

Enhancing Railway Station Safety: Advanced Object Detection and Anomaly Monitoring

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

Year 3, Sem V Computer Engineering

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(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 Railway Station Safety: Advanced Object Detection and Anomaly Monitoring**" is a bonafide work of "**Yuvraj Rasal (60004210196), Aditya Dighe (60004210212), Mohit Dhattrak (60004210214), Aradhya Sakalley (60004210253)**" submitted as a project work for the course **Innovative Product Development (IPD) III, Year 3, Semester V, B.Tech Computer Engineering**

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IPD Project Report Approval for BTech Semester V

This project report entitled **Enhancing Railway Station Safety: Advanced Object Detection and Anomaly Monitoring** by **Yuvraj Rasal, Aditya Dighe, Mohit Dhattrak, and Aradhya Sakalley** is approved for the Innovative Product Development (IPD) III examination of Year 3, Semester V, 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.

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Abstract

Our research project focuses on revolutionizing the safety and security measures within the Indian Railways by implementing cutting-edge technology in the form of Advanced Object Detection and Anomaly Monitoring. The prevailing challenges in railway security, such as trespassing, crowd monitoring, and the real-time detection of abandoned objects ranging from misplaced belongings to potential threats, demand a comprehensive solution. Our approach aims to redefine the current monitoring system by integrating real-time object detection and suspicious activity monitoring, optimizing the efficiency, accuracy, and collaboration between human oversight and machine capabilities. The core objective of our project is to address the limitations of the existing security infrastructure, where personnel are burdened with monitoring numerous camera feeds simultaneously. By incorporating state-of-the-art technology, we aim to streamline the surveillance process and enhance the overall safety of railway stations. For the critical task of object detection, we opted for YOLO V8 due to its unparalleled speed, accuracy, and versatility. YOLO (You Only Look Once) V8 excels in real-time object detection, making it ideal for our application where swift decision-making is paramount. Its ability to process images in a single pass and detect multiple objects simultaneously ensures a rapid response to potential security threats. To bolster the accuracy of our model, we meticulously annotated our dataset using Roboflow. This annotation process not only facilitates the training of the YOLO V8 model but also contributes to a more precise and reliable object detection system. The synergy between YOLO V8 and Roboflow empowers our project with the ability to distinguish between various objects, ensuring that the system is adept at identifying both common items and potential security risks. In addition to object detection, our project introduces innovative features such as person counting through zone assignment and abandoned object detection. By strategically defining zones and establishing a virtual link between individuals and their belongings, we can promptly identify and flag instances where objects are left unattended. This proactive approach mitigates the risk of overlooking potential threats, enabling a timely response to ensure passenger safety. The proposed system not only leverages the speed and efficiency of machine-based detection but also incorporates a crucial human oversight element. Screens are intelligently prioritized based on real-time object detection and suspicious activity alerts. This collaborative approach ensures a balanced and reliable system where human intuition complements the precision of machine algorithms. In conclusion, our research project aims to significantly enhance railway station safety by introducing an advanced security system that addresses the prevalent challenges faced by the Indian Railways. Through the utilization of YOLO V8, Roboflow, and innovative features like person counting and abandoned object detection, we strive to create a comprehensive solution that sets a new standard for railway security, combining the strengths of machine intelligence with human vigilance.

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.....	15
5.1. Proposed model.....	15
5.2. Database design (DFDs, CFDs, ER diagrams).....	16
5.3. Use cases.....	18
6. IMPLEMENTATION.....	19
6.1. GUI design (Screenshots of GUI).....	19
6.2. Modules implementation (Pseudocode/algorithm of the model).....	22
7. EXPERIMENTATION & RESULTS.....	25
7.1. Datasets / Tables.....	25
7.2. Test cases (or Hypothesis).....	28
7.3. Parameter tuning experiments (if any).....	33
7.4. Results.....	34
8. CONCLUSION.....	35
9. REFERENCES / BIBLIOGRAPHY.....	35
10. APPENDIX.....	36
1. Technical paper.....	36
2. Patent filing (if any).....	36

List of Figures

Figure No.	Figure Caption	Page No.
1	CCTV surveillance and crime index graph	9
2	Product architecture	15
3	ER diagram	16
4	YOLO architecture	22

List of Tables

Table No.	Table Title	Page No.
1	Entity description table	17

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 RAILWAY STATION SAFETY: ADVANCED OBJECT DETECTION AND ANOMALY MONITORING

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

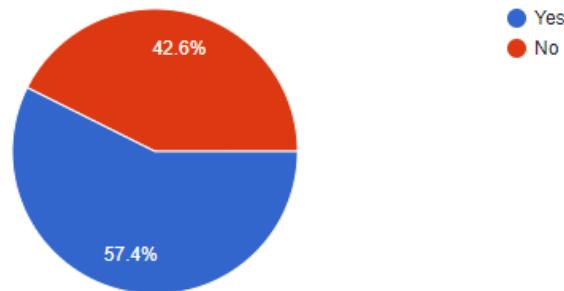
3.1. Field survey

Google form survey: <https://forms.gle/nuvp7pKBzVfefDB7>

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

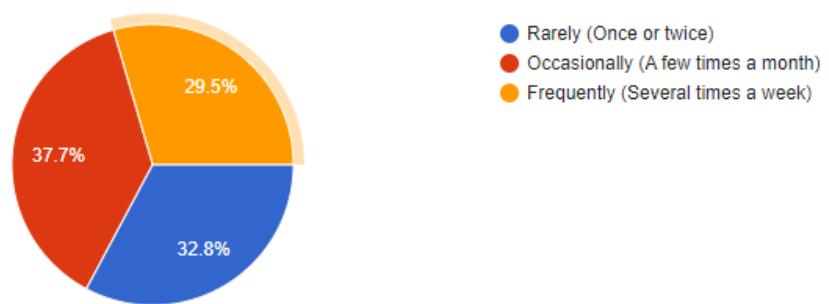
[Western Railways installs 2,729 high-resolution cameras across 30 Mumbai suburban stations](#)

61 responses



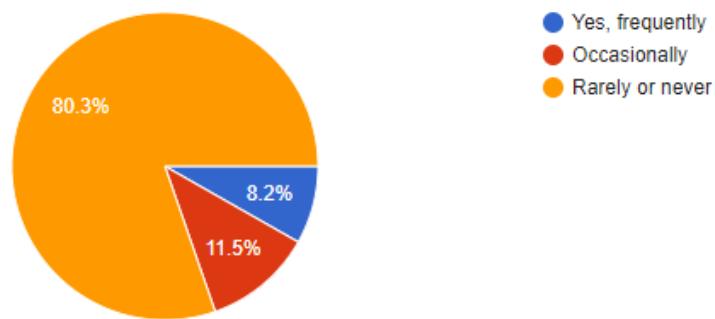
How often do you witness abandoned/unattended objects on railway platforms?

61 responses



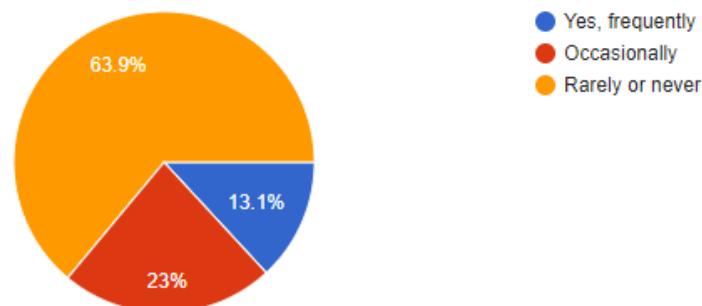
Have you reported or have witnessed others reporting abandoned/unattended objects when observed?

61 responses



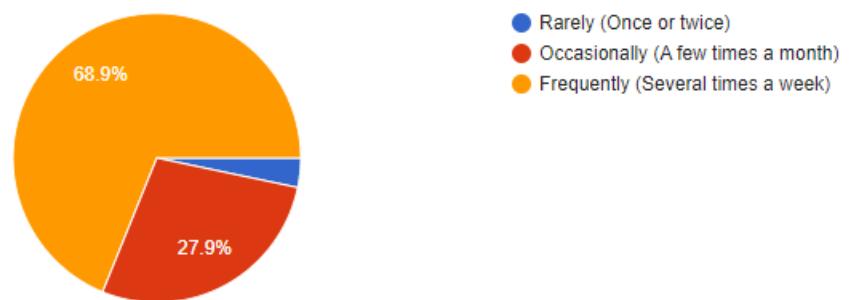
Are actions promptly taken upon reporting such unattended luggage and objects?

61 responses



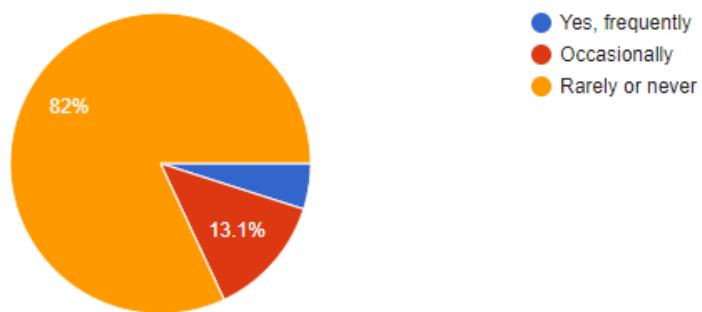
How often do you observe incidents of trespassing (crossing railway tracks)?

61 responses



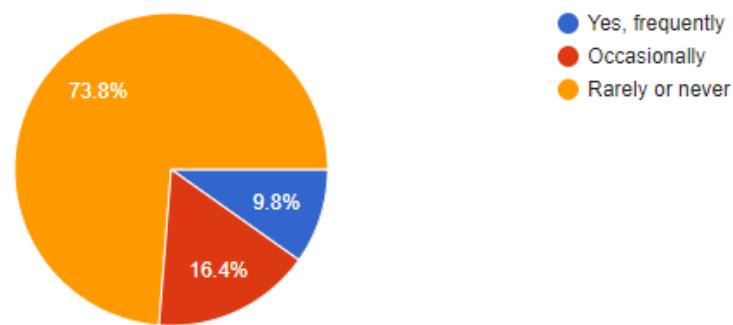
Have you reported or have witnessed others reporting incidents of trespassing on railway tracks?

61 responses



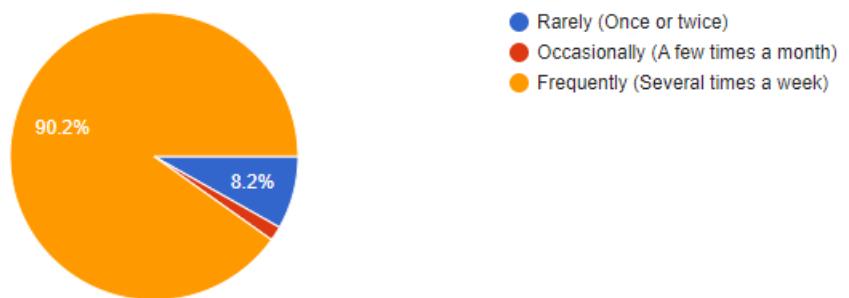
Are prompt actions taken upon receiving reports of trespassing incidents?

61 responses



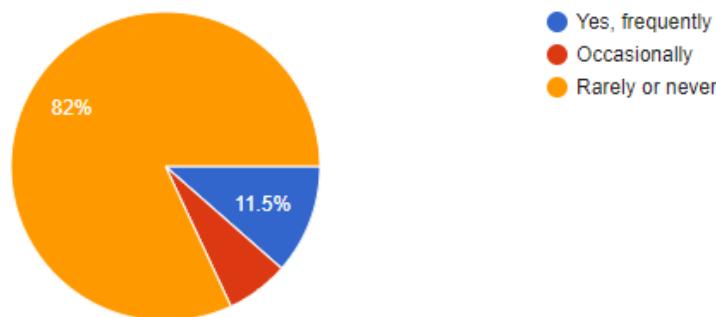
How frequently do you notice overcrowding at train stations?

61 responses



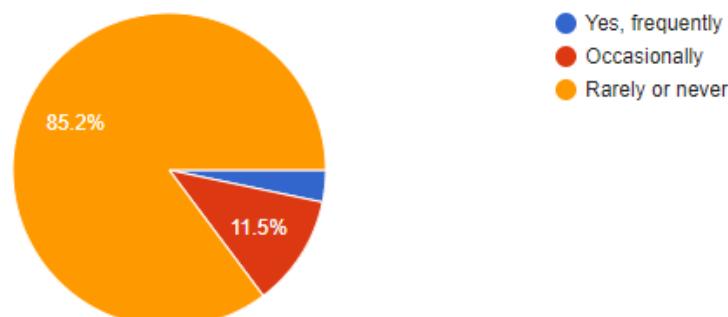
Have you reported or have witnessed others reporting incidents of overcrowding?

61 responses



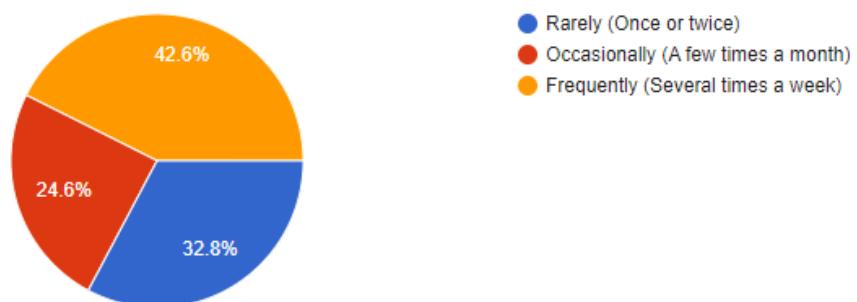
Are prompt actions taken upon receiving reports of overcrowding?

61 responses



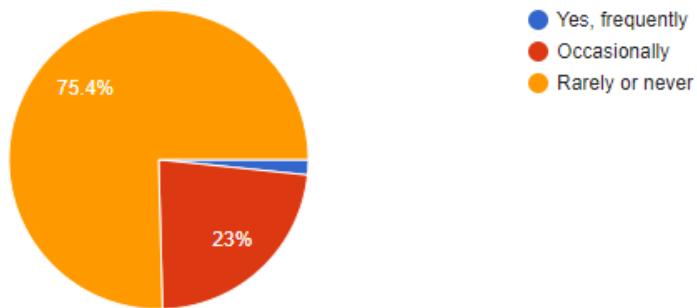
How frequently do you observe maintenance of a safe distance from the train on platforms?

61 responses



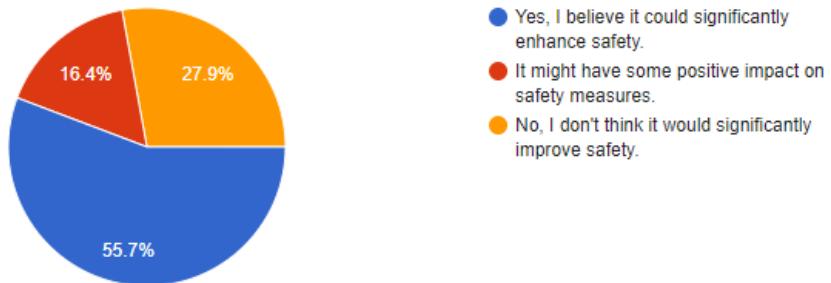
Are measures taken by the officials to ensure maintenance of safe distance from trains?

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.

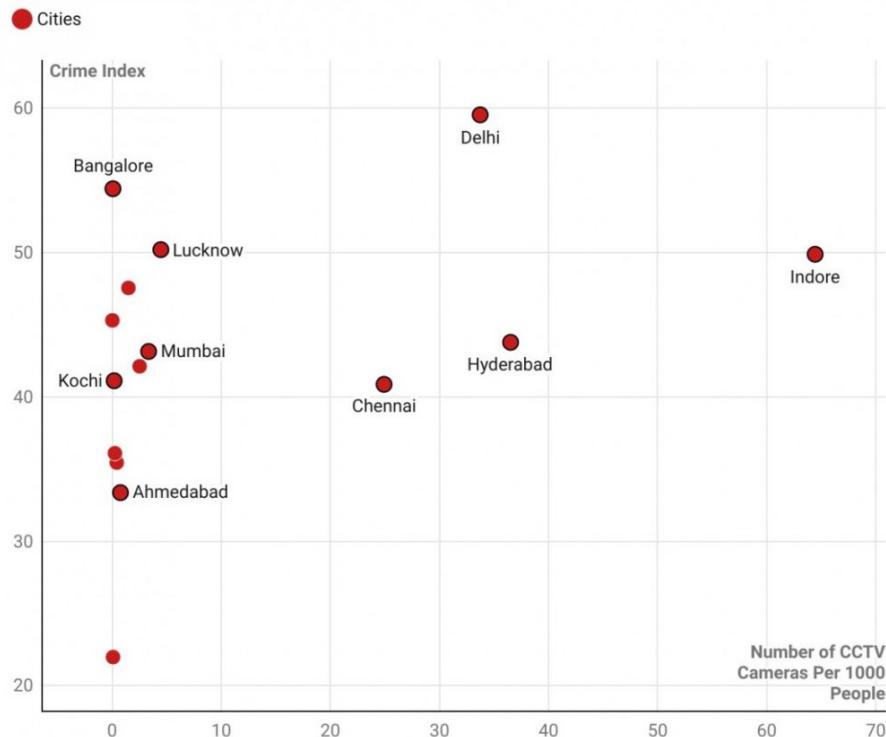
Action Points:

- 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.

Correlation between number of CCTV Cameras and Crime Index

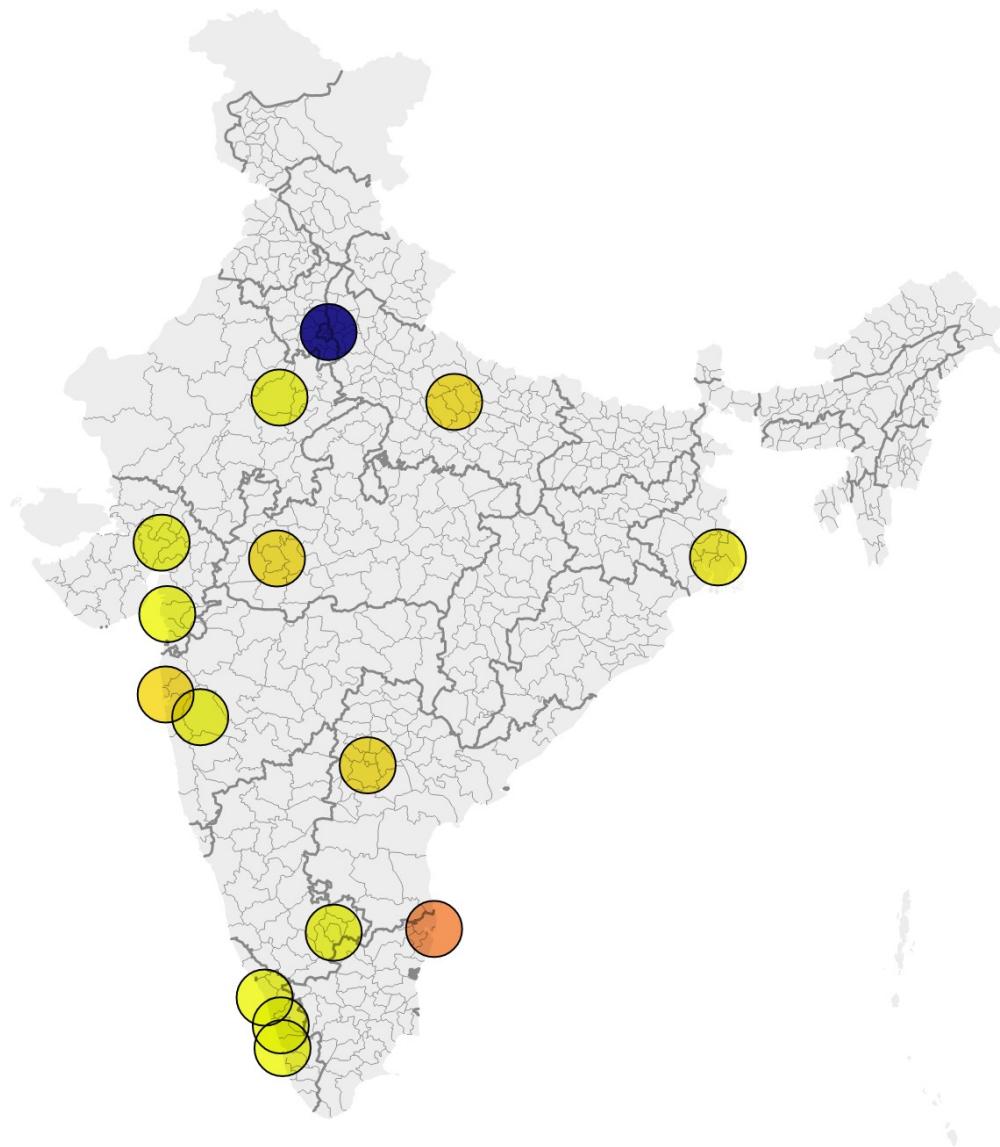


Source: Comparitech • Created with Datawrapper

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.

Cameras Per Square Mile



Source: Comparitech • Created with Datawrapper

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

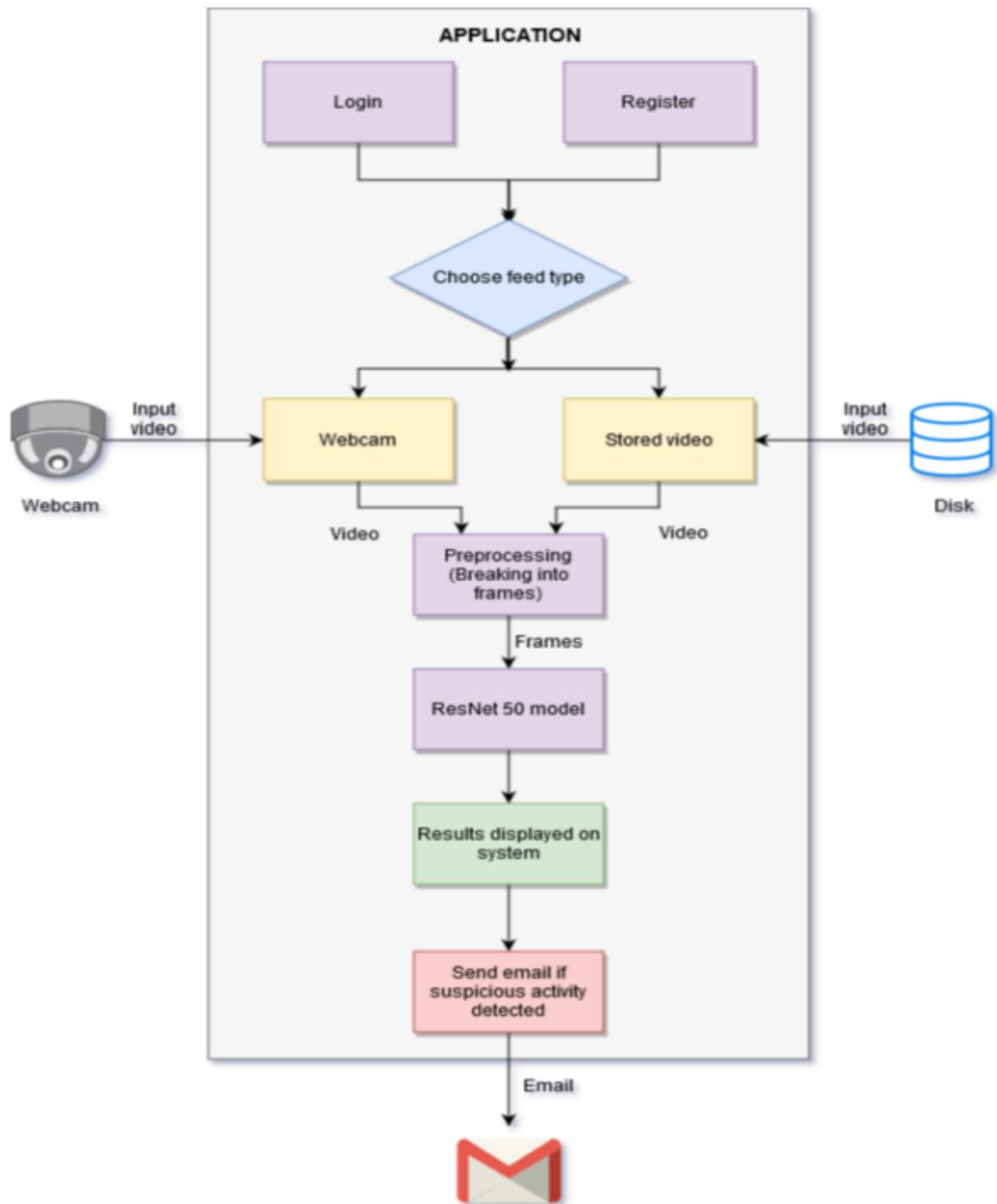
The implementation of a CCTV surveillance system with suspicious activity detection using Convolutional Neural Networks (CNN) introduces a novel approach to enhancing security measures. By integrating CNN algorithms into existing CCTV infrastructure, the system automates the analysis of video footage, 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



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

- Entity-Relationship Diagram (ERD) Overview:

Entities:

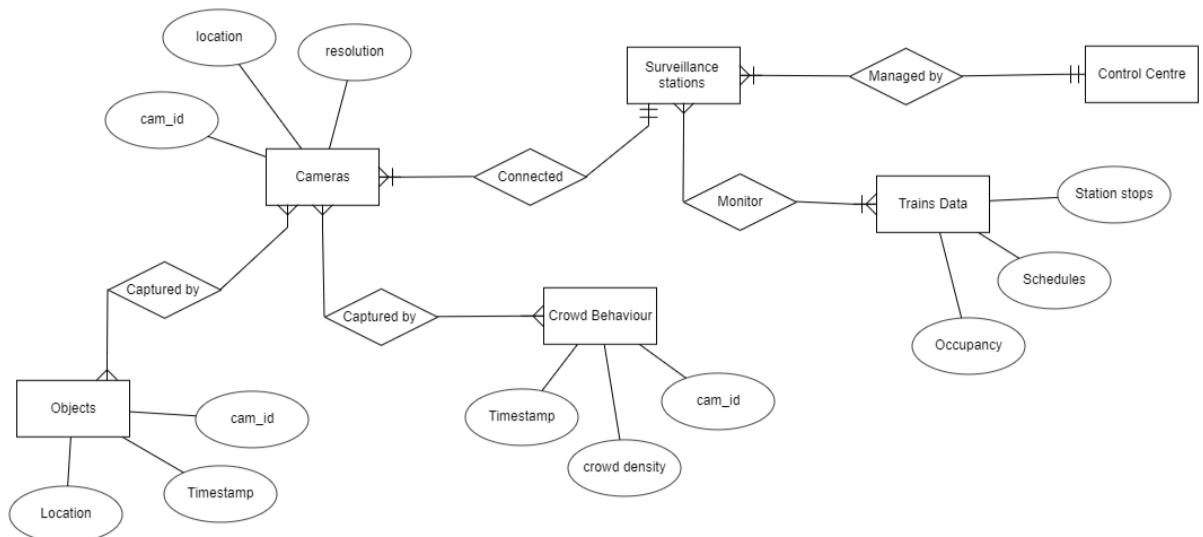
Cameras
 Surveillance Stations
 Unified Control Center
 Objects
 Crowd Behavior
 Train Data

- 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.
 Please note that 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



→ 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

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)

Anomalies +3

- Fighting detected in platform**
05:23 PF 1 HIGH
ENTRY | CAM 0918
- Over crowd detected in platform**
03:13 PF 4 LOW
BACK | CAM 0458
- 5 people rushing in platform**
12:34 PF 3 MID
EXIT | CAM 0448
- Violence detected in platform**
23:12 PF 1 LOW
UPSIDE | CAM 1124
- Alerts**
16:2 PF 5 HIGH
ENTER | CAM 0945

Platform 1

- CAM 1: 1 ALERT
- CAM 2: 0 ALERT
- CAM 3: 0 ALERT

Platform 2

- CAM 1: 3 ALERT
- CAM 2: 1 ALERT
- CAM 3: 0 ALERT

Platform 3

- CAM 1: 5 ALERT
- CAM 2: Fighting Detected
- CAM 3: 0 ALERT

Live

Crowd Trend

Time	Count
00:00 AM	200
02:00 AM	150
04:00 AM	80
06:00 AM	250

Platform Selection

- Platform 1
- Platform 2
- Platform 3
- Platform 4
- Platform 5

Metric Cards

- Cleanliness**: 20% (WET)
- Est. time to onboard**: 3 Minutes (300)
- Alerts**: Cleanliness | Crime | Work
- Crime Rate**: Safe (19%)
- ATTENTION**: WET Floor, Need 2 Security Guards

Notification +3

Live Crowd Count

PF 1 230+ ↑ PF 2 124+ ↓ PF 3 60+ ↓ PF 4 246+ ↑ PF 5 230+ ↓ PF 6 230+ >

Forecasted Crowd Count showing results for next 1hr

Select time period ▾

PF 1 230+ PF 2 124+ PF 3 60+ PF 4 246+ PF 5 230+ PF 6 230+ >

Crowd Trend | Live

select date ▾ select platform ▾

Announcements

Auto announce

Crowd standing ahead of yellow line

- Announce in PF 3
- Announce in PF 2
- Announce in PF 5
- Announce in PF 1

Notification +3

Platform 1

Platform 1

Recommended Guard Count

showing live results

PF 1 3+ PF 2 4+ PF 3 6+ PF 4 3+ PF 5 1+ PF 6 7+ >

Assign Duties to guard

select platform ▾ select guard name ▾ Assign | Send Alert

Emergency Announcements

Auto announce

Fire detected, need evacuation

Announce in PF 3

Person detected on rail track

Announce in PF 2

Gun detected in person hand

Announce in PF 5

Fire detected, need evacuation

Announce in PF 1

Notification +3

Platform 1

● Recommended Worker Count showing live results

PF 1 3+ PF 2 4+ PF 3 6+ PF 4 3+ PF 5 1+ PF 6 7+ >

Assign Duties to workers

select platform select worker name Assign | Send Alert

Work Monitoring

Rewarded +3

Today's Rewarded

Platform	Points
Platform 1	5200
Platform 2	2100
Platform 3	634
Platform 4	2300
Platform 5	4298

Monthly Rewarded

Platform	Percentage
Platform 1	30%
Platform 2	14%
Platform 3	26%
Platform 4	17%
Platform 5	13%

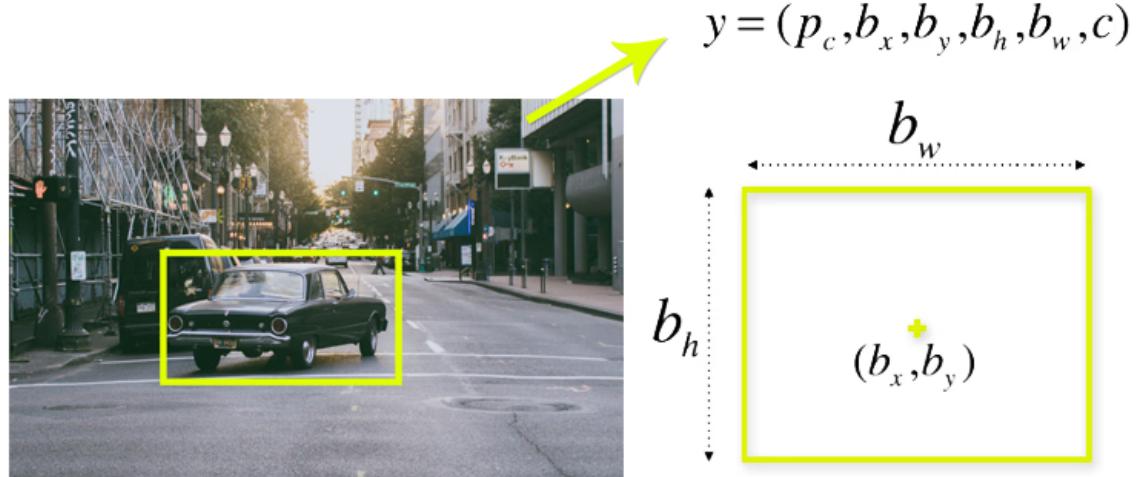
6.2. Modules implementation (Pseudocode/algorithm of the model)

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](#).

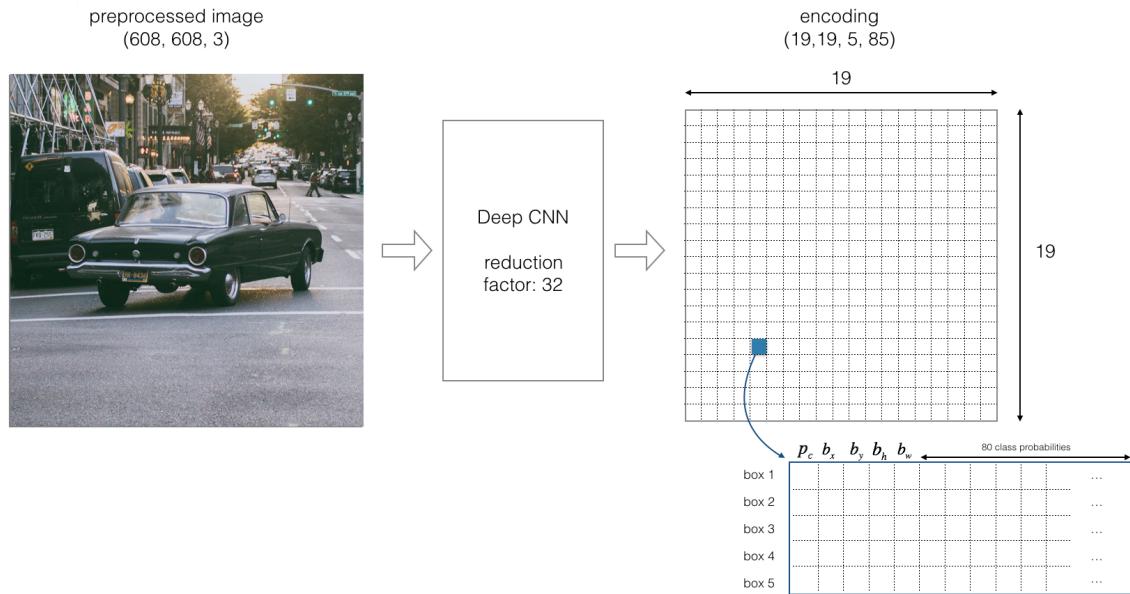
In addition, we have to predict the **pc** value, which is the probability that there is an object in the bounding box.



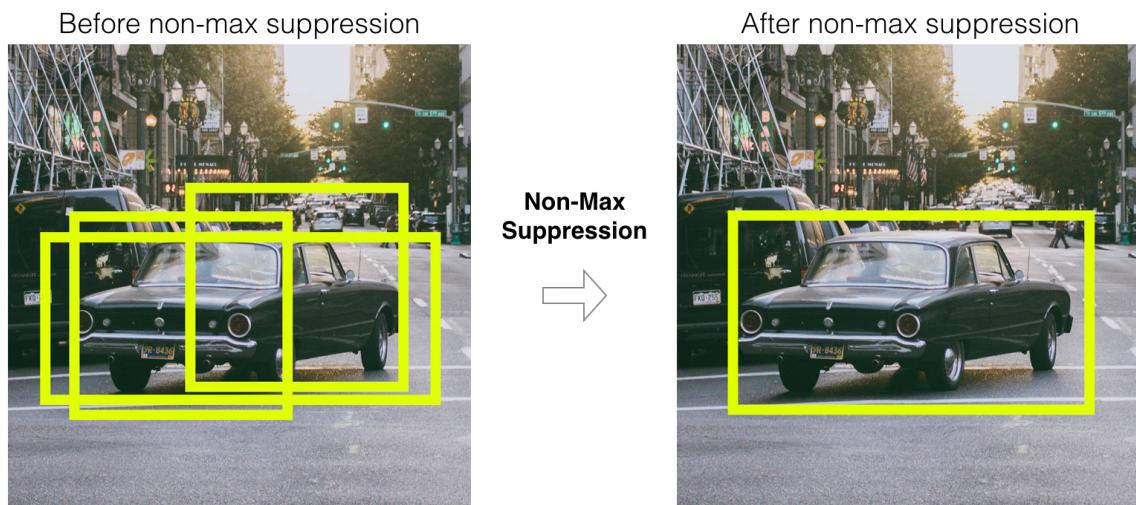
As we mentioned above, when working with the YOLO algorithm we are not searching for interesting regions in our image that could potentially contain an object.

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.

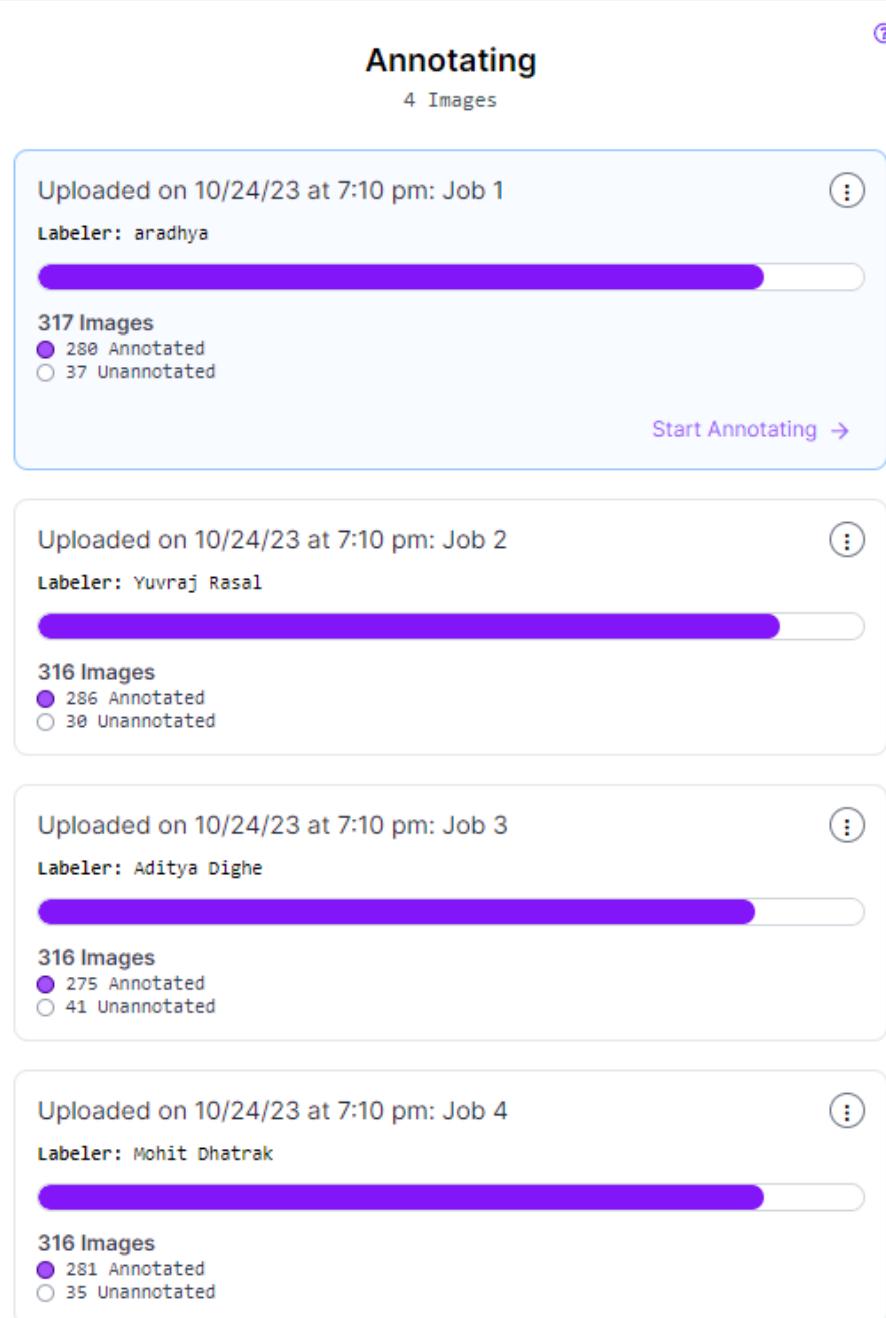


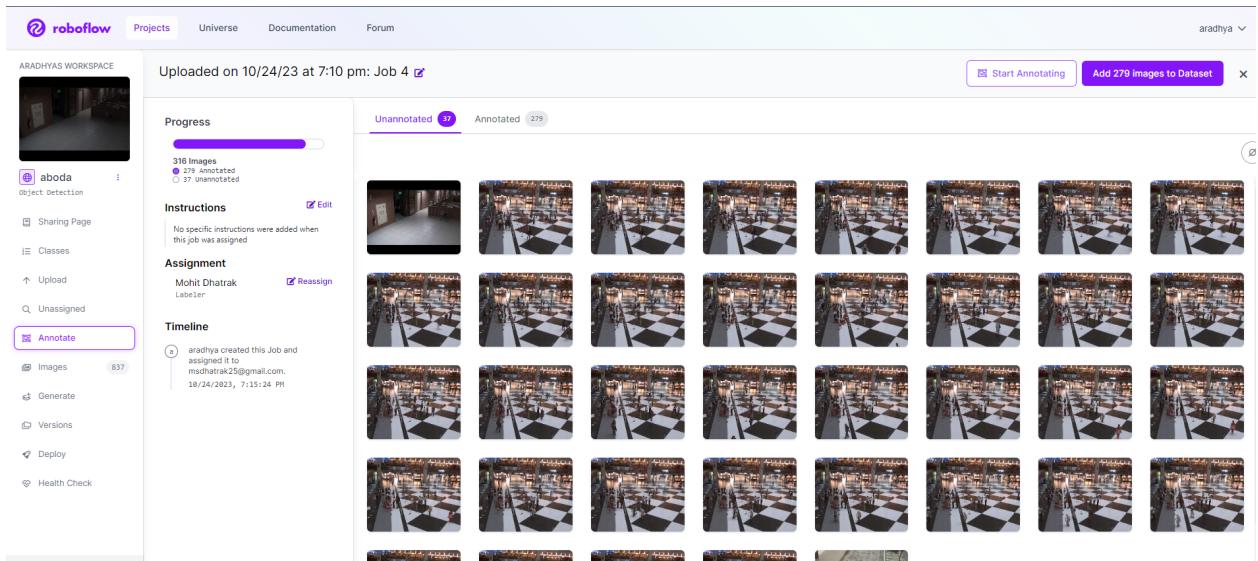
Most of these cells and bounding boxes will not contain an object. Therefore, we predict the value p_c , which serves to remove boxes with low object probability and bounding boxes with the highest shared area in a process called **non-max suppression**.



7. EXPERIMENTATION & RESULTS

7.1. Datasets / Tables





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	X
Bounding Box: Blur Up to 2.5px	Edit	X
Bounding Box: Noise Up to 5% of pixels	Edit	X
+ Add Augmentation Step		

Continue

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Object Detection

Overview

Images 1115

Dataset 1

Model

API Docs

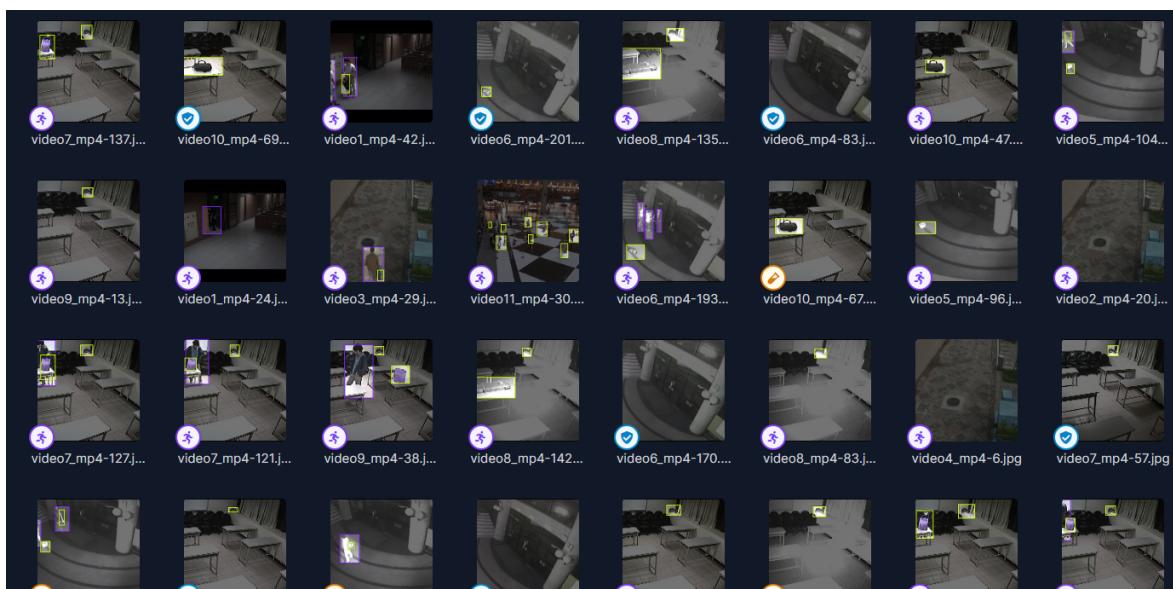
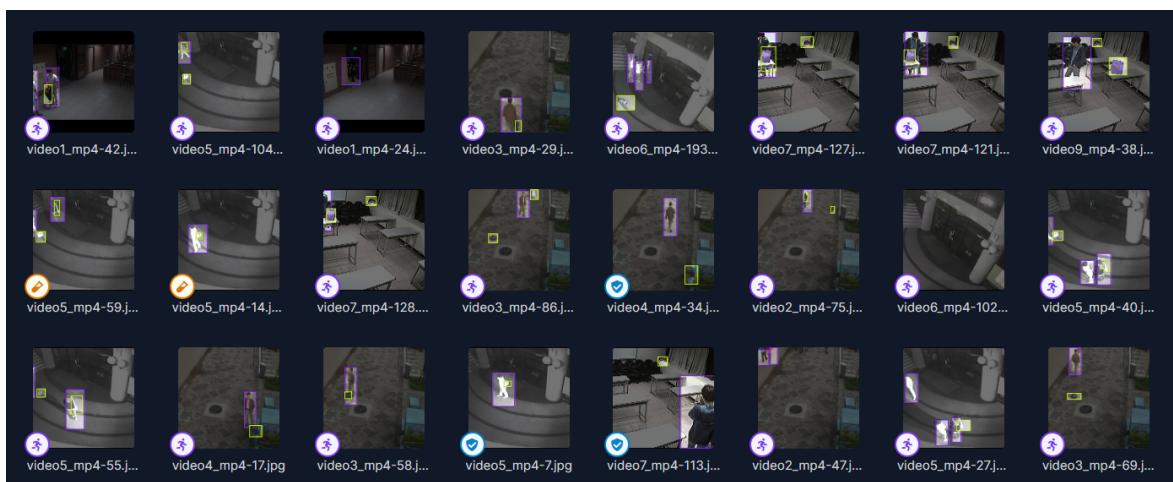
Health Check

Search images

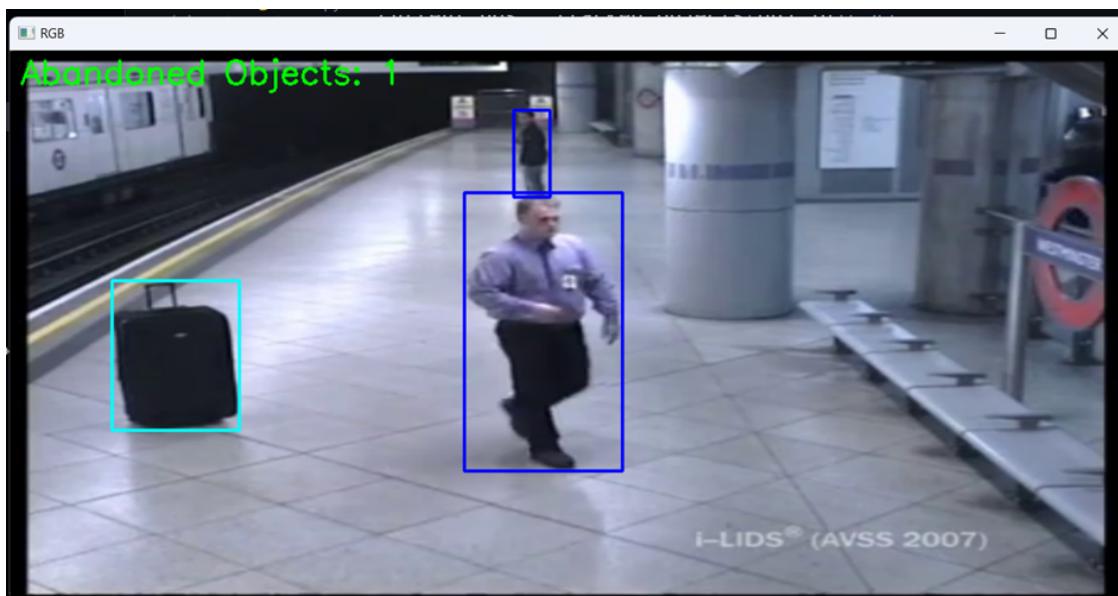
Split Classes Sort By Newest

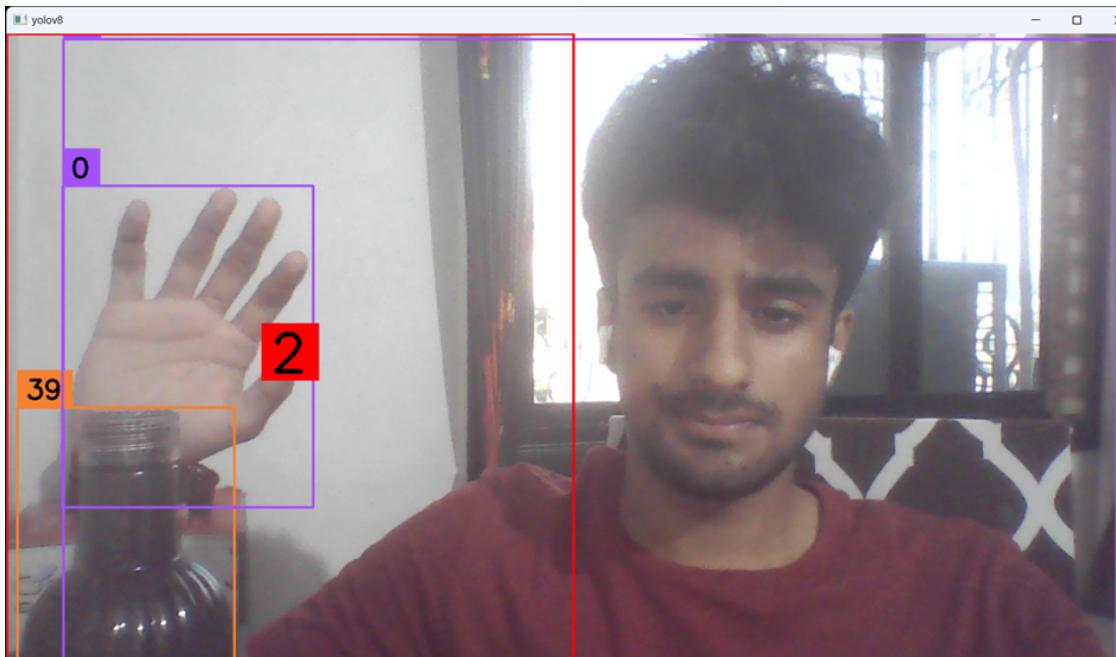
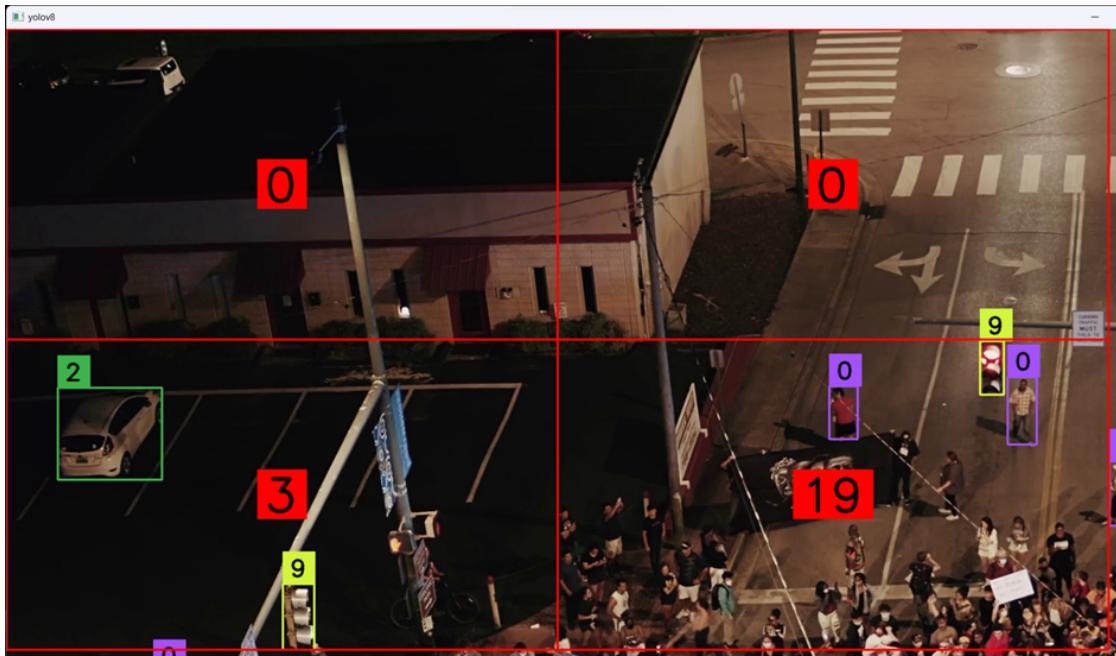
CC Search

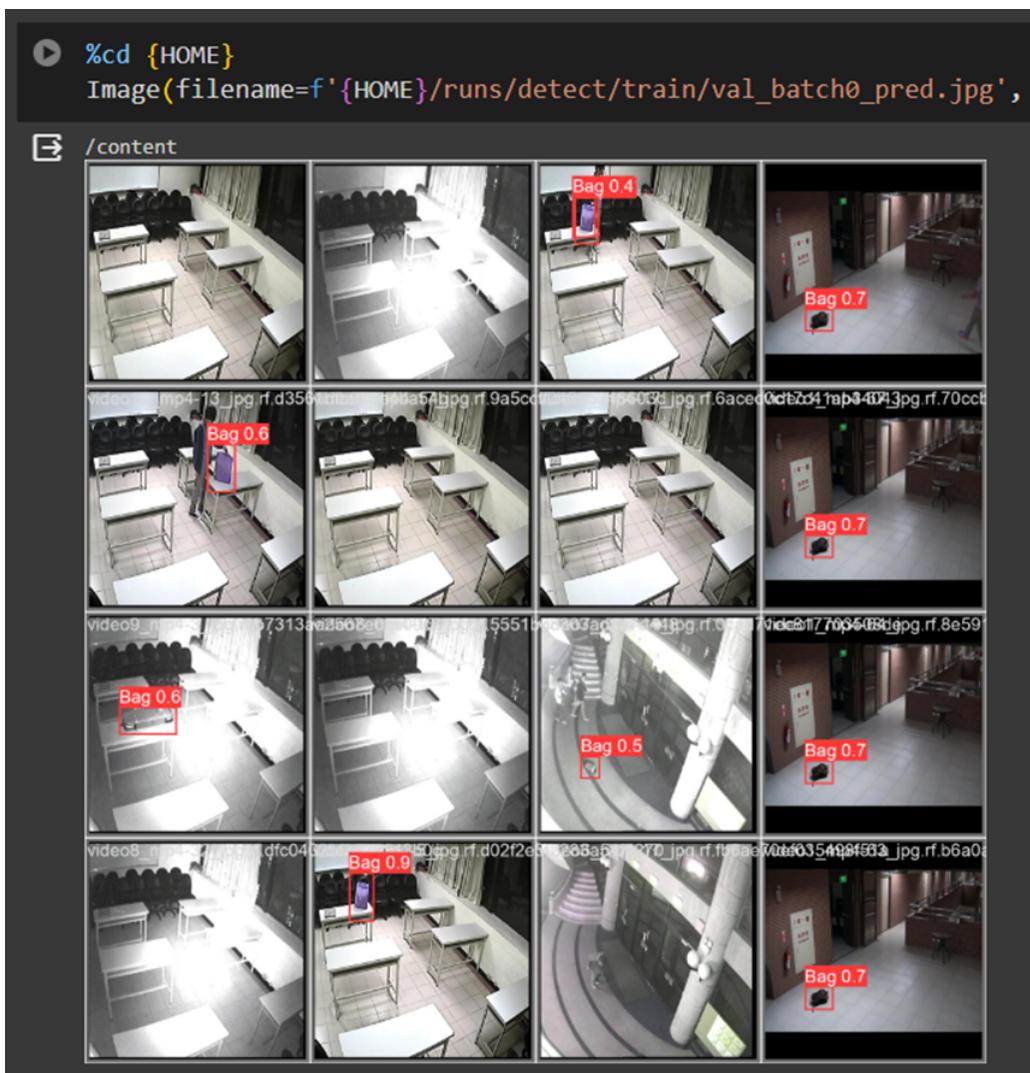
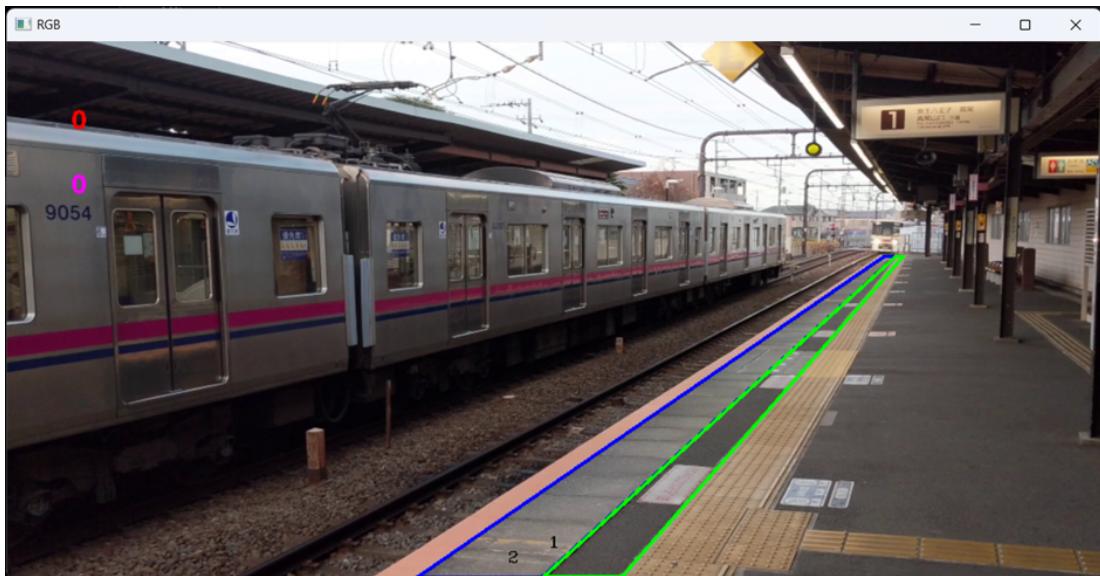
grid



7.2. Test cases (or Hypothesis)





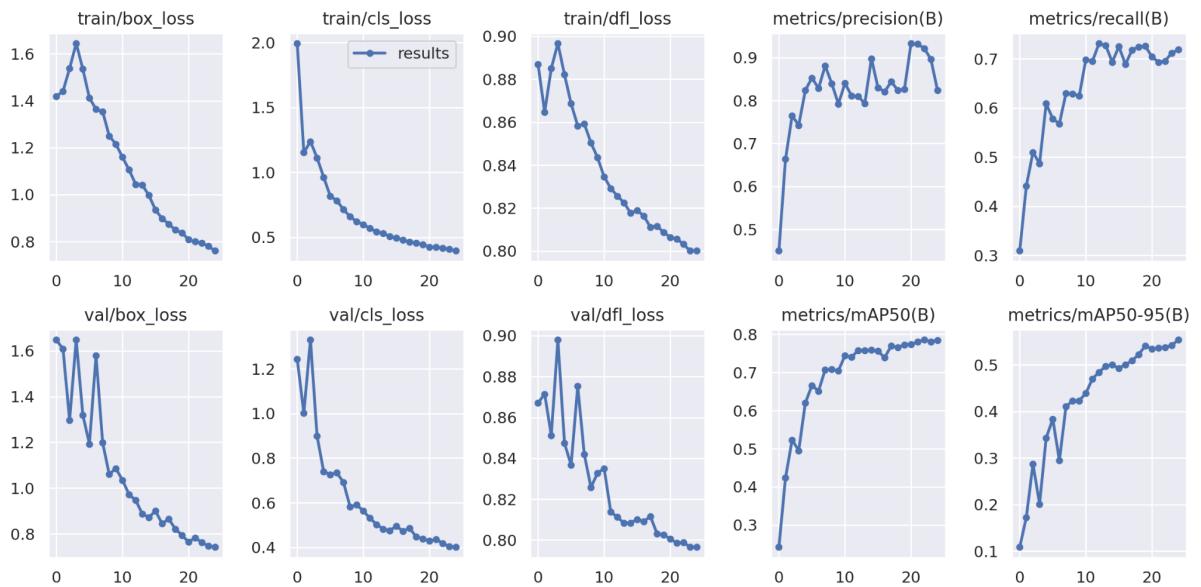
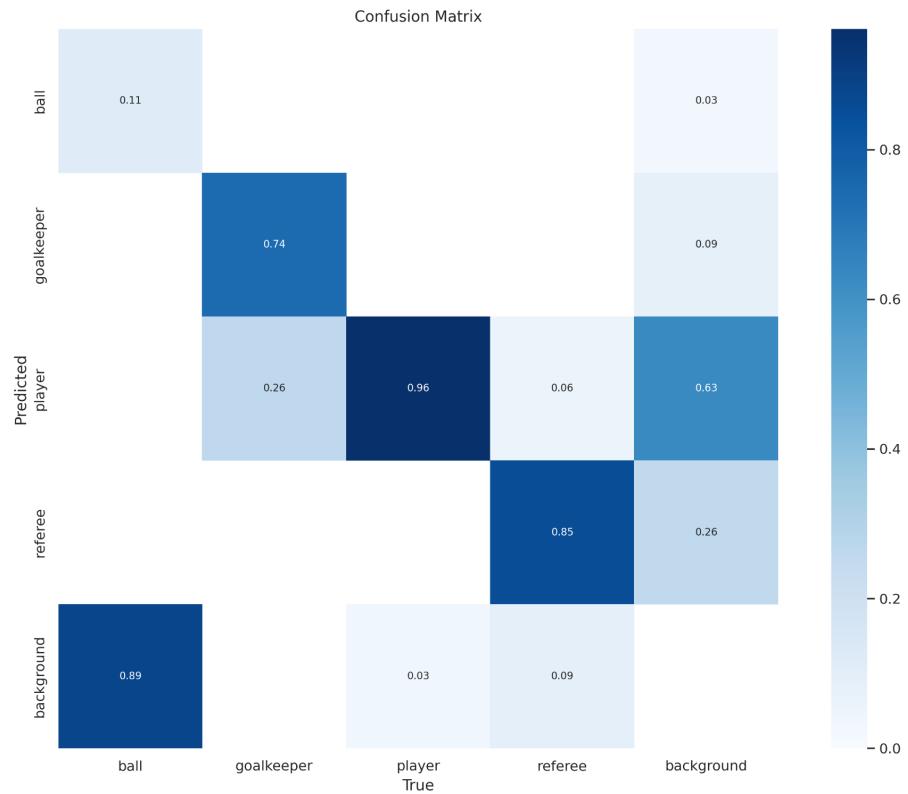


```
❶ import glob  
from IPython.display import Image, display  
  
for image_path in glob.glob(f'{HOME}/runs/detect/predict2/*.jpg'):  
    display(Image(filename=image_path, width=600))  
    print("\n")
```

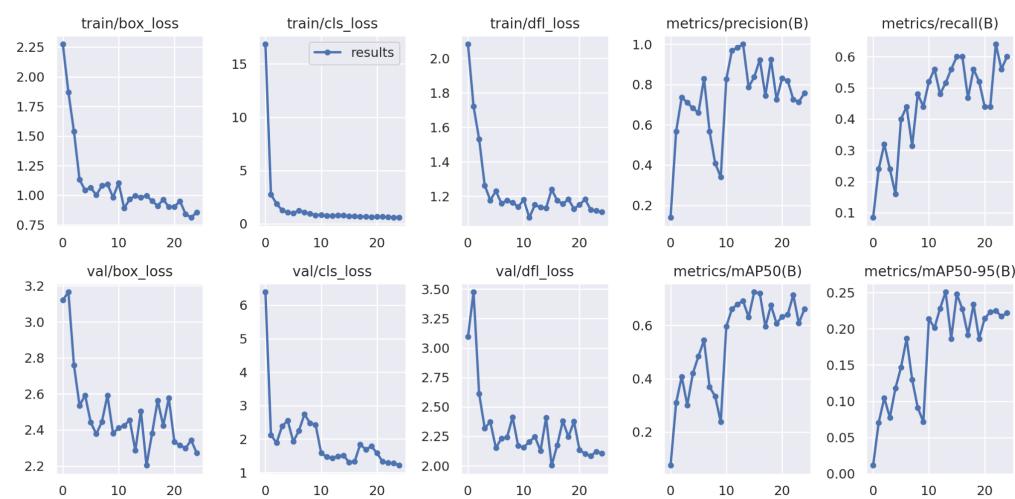
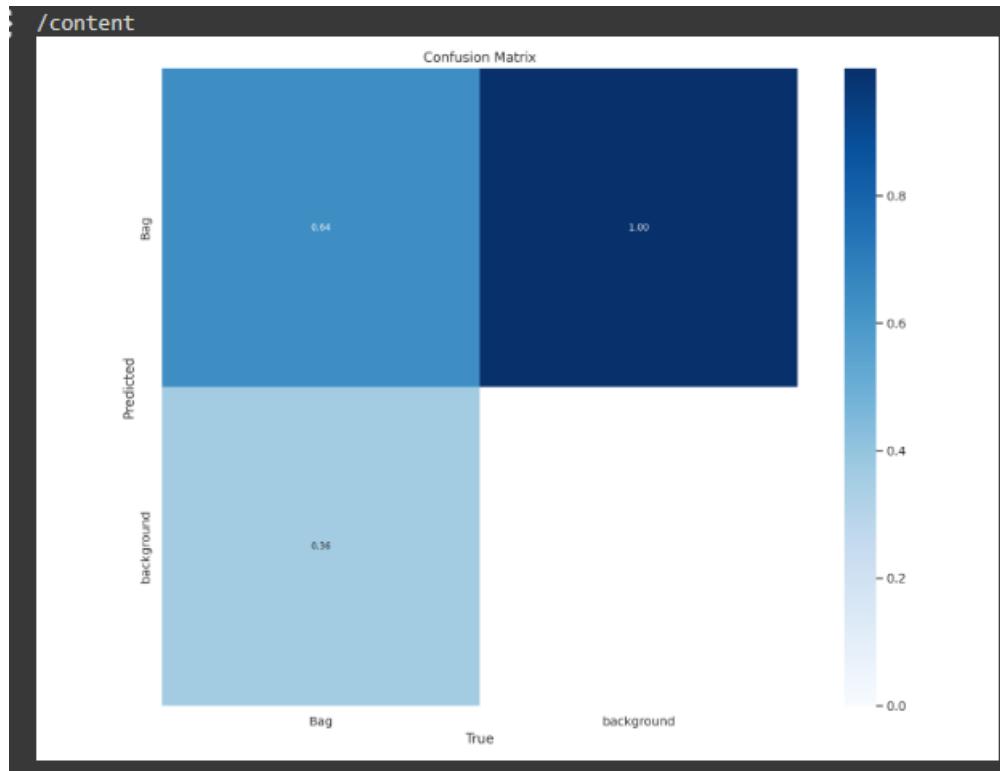




7.3. Parameter tuning experiments (if any)



7.4. Results



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

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- 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 Katakdond 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.