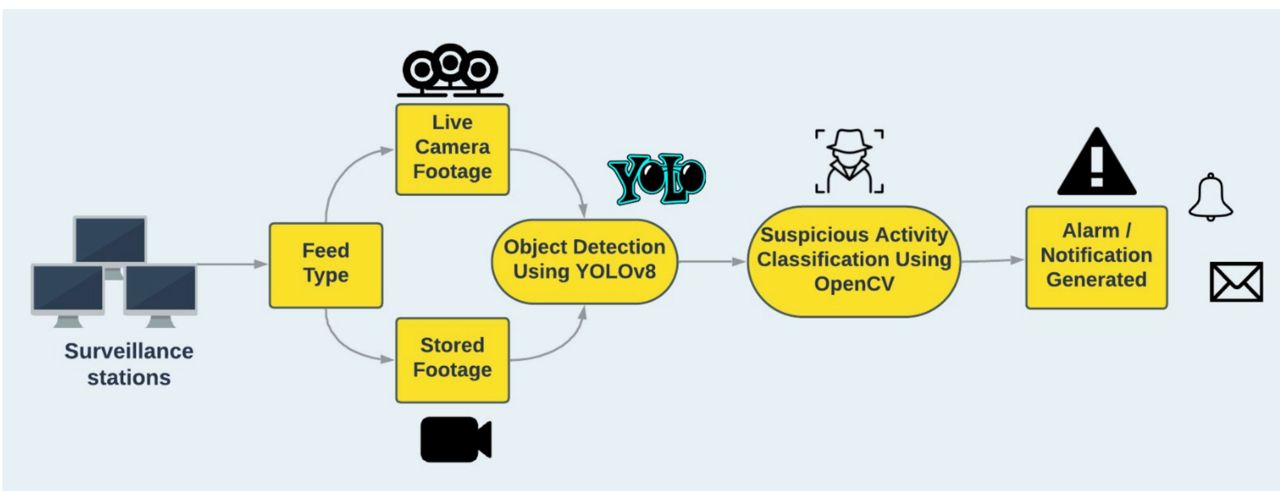


Figure - Product architecture

5.2. Database design (DFDs, CFDs, ER diagrams)

- Entity-Relationship Diagram (ERD) Overview:

  Entities:

  Cameras
  Surveillance Stations
  Unified Control Center
  Objects
  Crowd Behavior
  Train Data

- Relationships:

  Cameras are connected to Surveillance Stations.
  Surveillance Stations are managed by the Unified Control Center.
  Objects and Crowd Behavior are captured by Cameras.
  Train Data includes information related to station stops, schedules, and compartment occupancy.
  This is a high-level overview, and in a real-world scenario, each entity would have multiple attributes and might have more detailed relationships.

- ERD Representation (Simplified):

➔ ERD Diagram

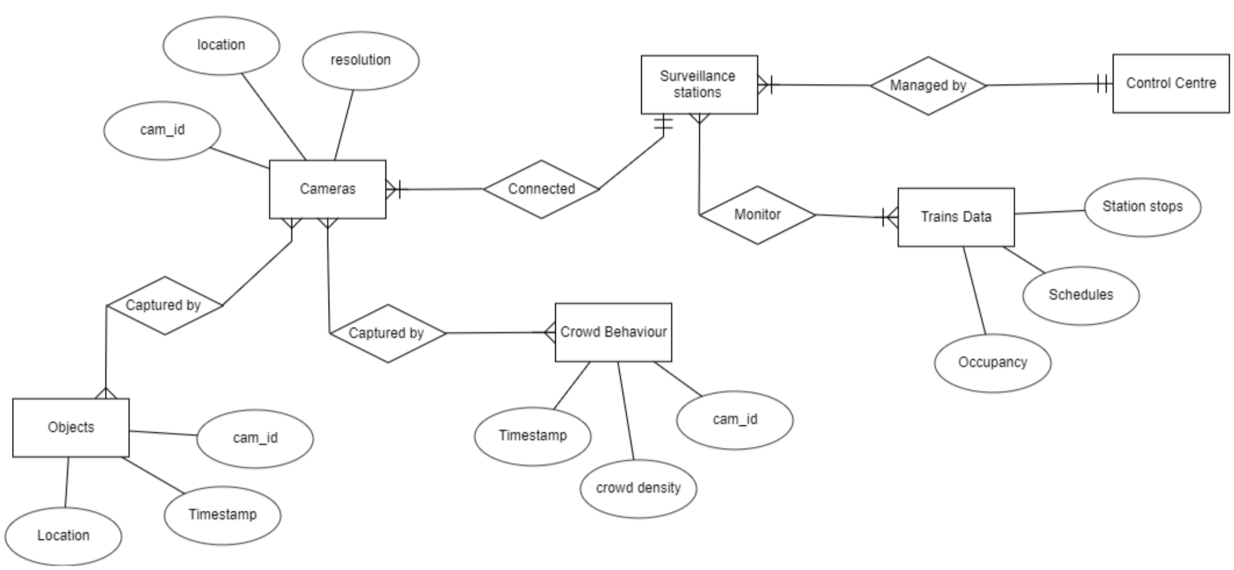


Figure - ER diagram

➔ Explanation:

Cameras have attributes such as Camera_ID, Location, Resolution, Type, etc.
Surveillance Stations are connected to Cameras and have details like Station_ID, Location, etc.
Unified Control Center manages Surveillance Stations and has information like Control_Center_ID, Location, etc.
Objects detected by Cameras contain Object_ID, Location, Timestamp, Camera_ID, etc.
Crowd Behavior recorded by Cameras includes Crowd_ID, Timestamp, Camera_ID, Movement_Type, Density, etc.
Train Data comprises details about Train_ID, Schedule, Station Stops, Compartment_Occupancy, etc.

Entities	**Key Fields**	**Description**
Cameras	Camera_ID, Location, Resolution, Type	Details about cameras deployed for surveillance
Surveillance Stations	Station_ID, Location, Connected_Cameras	Surveillance station information and connected cameras
Unified Control Center	Control_Center_ID, Location, Contact_Info	Central control center details
Objects	Object_ID, Location, Timestamp, Camera_ID	Identified objects and their details
Crowd Behavior	Crowd_ID, Timestamp, Camera_ID, Movement_Type	Crowd behavior details observed by cameras
Train Data	Train_ID, Schedule_Details, Station_Stops	Information about train schedules and stops

Table - Entities, key fields & description

5.3. Use cases

1. Public Spaces: Detecting suspicious activities in city centers, transportation hubs, and stadiums to enhance public safety and crowd management.

2. Retail Security: Identifying shoplifting, theft, or suspicious behaviors in retail environments for proactive loss prevention and improved security.

3. Critical Infrastructure Protection: Monitoring critical facilities like power plants or airports to detect unauthorized access and potential security threats.

4. Smart Cities: Real-time monitoring of public areas, traffic management, and identifying unusual behaviors for improved safety in smart city initiatives.

5. Workplace Security: Enhancing safety in office buildings, factories, or warehouses by monitoring for unauthorized access and suspicious activities.

6. Residential Security: Monitoring residential complexes or neighborhoods to detect and deter potential criminal acts for the safety of residents.

6. IMPLEMENTATION

6.1. GUI design (Screenshots of GUI)

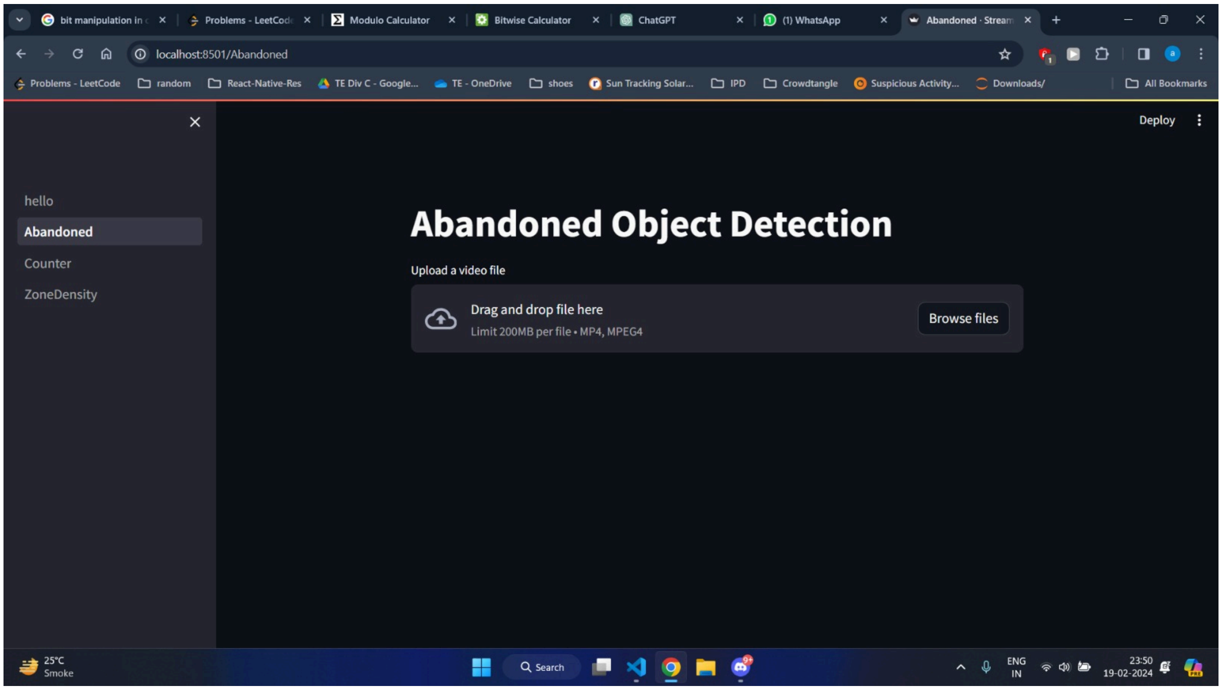


Figure - Drag and Drop files or Switch to Live video footage

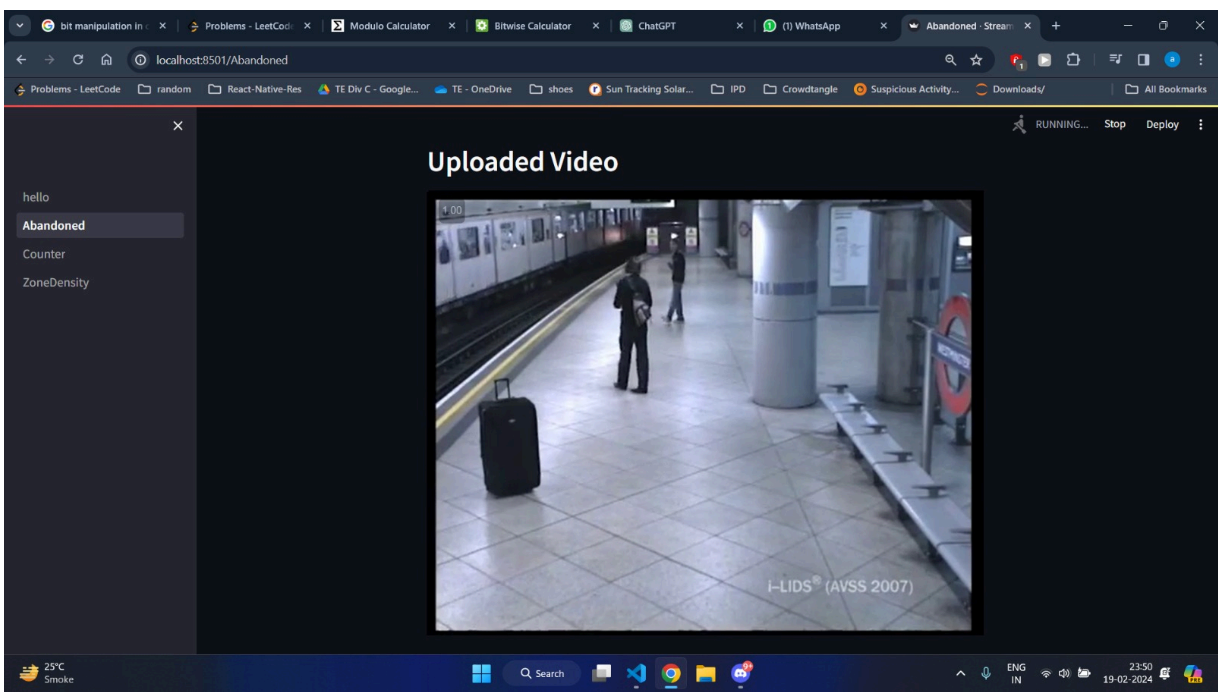


Figure - Uploaded video streamed (without inferences)

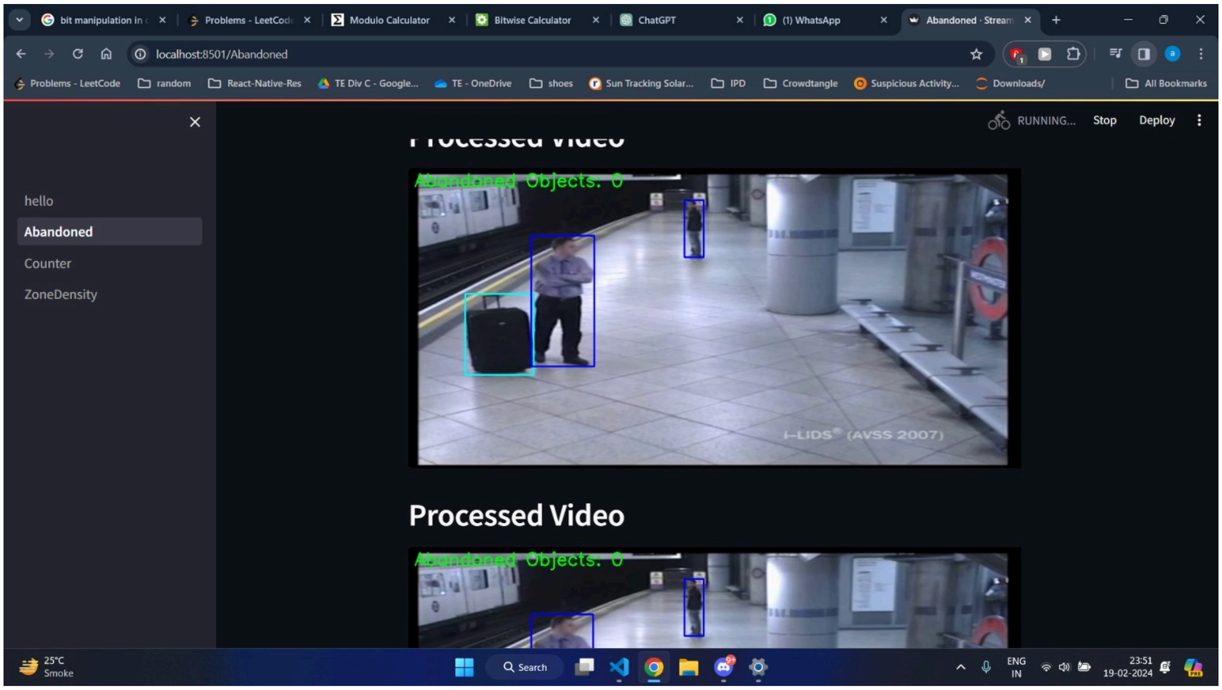


Figure - Uploaded video stream (with inferences) : Abandoned object detection

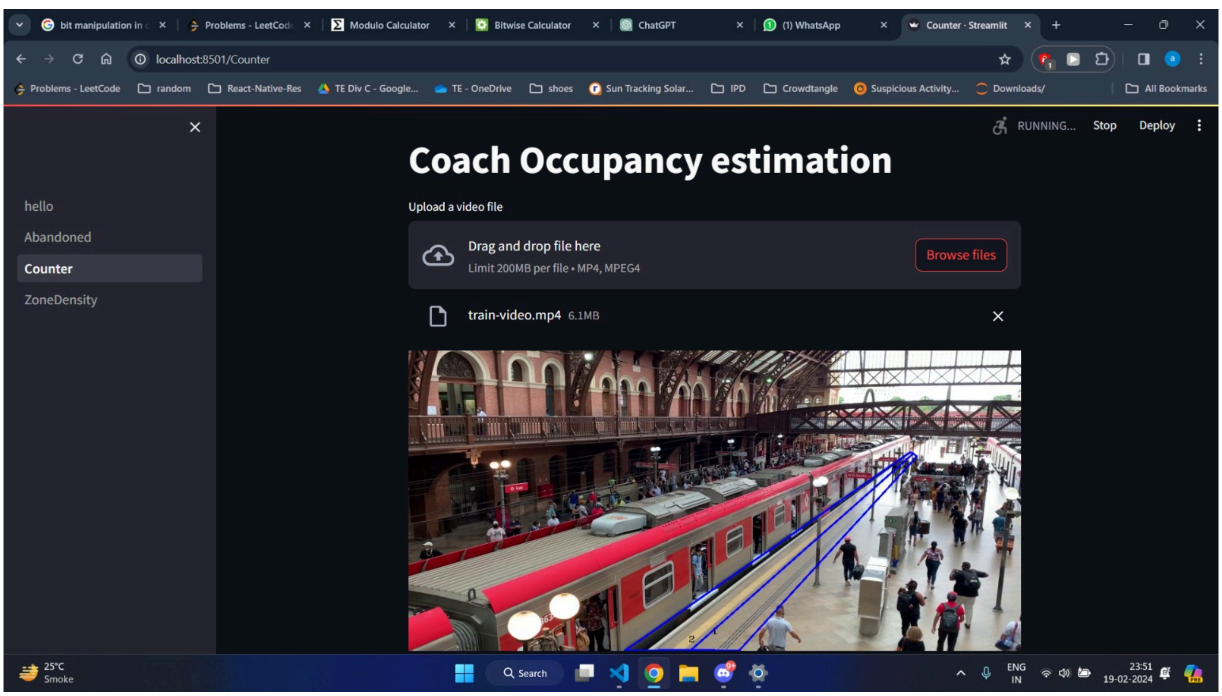


Figure - Coach occupancy estimation and tracking overcrowded coaches

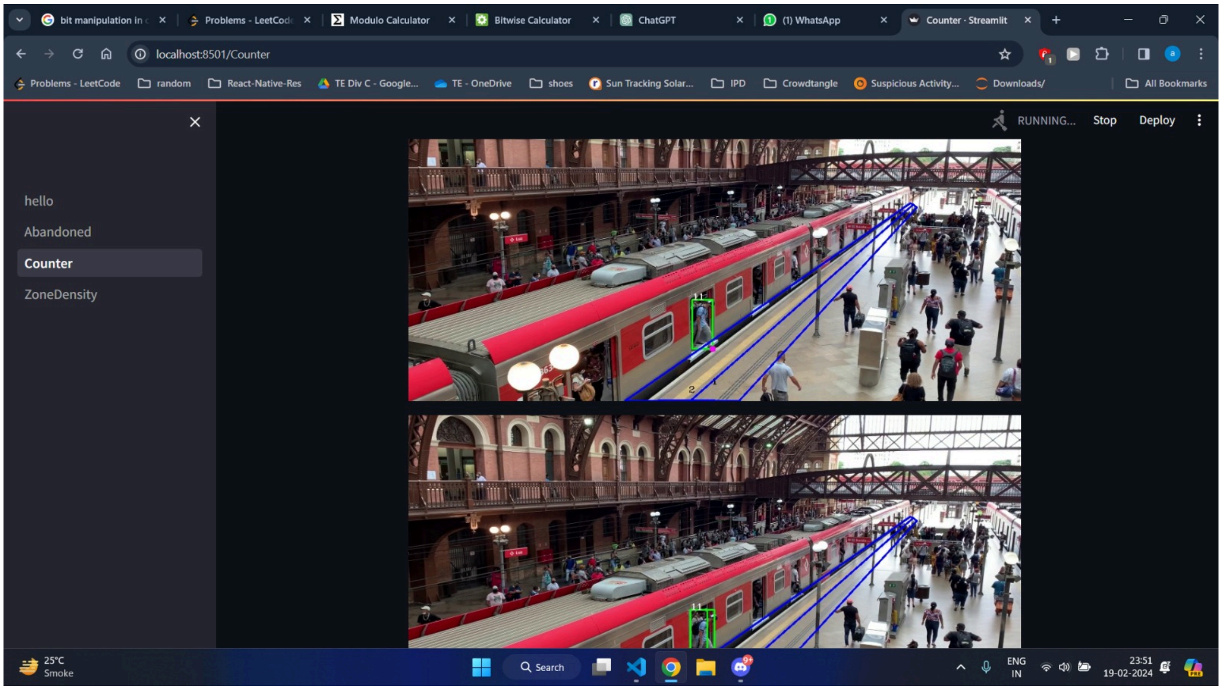


Figure - Counting number of people entering and exiting the coach

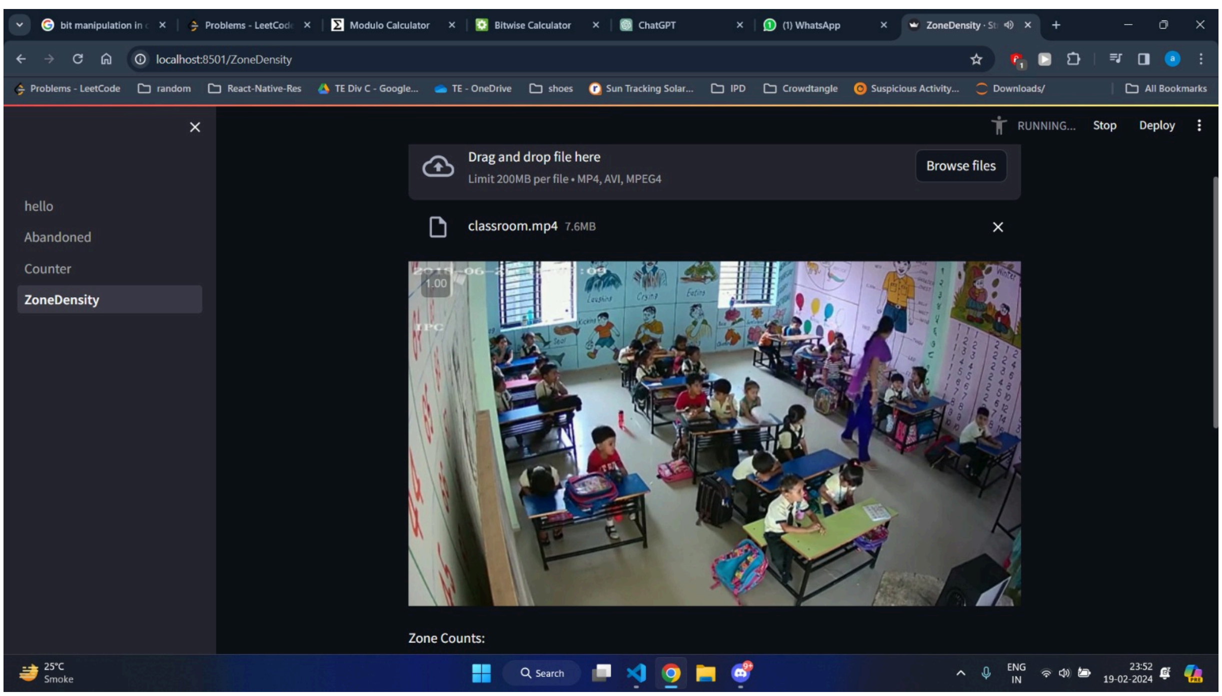


Figure - Counting number of people / Crowd control

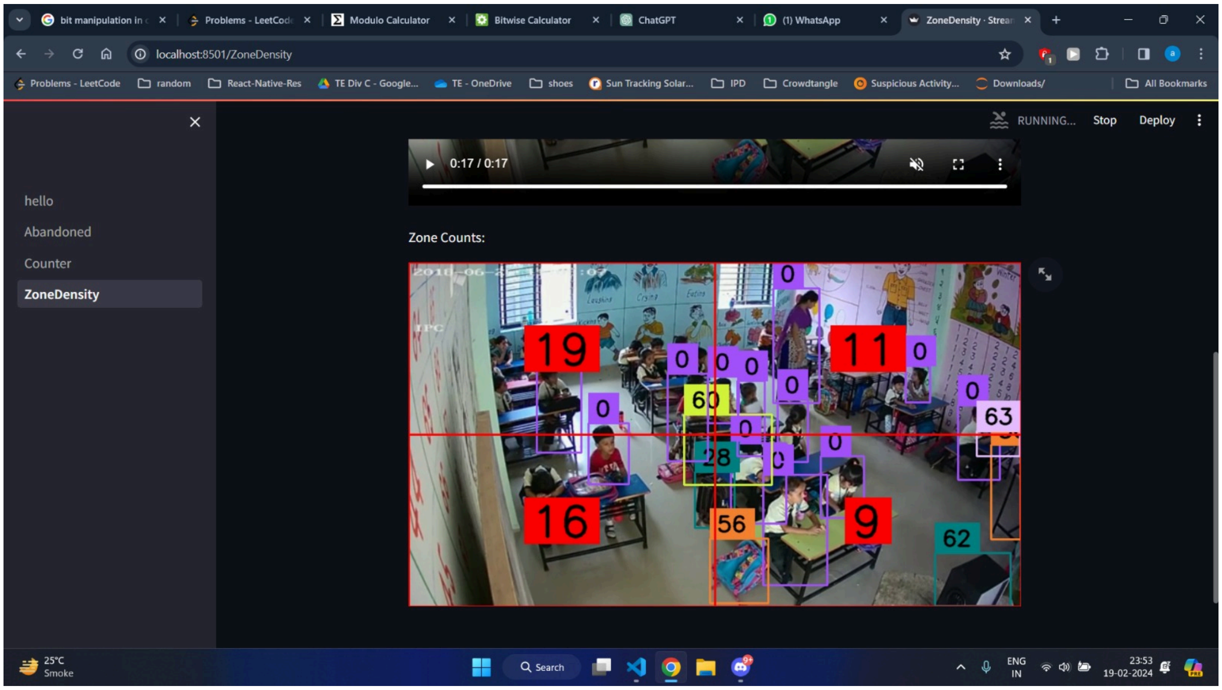


Figure - Zone based count to identify overcrowded zones

6.2. Modules implementation (Pseudocode/algorithm of the model)

To understand the YOLO algorithm, it is necessary to establish what is actually being predicted. Ultimately, we aim to predict a class of an object and the bounding box specifying object location. Each bounding box can be described using four descriptors:

- center of a bounding box (**bxby**)
- width (**bw**)
- height (**bh**)
- value **cis** corresponding to a class of an object (e.g., car, traffic lights, etc.)

To learn more about **PP-YOLO** (or PaddlePaddle YOLO), which is an improvement on YOLOv4, read our explanation of why PP-YOLO is faster than YOLOv4.

In addition, we have to predict the pc value, which is the probability that there is an object in the bounding box.

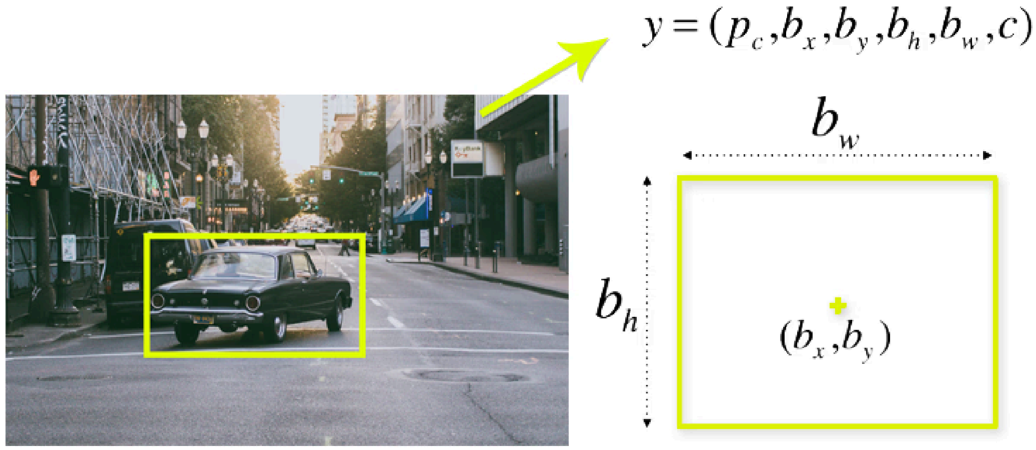


Figure - YOLO architecture

As we mentioned above, when working with the YOLO algorithm we are not searching for interesting regions in our image that could potentially contain an object.

Instead, we are splitting our image into cells, typically using a 19×19 grid. Each cell is responsible for predicting 5 bounding boxes (in case there is more than one object in this cell). Therefore, we arrive at a large number of 1805 bounding boxes for one image. Rather than seizing the day with #YOLO and Carpe Diem, we're looking to seize object probability. The exchange of accuracy for more speed isn't reckless behavior, but a necessary requirement for faster real-time object detection.

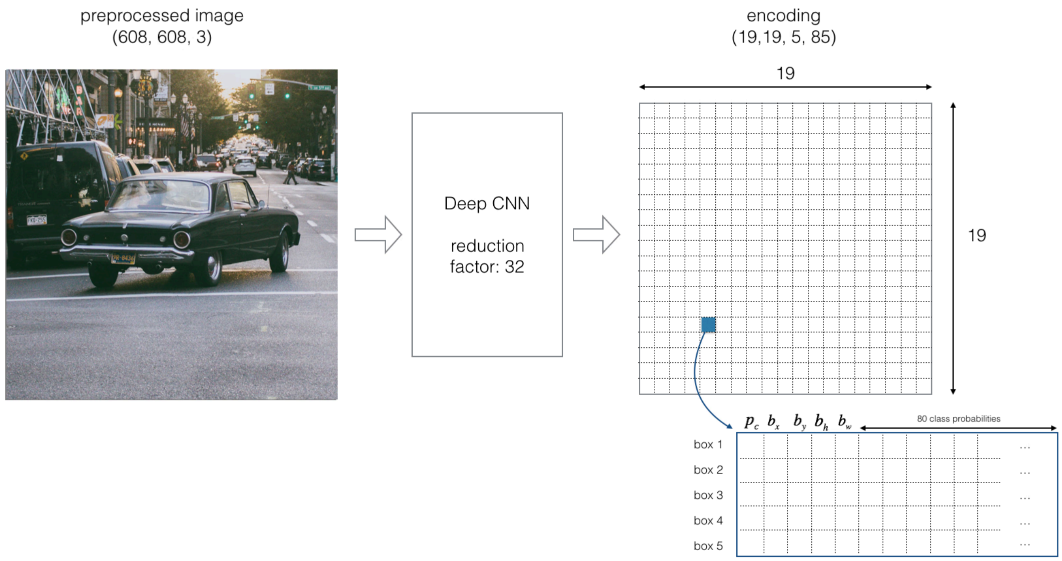
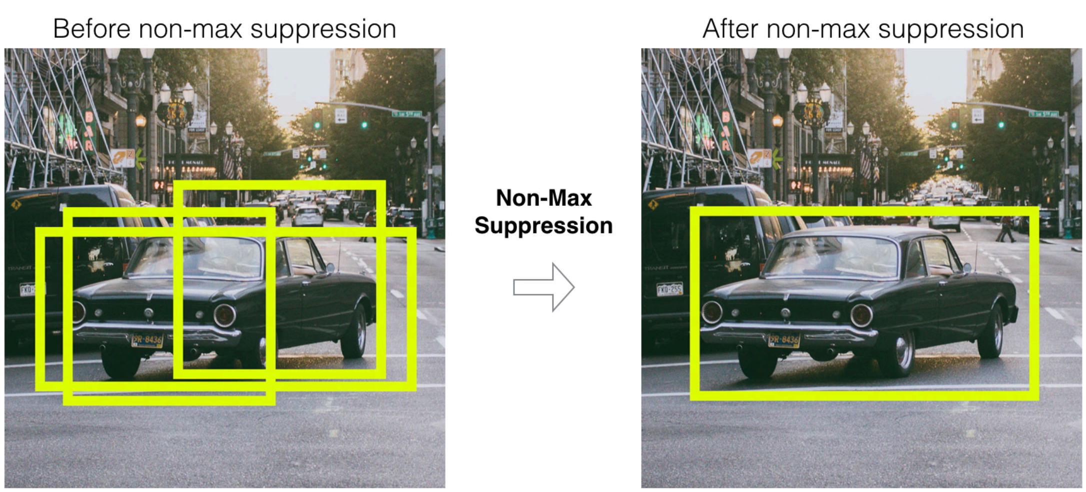


Figure - YOLO architecture

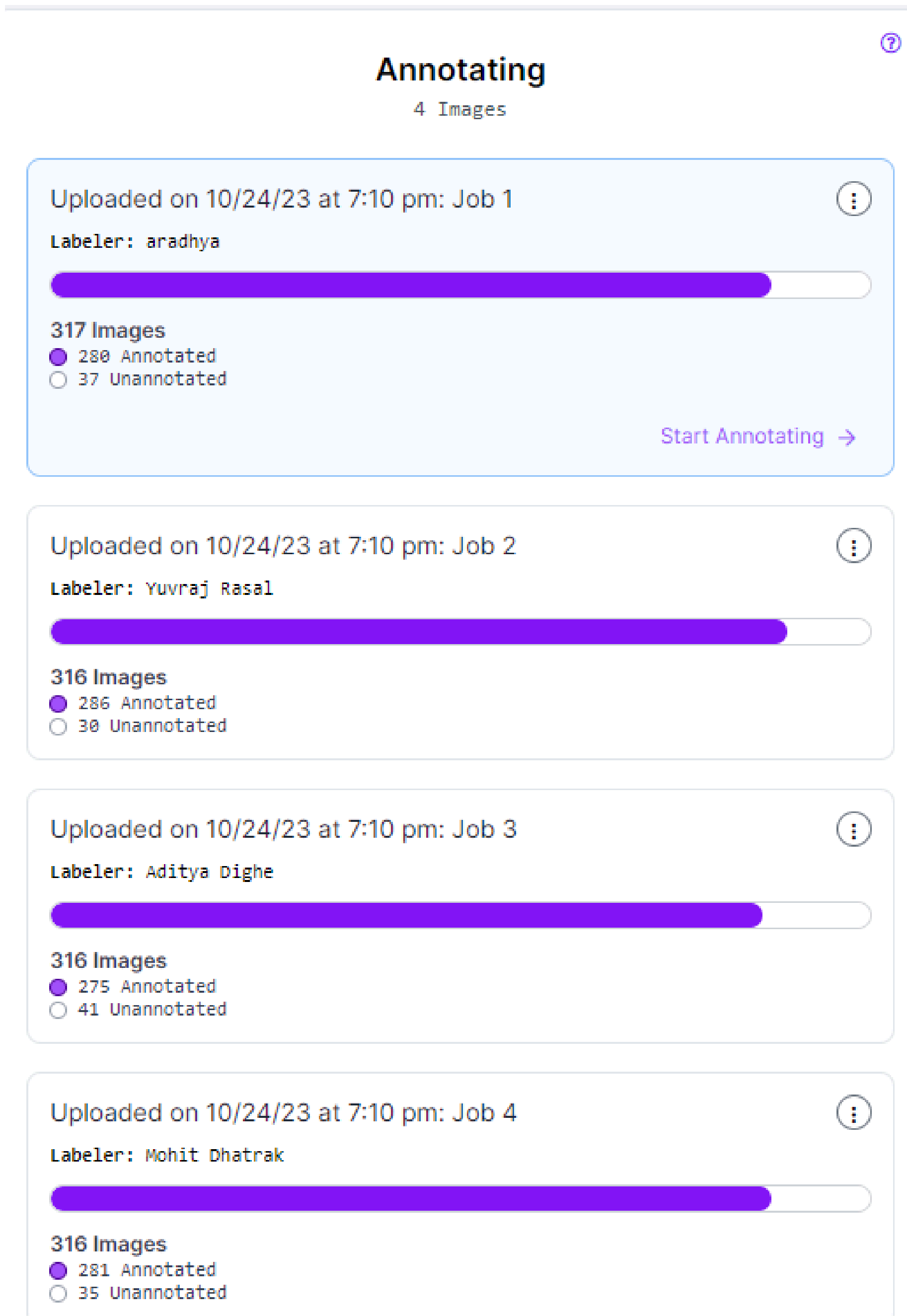
Most of these cells and bounding boxes will not contain an object. Therefore, we predict the value pc, which serves to remove boxes with low object probability and bounding boxes with the highest shared area in a process called **non-max suppression**.

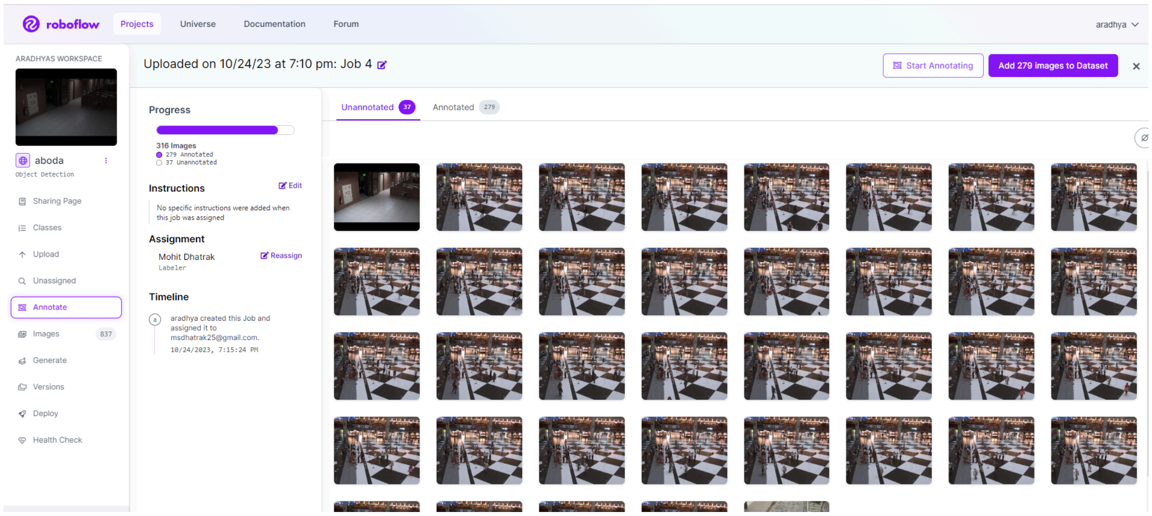


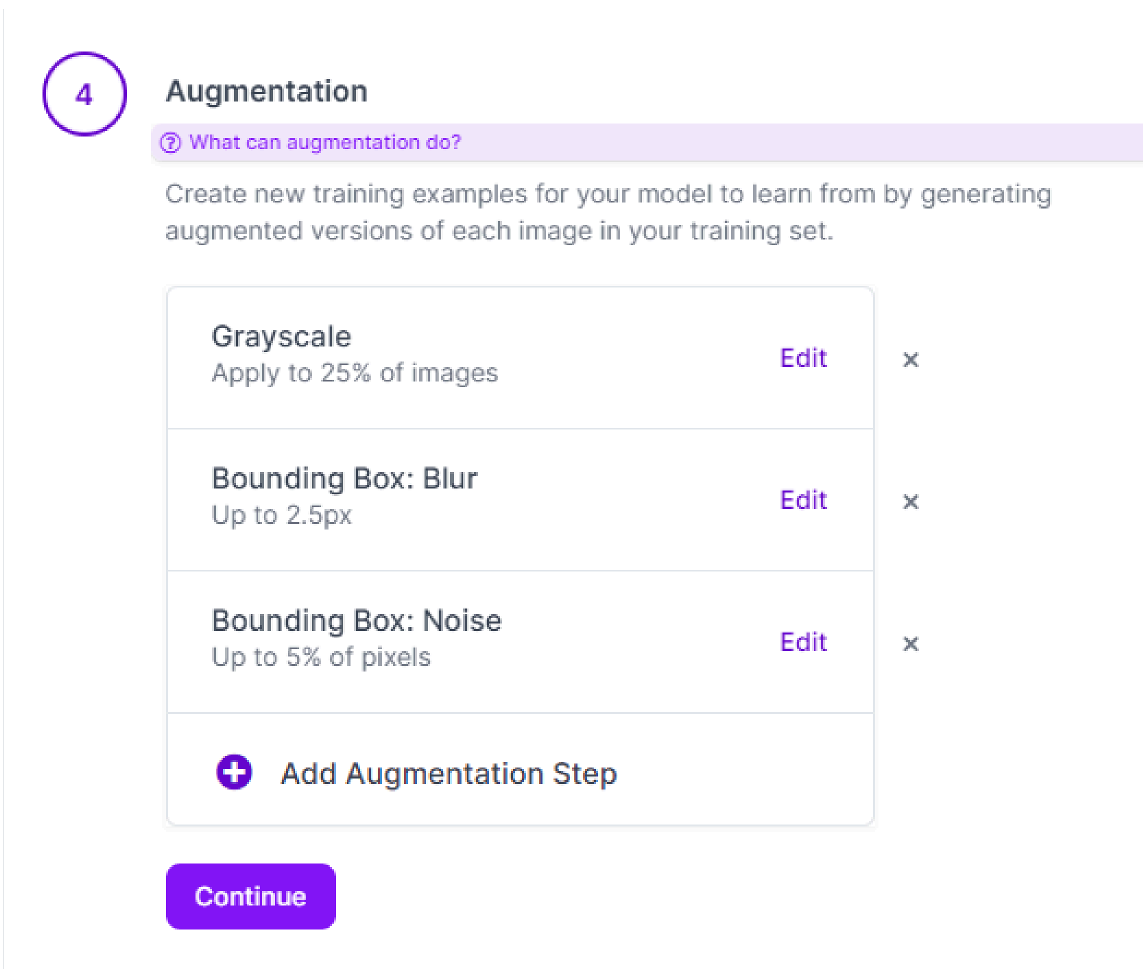
Before and After non-max suppression

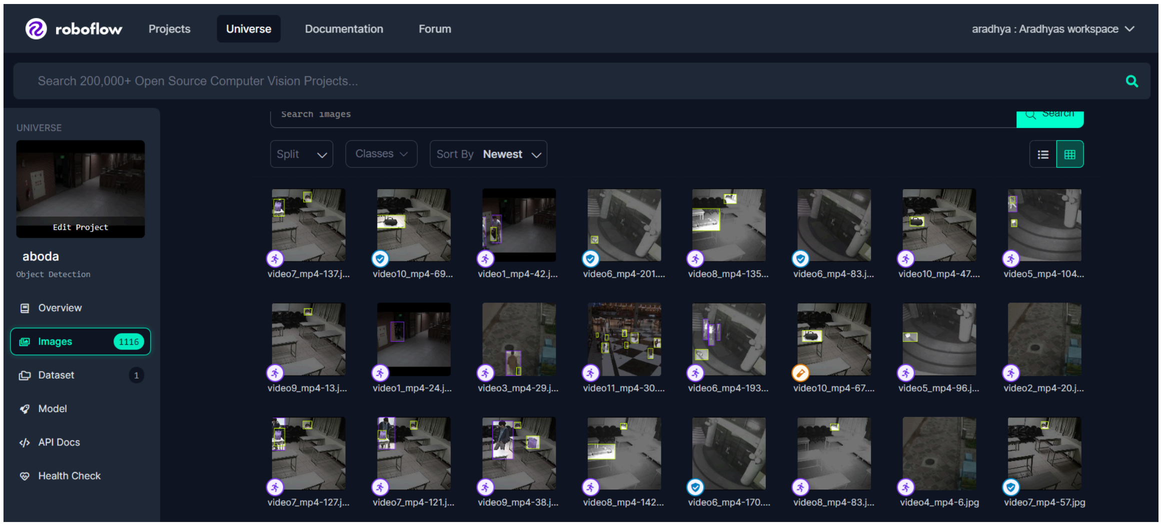
7. EXPERIMENTATION & RESULTS

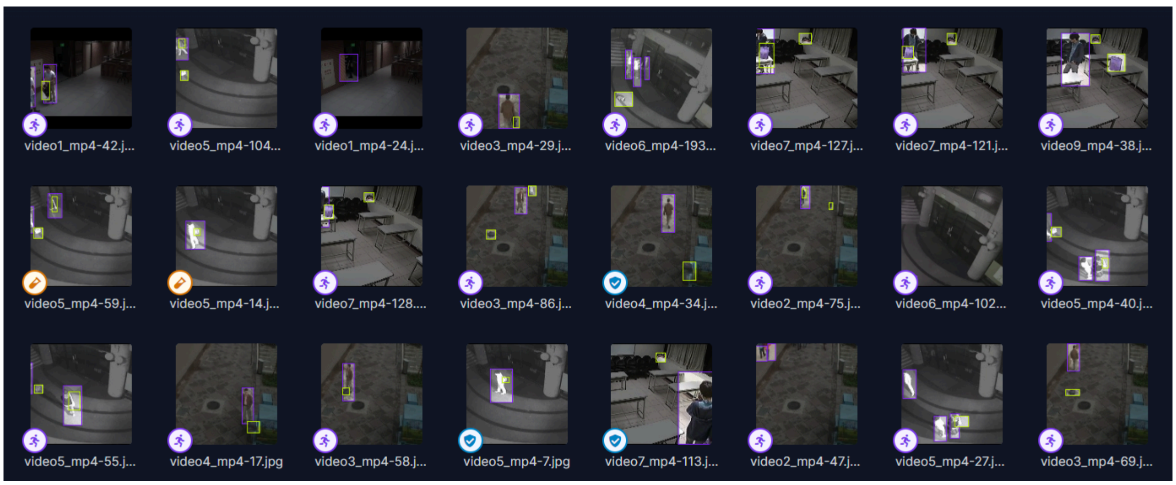
7.1. Datasets / Tables

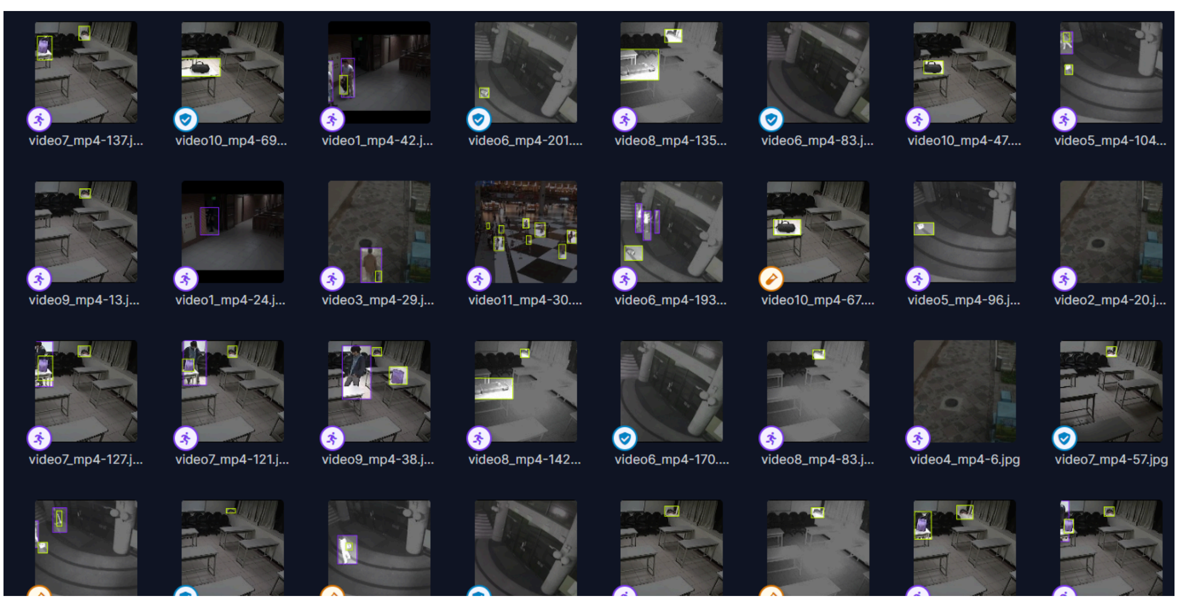



roboflow
Projects
Universe
Documentation
Forum
aradhya
ARADHYAS WORKSPACE
Uploaded on 10/24/23 at 7:10 pm: Job 4
Start Annotating
Add 279 images to Dataset
aboda
Object Detection
Sharing Page
Classes
Upload
Unassigned
Annotate
Images
Generate
Versions
Deploy
Health Check
Progress
316 Images
279 Annotated
37 Unannotated
Instructions
Edit
No specific instructions were added when this job was assigned
Assignment
Mohit Dhatrak
Labeler
Reassign
Timeline
aradhya created this Job and assigned it to msdhatrak25@gmail.com.
10/24/2023, 7:15:24 PM
Unannotated
37
Annotated
279


4
Augmentation
What can augmentation do?
Create new training examples for your model to learn from by generating augmented versions of each image in your training set.
Grayscale
Apply to 25% of images
Edit
Bounding Box: Blur
Up to 2.5px
Edit
Bounding Box: Noise
Up to 5% of pixels
Edit
Add Augmentation Step
Continue

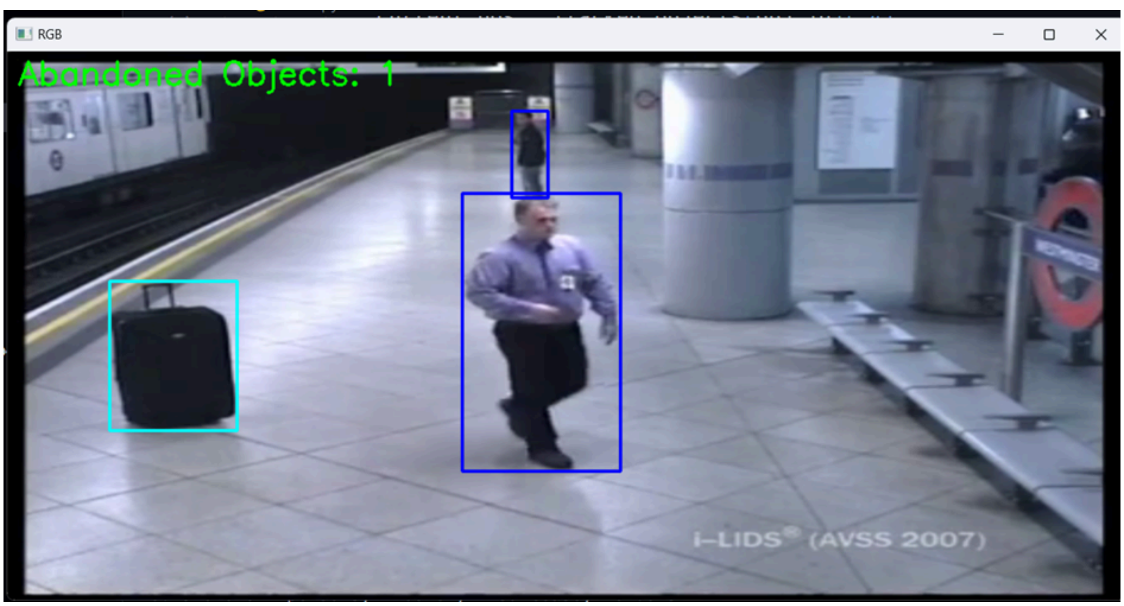

roboflow
Projects
Universe
Documentation
Forum
aradhya : Aradhyas workspace
Search 200,000+ Open Source Computer Vision Projects...
UNIVERSE
Edit Project
aboda
Object Detection
Overview
Images 1116
Dataset 1
Model
API Docs
Health Check
Search images
Split
Classes
Sort By Newest
video7_mp4-137.j...
video10_mp4-69...
video1_mp4-42.j...
video6_mp4-201....
video8_mp4-135...
video6_mp4-83.j...
video10_mp4-47....
video5_mp4-104...
video9_mp4-13.j...
video1_mp4-24.j...
video3_mp4-29.j...
video11_mp4-30....
video6_mp4-193...
video10_mp4-67....
video5_mp4-96.j...
video2_mp4-20.j...
video7_mp4-127.j...
video7_mp4-121.j...
video9_mp4-38.j...
video8_mp4-142...
video6_mp4-170....
video8_mp4-83.j...
video4_mp4-6.jpg
video7_mp4-57.jpg


video1_mp4-42.j...
video5_mp4-104...
video1_mp4-24.j...
video3_mp4-29.j...
video6_mp4-193...
video7_mp4-127.j...
video7_mp4-121.j...
video9_mp4-38.j...
video5_mp4-59.j...
video5_mp4-14.j...
video7_mp4-128....
video3_mp4-86.j...
video4_mp4-34.j...
video2_mp4-75.j...
video6_mp4-102...
video5_mp4-40.j...
video5_mp4-55.j...
video4_mp4-17.jpg
video3_mp4-58.j...
video5_mp4-7.jpg
video7_mp4-113.j...
video2_mp4-47.j...
video5_mp4-27.j...
video3_mp4-69.j...

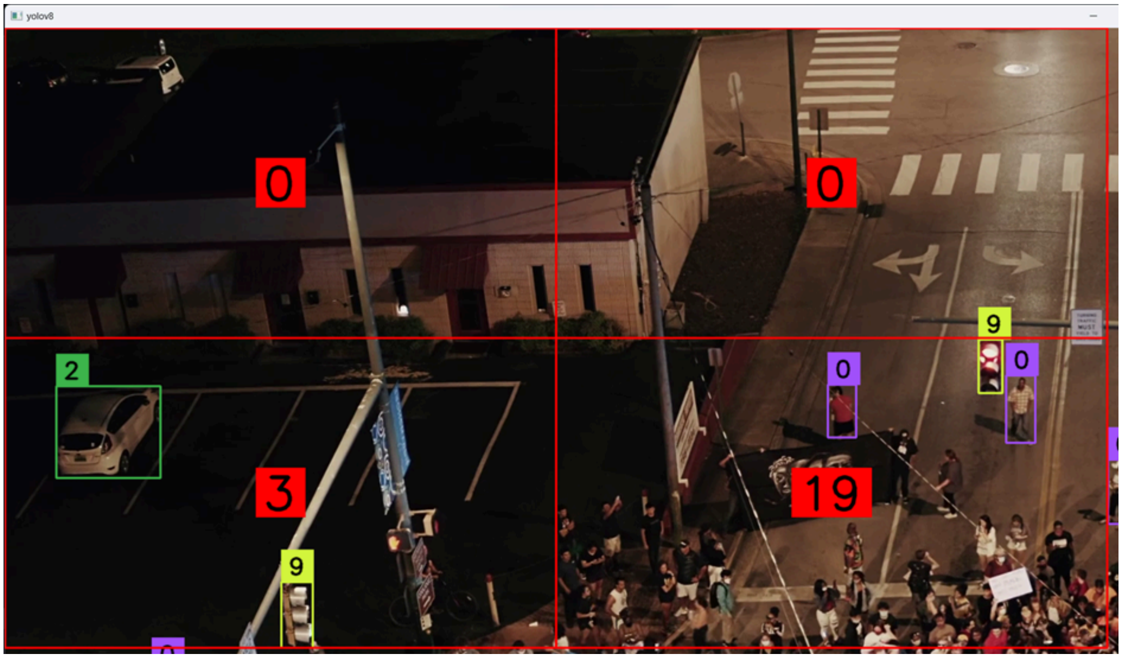

video7_mp4-137.j...
video10_mp4-69...
video1_mp4-42.j...
video6_mp4-201....
video8_mp4-135...
video6_mp4-83.j...
video10_mp4-47....
video5_mp4-104...
video9_mp4-13.j...
video1_mp4-24.j...
video3_mp4-29.j...
video11_mp4-30....
video6_mp4-193...
video10_mp4-67....
video5_mp4-96.j...
video2_mp4-20.j...
video7_mp4-127.j...
video7_mp4-121.j...
video9_mp4-38.j...
video8_mp4-142...
video6_mp4-170....
video8_mp4-83.j...
video4_mp4-6.jpg
video7_mp4-57.jpg

7.2. Test cases (or Hypothesis)

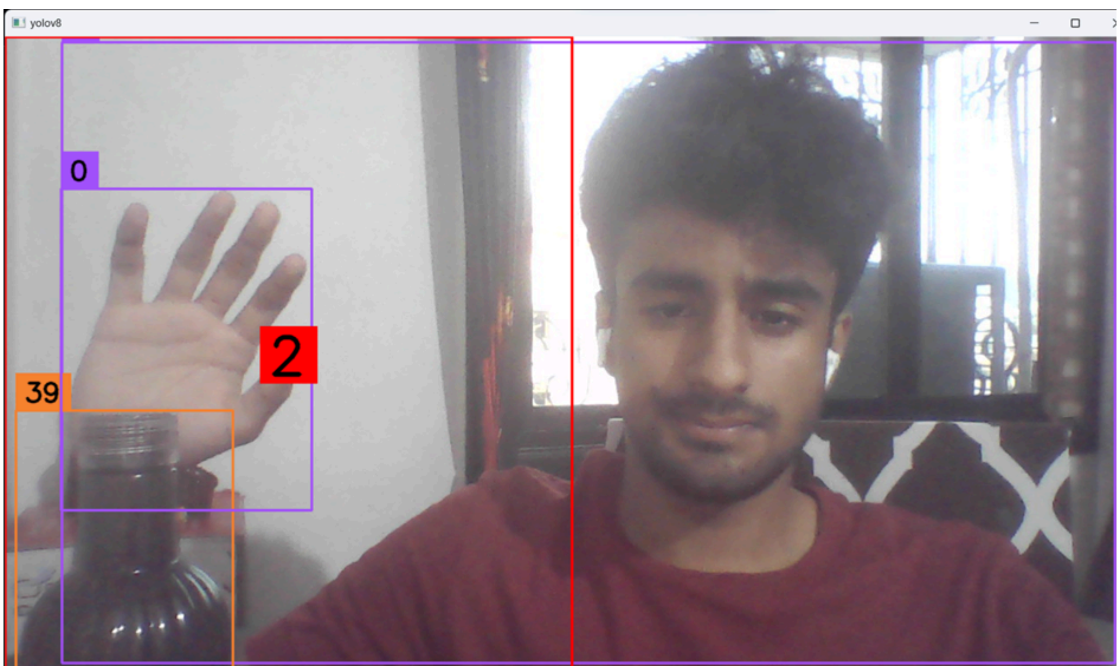
Test Case 1 - Abandoned object Detection (On platform)



Test Case 2 - Abandoned object Detection (On platform)

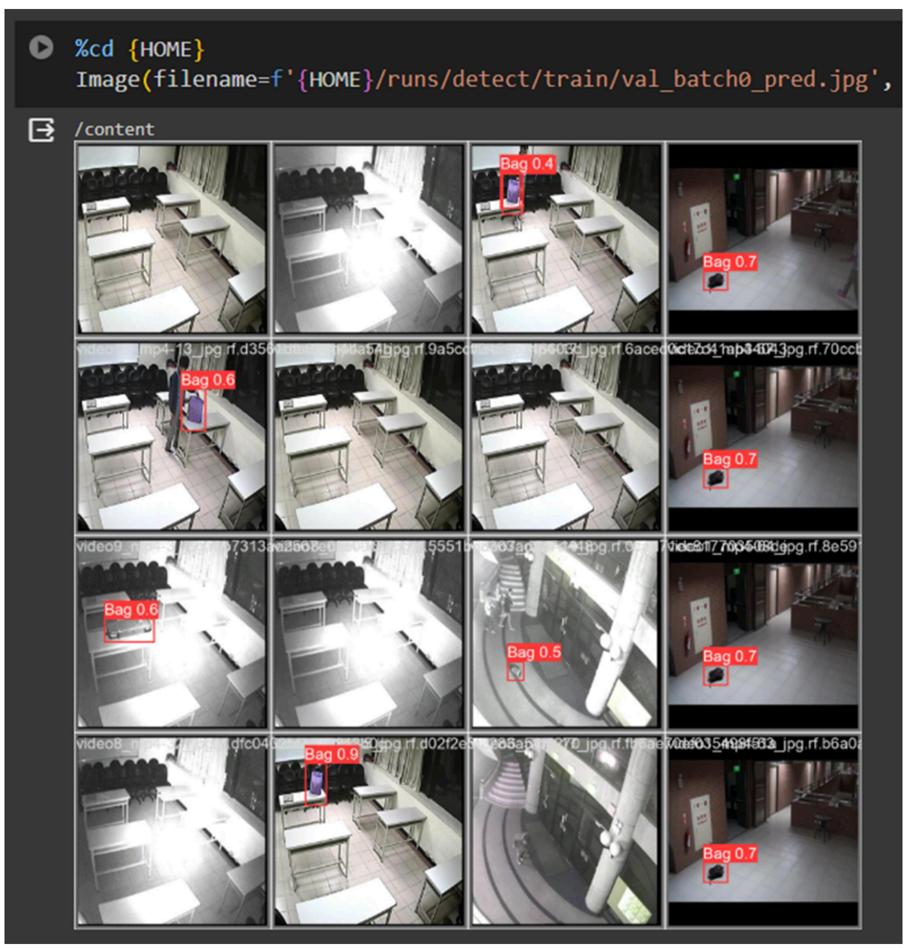


Test Case 1 - Crowd density detection using zone formation

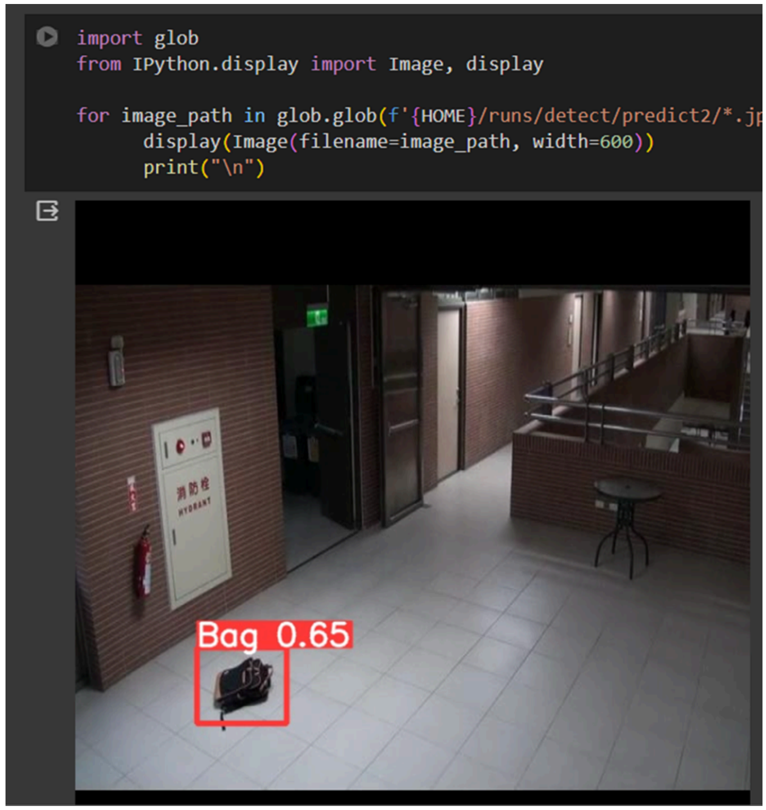


Test Case 2 - Live crowd density detection using zone formation

Safe distance monitoring using zone formation



Abandoned object detection (overview)



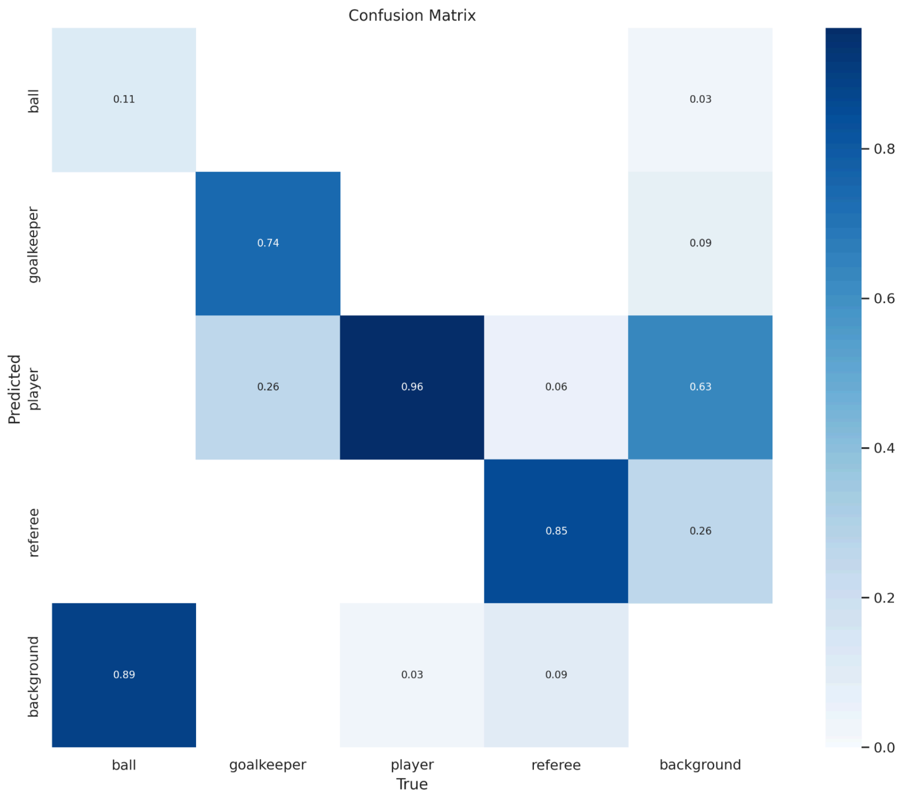
Test Case 1 - Abandoned object Detection

Test Case 2 - Abandoned object Detection

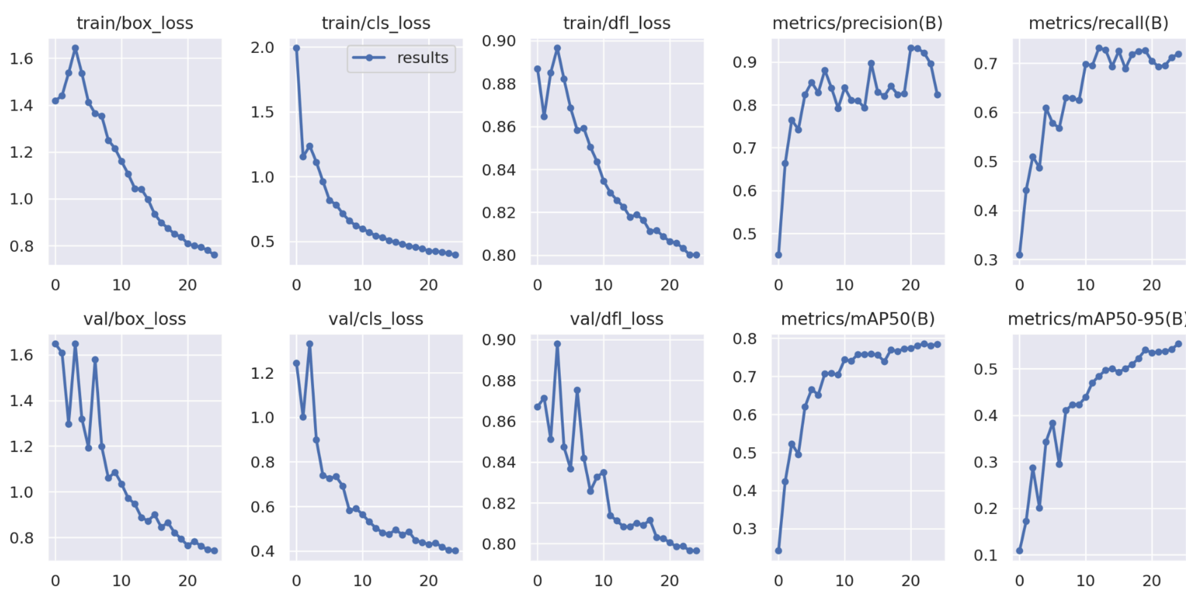
Number of people entering and exiting the train

'Person' being detected in the region of concern

7.3. Parameter tuning experiments (if any)

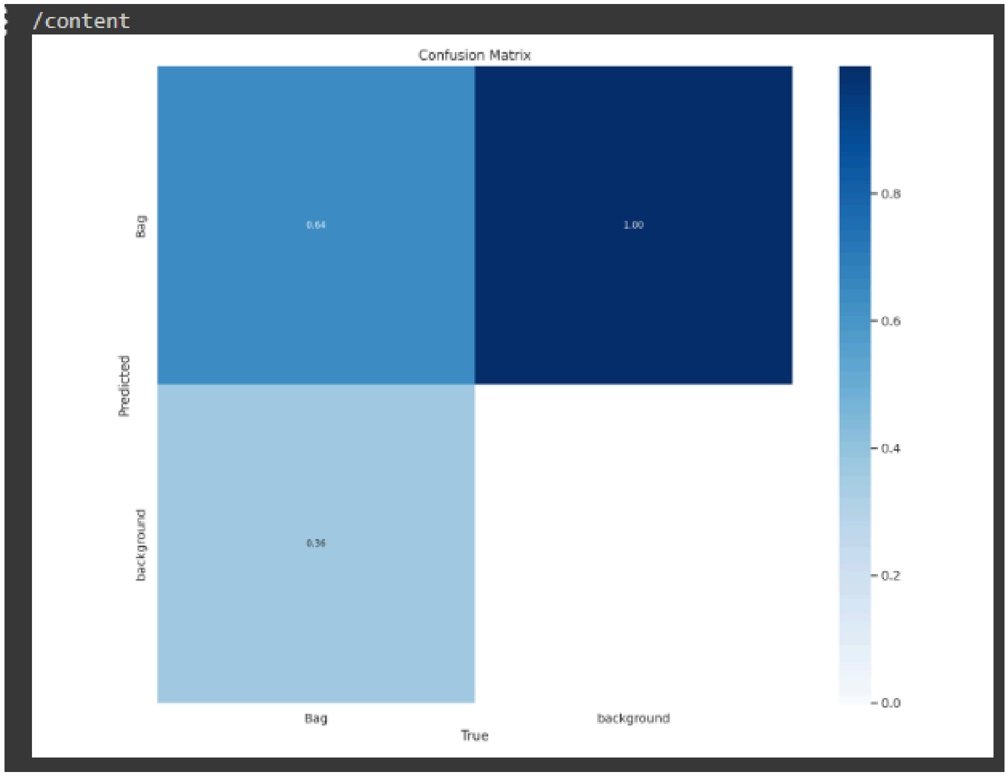


Confusion matrix based on custom dataset for parameter tuning

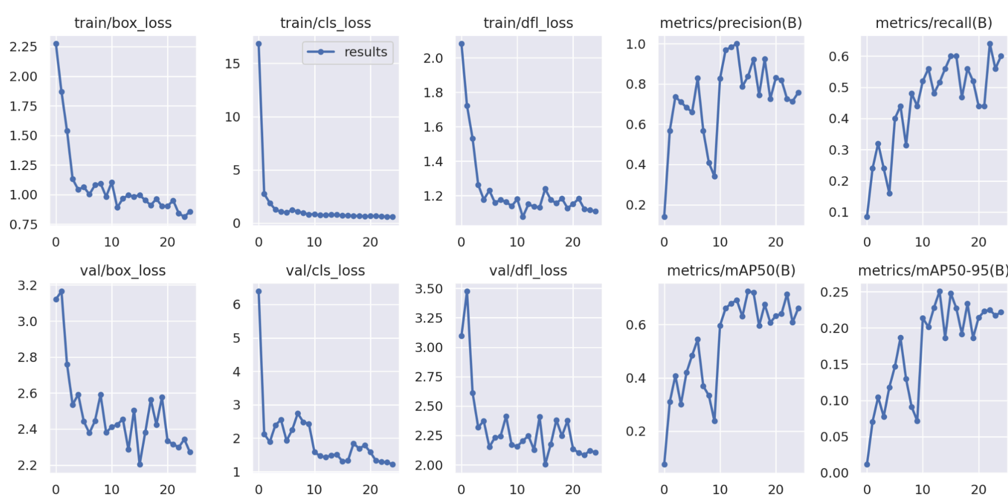


Precision analysis based on custom dataset for parameter tuning

7.4. Results



Confusion matrix based on the training dataset



Precision analysis based on the training dataset

8. CONCLUSION

In conclusion, the implementation of activity detection using Convolutional Neural Networks (CNN) in CCTV infrastructure is a novel and efficient approach to enhancing security measures. By automating the analysis of video footage, the system reduces reliance on manual monitoring and can detect suspicious activities in real-time, enabling proactive response measures and enhancing overall security. The solution is adaptable and scalable, making it suitable for various environments and applications, from small-scale deployments to large-scale implementations. Continuous learning mechanisms ensure that the system improves over time by retraining the CNN model with new data, enabling it to adapt to evolving threats and enhance accuracy. Additionally, the system can be seamlessly integrated with existing infrastructure, minimizing the need for extensive hardware changes. Privacy considerations are also addressed, ensuring compliance with regulations and protecting personal information captured by the CCTV system.

The proposed system addresses the limitations of manual monitoring, improves response times, and enhances the overall efficiency and accuracy of detecting suspicious activities, ultimately ensuring a higher level of security and safety in monitored environments. The scale and range of the project can vary based on available resources, technical constraints, and specific domain requirements, making it a flexible solution for various applications. Overall, the implementation of activity detection using CNN in CCTV infrastructure is a significant improvement over traditional manual monitoring and has the potential to significantly enhance security and safety in various environments.

9. REFERENCES / BIBLIOGRAPHY

Research papers:

- Human Suspicious Activity Detection using Deep Learning Rachana Gugale1, Abhiruchi Shendkar2, Arisha Chamadia3, Swati Patra4, Deepali Ahir5

- Deep Learning Approach for Suspicious Activity Detection from Surveillance Video Amrutha C.V, C. Jyotsna, Amudha J.

- HUMAN SUSPICIOUS ACTIVITY DETECTION SYSTEM USING CNN MODEL FOR VIDEO SURVEILLANCE Tejashri Subhash Bora1, Monika

Dhananjay Rokade2

- Suspicious Activity Detection Using Convolution Neural Network S. A. Quadri 1, Komal S Katakdhond 2
- ADVANCE SUSPICIOUS ACTIVITY DETECTION Ms. Archana R. Ghuge*1, Mr. Rushikesh S. Wakchaure*2, Mr. Sagar D. Wagh*3, Mr. Parag S. Hude*4, Ms. Aishwaraya V. Pingale*5

10. APPENDIX

1. Technical paper

1) F. S. K U and S. M, "Subduing Crime and Threat in Real-Time by Detecting Weapons Using Yolov8," 2023 International Conference on Circuit Power and Computing Technologies (ICCPCT), Kollam, India, 2023, pp. 864-868, doi: 10.1109/ICCPCT58313.2023.10245146.

2) S. Shafi, T. Pavan Sai Kumar Reddy, R. Silla and M. Yasmeen, "Deep Learning based Real-time Stolen Vehicle Detection Model with Improved Precision and Reduced Look Up Time," 2023 3rd International Conference on Intelligent Technologies (CONIT), Hubli, India, 2023, pp. 1-6, doi: 10.1109/CONIT59222.2023.10205684.

3) M. Pullakandam, K. Loya, P. Salota, R. M. R. Yanamala and P. K. Javvaji, "Weapon Object Detection Using Quantized YOLOv8," 2023 5th International Conference on Energy, Power and Environment: Towards Flexible Green Energy Technologies (ICEPE), Shillong, India, 2023, pp. 1-5, doi: 10.1109/ICEPE57949.2023.10201506.

2. Patent filing (if any)

No patent filed yet.