Social Distance Detection

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Abstract:

Given that COVID-19 vaccines are not yet generally available, it is imperative that efforts to curb the virus's spread continue to be undertaken in the middle of the global catastrophe. At the moment, social distance is the primary strategy used to stop the virus's transmission. This document suggests a new approach using YOLOv3, a sophisticated object detection model, combined with OpenCV, for the real-time supervision and implementation of social distancing measures.

The system starts by using YOLOv3 to detect people in a specific area, utilizing bounding boxes and distinct IDs for thorough monitoring. Analyses comparing modern models like CNN-based regional speed and Single-Shot Detector (SSD) are carried out using metrics including mean Average Precision (mAP), Frames Per Second (FPS), and loss values for object classification and location. Moreover, the framework presents the idea of calculating L2 pairwise distances within a three-dimensional feature space based on bounding box dimensions and spatial relationships. A measure called the infringement index is suggested to measure how much people are straying from advised social distancing rules, to improve the effectiveness of encouraging public obedience.

The effectiveness of the YOLOv3-based tracking method is proven through experiments, showing positive scores in mean average precision (mAP) and frames per second (FPS) for monitoring community deviation in real-time. By utilizing the YOLOv3 object detection model and OpenCV image processing library, the suggested framework shows great potential for use in busy locations like shopping malls, movie theaters, and airports. By following social distancing rules, this project is ready to help reduce COVID-19 spread in crowded areas, protecting public health and promoting responsible social conduct.

INTRODUCTION:

Social distancing has become crucial in combating serious infections, especially in the context of the worldwide COVID-19 pandemic. Keeping enough distance between individuals can lower the chances of becoming ill due to physical proximity. Top priority should be given to developing effective social distancing measures, as COVID-19 is currently widespread in more than 180 countries. The absence of a clear solution emphasizes the ongoing importance of employing social distancing as a vital precautionary step, despite the continual endeavors of medical groups and researchers to create vaccines and treatments.

This study aims to tackle the urgent need for creative solutions to promote successful social distancing in public spaces while also minimizing the impact on economic activities. This research aims to create a strong system using technologies like CNNs, Deep Learning, and AI to detect and track social distancing compliance in public gatherings.

The World Health Organization recommends keeping at least a six-foot distance between individuals as per social distancing recommendations. By adhering to these suggestions, the spread of COVID-19 can be minimized, reducing the likelihood of transmission through physical contact and relieving pressure on healthcare systems.

In order to reach this goal, mathematical models and new technologies will be used to study epidemiological occurrences and implement social distancing measures in a successful manner. The suggested approach involves the use of YOLOv3 and Deepsort algorithms to detect and track pedestrians, along with adding a violation index to spot cases of not following social distancing guidelines. When violations are detected, the system sends notifications to authorized personnel to intervene promptly, warning individuals and ensuring they follow social distancing protocols.

This document highlights the issue, goals, and execution specifics of the suggested system, stressing the significance of utilizing technological progress to lessen the effects of the COVID-19 outbreak while protecting public health and economic concerns. This study aims to help develop effective strategies for controlling the spread of infectious diseases in public settings by giving a detailed summary of the research goals and methods.

3.An exact description of the proposed product:

The new product is a creative tool created to make it easier to understand and follow social distancing rules in busy places like airports, cinemas, and shopping centers. By utilizing security cameras and drones, the app employs advanced technology and complex algorithms to detect and monitor large crowds of people in real-time. The system quickly notifies authorized personnel to intervene and enforce social distancing guidelines by monitoring video footage for instances of people not maintaining safe distances. Compared to traditional manual methods, which can endanger public safety and stretch law enforcement resources, this automated solution provides a smooth and effective way to control crowd density and reduce the transmission of infectious diseases. The app gives authorities the ability to address potential gatherings and enforce public health measures proactively, without disrupting daily activities, through timely notifications and useful insights. With its user-friendly interface and adaptable

structure, the suggested product effectively functions as a useful instrument in encouraging accountable social conduct and ensuring the safety of people in public areas during the current difficulties brought about by the COVID-19 crisis.

4.A discussion about why the proposed product would be valuable:

The suggested product has great worth in its capacity to make enforcing social distancing measures more efficient and effective, especially in busy areas with a high risk of disease spread. The product uses automation to detect mass gatherings and social distancing violations, offering a proactive way to control crowd density and reduce the spread of diseases like COVID-19. This automation decreases the need for manual involvement, allowing law enforcement resources to be utilized more efficiently in addressing potential public health threats.

Additionally, the flexibility of the new product allows it to easily be used in various environments such as malls, movie theaters, and airports, which are popular gathering places for large crowds. Its adaptability allows for easy incorporation into current surveillance systems, facilitating broad deployment and usage in different settings without needing major infrastructure modifications or financial commitments. This ability to scale is important for dealing with the changing characteristics of public areas and the developing difficulties brought by the COVID-19 outbreak.

Moreover, the product enables authorities to quickly respond to crowds and ensure adherence to social distancing rules through real-time notifications and actionable insights. The product helps authorized personnel respond proactively to possible gatherings and non-compliance, which reduces COVID-19 transmission and protects community health by flattening the curve. This proactive strategy not just reduces the current effects of the pandemic, but also aids in long-term initiatives to prevent future outbreaks and enhance a safer and healthier society.

Overall, the recommended product offers a comprehensive and effective answer to the issues arising from the enforcement of social distancing measures in communal spaces. Its automated, scalable, and real-time characteristics can be advantageous for governments, businesses, and the general population as they combat the COVID-19 crisis and promote ethical conduct. The product plays a crucial role in safeguarding public health and limiting the spread of infectious diseases, ultimately enhancing resilience and benefiting communities worldwide through the reinforcement of social distancing protocols.

5. A discussion about possible ways to build the produt with what we have available

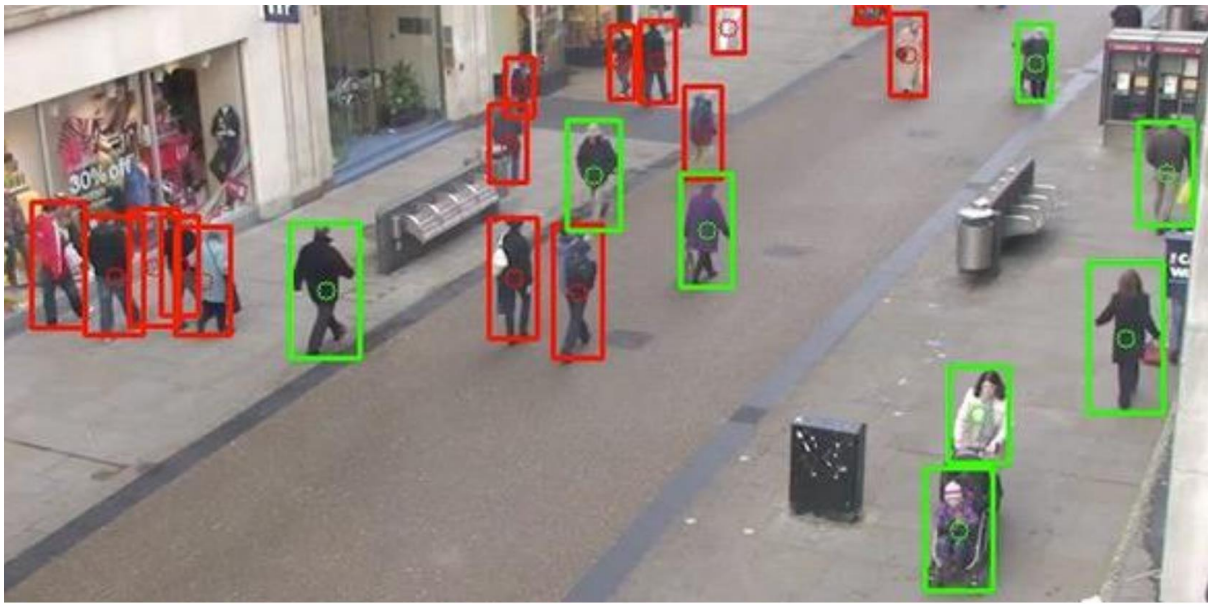
OpenCV:

For computer vision and machine learning, OpenCV is a popular open-source software library. It provides functions for analysing images and videos, such as motion tracking, facial identification, and object detection. Its algorithms are capable of classifying actions captured

by cameras, identifying faces, objects, and people. With the use of a particular dataset, OpenCV is trained in our project to detect and identify persons.

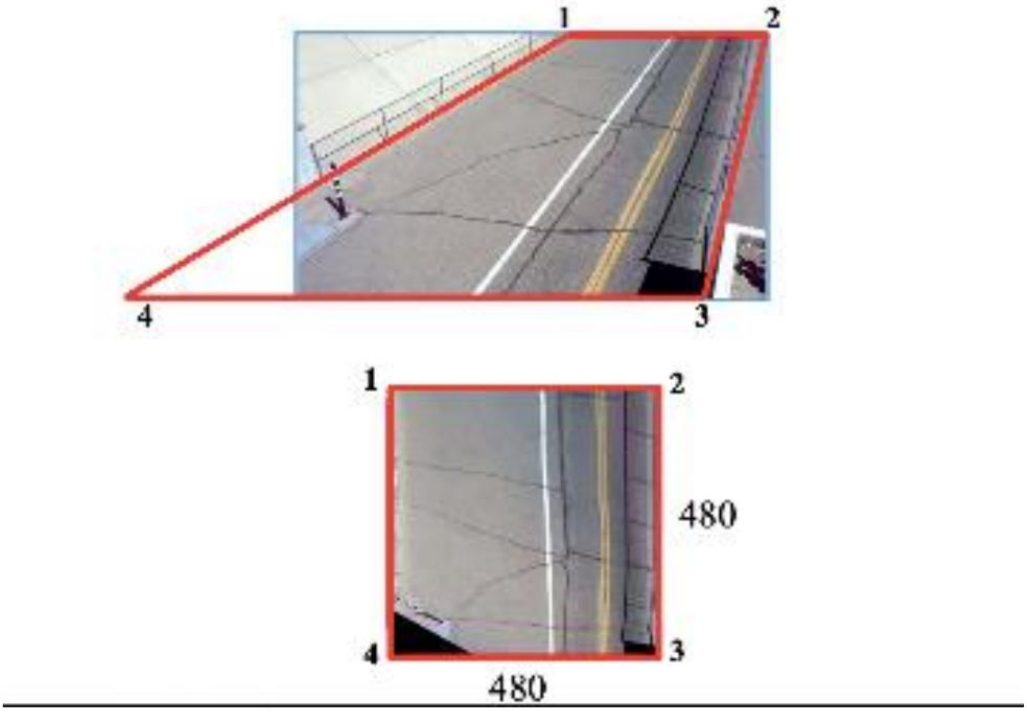
YOLOV3:

Popular object detection method You Only Look Once (YOLOV3) is well-known for its accuracy and quickness. We looked into a number of variants before deciding on YOLOV3 for our project because it met the necessary distance and accuracy requirements. Use OpenCV to load weights and configurations in order to download YOLOV3 and its configurations. The input from the user is transformed into a format that the YOLOV3 model, which finds objects in previously processed photos or videos, can use. When objects are spotted, bounded boxes are displayed. Red boxes show that people are not keeping a safe distance, while green boxes show that people are adhering to the social distance protocol. This can be accomplished by using calculations of the camera view calibration distance.



Camera view calibration:

The process of figuring out camera parameters to accomplish desired activities using predetermined performance metrics is known as camera calibration. The camera is calibrated using OpenCV, objects are detected using YOLOv3 or an alternative object detection algorithm, object dimensions are estimated using real-world dimensions or reference items of known size, and distance is computed using methods such as triangulation or depth estimation. Usually, these procedures are followed in a project to ensure accurate and efficient camera operation.



6. A discussion about how we can determine if we have successfully created the product

The rate of hospitalisations, deaths, and COVID-19 transmission can all be tracked to see how successful social distancing is. These measures are safeguarding vulnerable people, as evidenced by a decline in deaths and severe cases demanding hospitalisation. The degree to which social distancing rules are followed by the public can reveal information about the efficacy of enforcement actions and messages. Furthermore, it is possible to determine whether these steps are being applied without interfering with vital functions by keeping an eye on the continuation of crucial services including emergency response, food supply chains, and healthcare.

Regarding the efficacy of social distancing methods in controlling patient care and stopping the spread of COVID-19, healthcare experts might provide insightful opinions. Through social media monitoring or surveys, one can gauge public impression and awareness. The alignment of efforts with expectations and the necessity for modifications can be determined by comparing projected and actual COVID-19 data. Determining whether to keep or change social distancing policies requires careful consideration of a number of issues, which is assisted by

comprehensive analysis of these aspects and community input.

7. A discussion about how you might deploy the product in the real world to create value for someone.

Individuals, communities, and society as a whole can gain a great deal from the implementation of social distancing measures since they lower the risk of infection, safeguard vulnerable groups, and conserve healthcare resources. By taking these precautions, the danger of catching infectious diseases like COVID-19 is reduced, protecting one's health and wellbeing. They improve people's general quality of life, especially the elderly, immunocompromised people, and those with underlying medical issues. Additionally, social separation ensures that resources are allocated to people in need effectively and keeps healthcare systems from being overburdened by lowering the number of severe cases that need hospitalisation.

Social distancing practices keep people healthy and enable enterprises to run securely, which both contribute to economic stability. By reducing the negative effects of infectious diseases on consumer confidence and worker productivity, they benefit the economy and enterprises. In addition to fostering social cohesiveness, these actions encourage communities to band together in solidarity to safeguard one another's health and safety. Social distancing practices improve social ties and advance a mutually supportive society by encouraging a sense of empathy and group responsibility. By lessening the impact of upcoming health crises and lowering the need for severe actions, effective social distancing practices assist people and communities in developing resilience against future infectious disease epidemics. In addition, social distancing practices frequently minimise travel and energy use, which lowers carbon emissions and enhanced air quality, adding worth for both the current and upcoming generations.

8. Include the slides. from your presentation.

Introduction

- Social distance detection is a crucial aspect of public health and safety, especially during pandemics like COVID-19.
- This technology analyzes video footage captured by cameras to monitor whether individuals are maintaining a safe distance from each other.
- It's particularly useful for monitoring people in workplaces, schools, and shops, ensuring adherence to social distancing guidelines.
- We have utilized advanced computer vision techniques, specifically OpenCV (Open Source Computer Vision Library) and YOLOv3 (You Only Look Once), to develop a system capable of detecting and monitoring social distancing violations in real-time video streams.

Problem statement

Manual monitoring and enforcement of social distancing is challenging, An automated system is needed to detect violations and facilitate adherence to social distancing guidelines.

Literature Survey

- Landing AI Creates an AI Tool to Help Customers Monitor Social Distancing in the Workplace [Onlive]. Available at https://landing.ai/landing-ai-creates-an-ai-tool-to-help-customers- monitor-social-distancing-in-the-workplace/ (Access on 4 May 2020).
- R.Girshick,J.Donahue,T.Darrell,J.Malik."Richfeaturehierarchies for accurate object detection and semantic segmentation." In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 580-587. 2014.
- J. Redmon, S. Divvala, R. Girshick, A. Farhadi, “You only look once: Unified, real-time object detection”, In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 779-788. 2016.
- K. Simonyan, A. Zisserman, “Very deep convolutional networks for large-scale image recognition”, arXiv preprint arXiv:1409.1556, 2014.

System Requirements

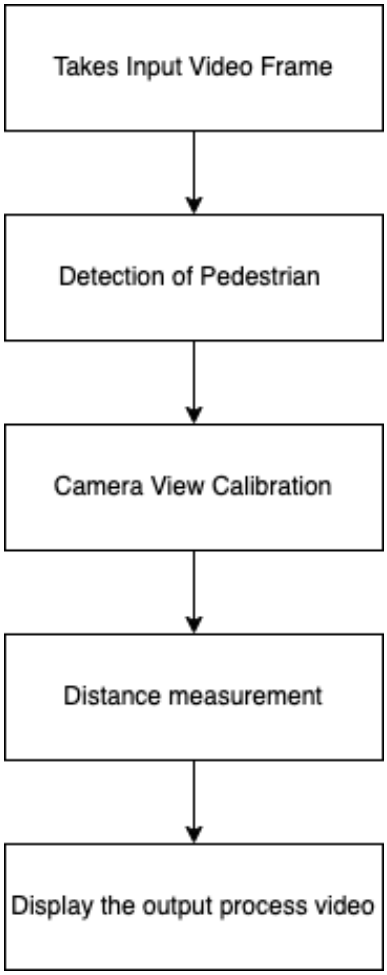
SOFTWARE REQUIREMENTS :

- Programming language : Python
- Operating system : Windows / Mac OS / ubuntu
- IDE : Visual Studio

HARDWARE REQUIRMENTS :

- Ram : Minimum 4GB
- Processor : Minimum i3
- Hard disc : 250 GB

Workflow

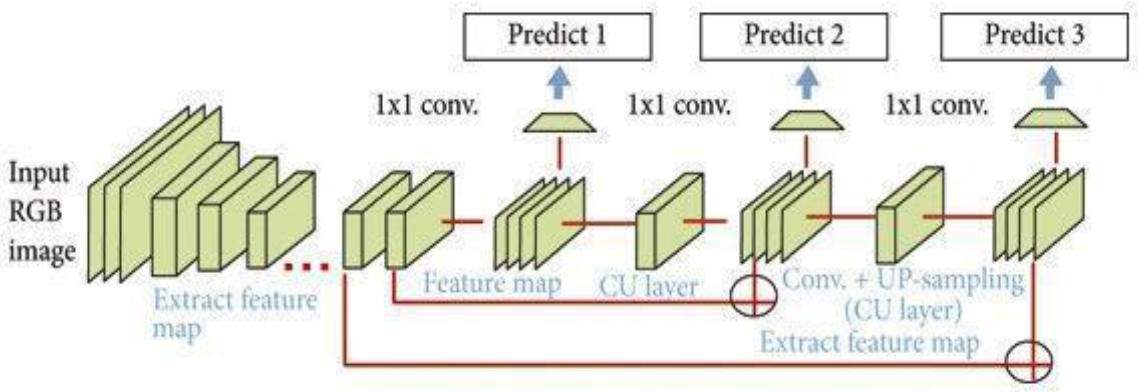


Algorithms and Datasets

- YOLOV3 algorithm is used to detect the pedestrian in the video frame.
- OpenCV for camera view calibration
- COCO dataset for object detection
- Video Frame for taking the input and giving the processed output.
- Flask for User Interface to facilitate users to upload video.

YOLOv3

- YOLOv3 is a state-of-the-art object detection algorithm known for its speed and accuracy.
- YOLOv3 is employed for accurate object detection, specifically for detecting humans in the video feed.



YOLOV3 model was utilized to detect pedestrians effectively.

https://www.researchgate.net/figure/YOLOv3-object-detection-architecture_fig4_358207277

OpenCV

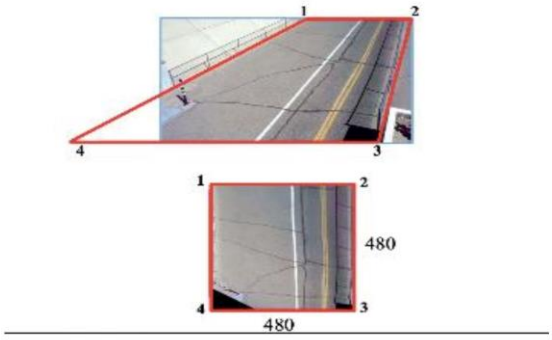
- OpenCV is a powerful open-source computer vision and machine learning library widely used for various image and video analysis tasks.
- OpenCV complements YOLOv3 by handling tasks such as image or video loading, preprocessing (e.g., resizing, normalization), and post-processing the detection outputs (e.g., drawing bounding boxes).

https://analyticsindiamag.com/getting-started-with-opencv-in-python/

Camera View Calibration

- Camera view calibration in simple terms involves setting up a camera to accurately capture and represent three-dimensional (3D) space in a two-dimensional (2D) image or video.

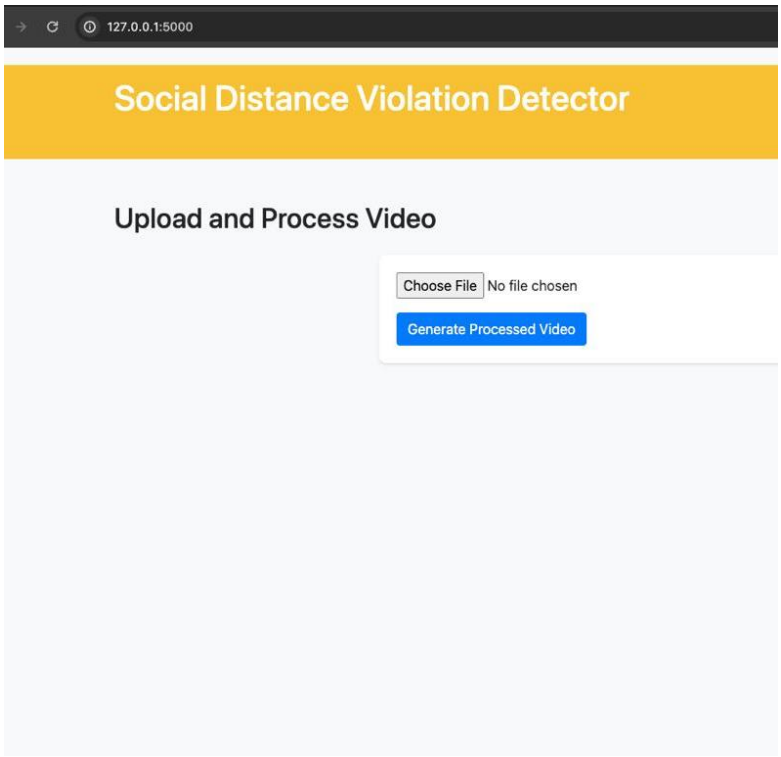
- This process adjusts the camera to account for factors like distance, size, and shape of objects in the real world, ensuring that the **3D information is accurately translated into the 2D images or videos** captured by the camera.



An example of the original viewpoint (above) and the subsequent top-down perspective following calibration (below)

Web-Based Application

- For the user interface, we use the web-based framework, Flask.
- Users can upload videos, and the application displays detection results using colored bounding boxes, indicating whether individuals are adhering to social distancing guidelines.

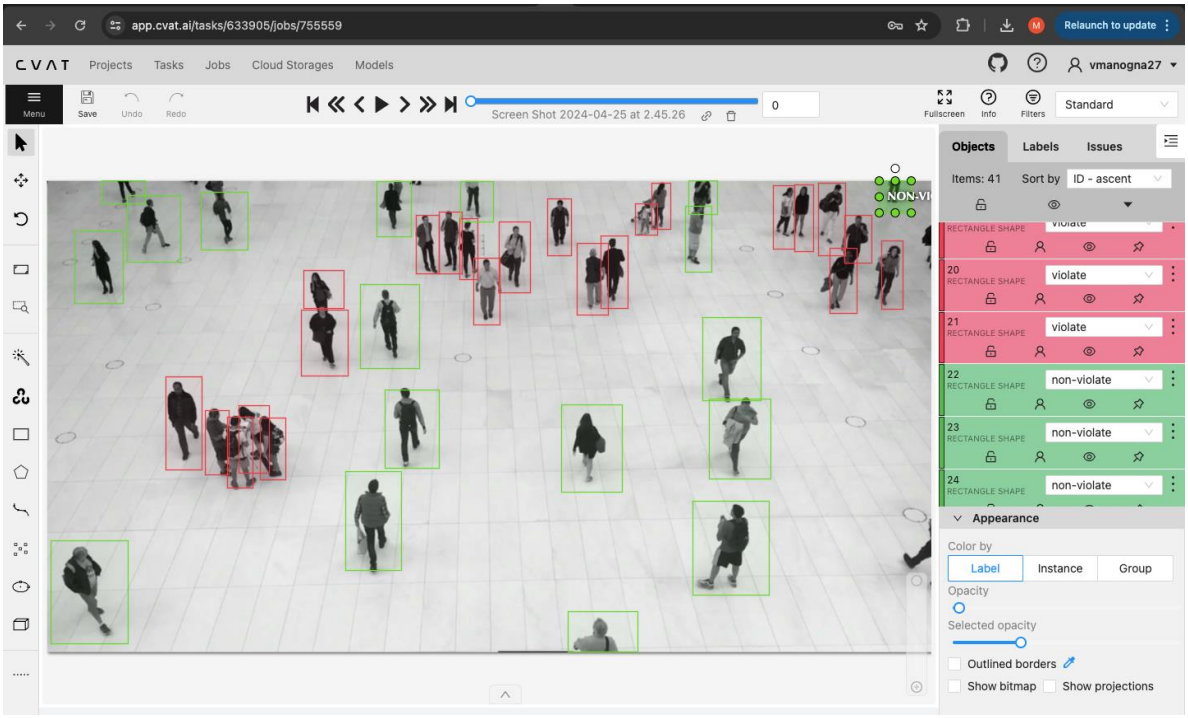


User Interface Using Flask

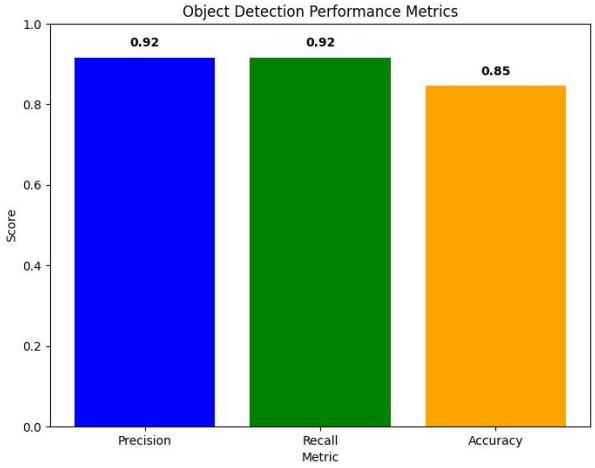
Results and Evaluation

CVAT Tool for Annotation

- Computer Vision Annotation Tool.
- Open-source tool designed for annotating images and videos used in computer vision tasks, particularly for training and evaluating machine learning models.
- CVAT allows importing and exporting annotations in various formats.



- Compared ground truth values from the annotation file from CVAT tool with the predicted values from our model.
- Calculated the accuracy, precision and recall values.
- Attained 85% accuracy.




```python
tp, fp, tn, fn = evaluate_detection(gt_boxes, pred_boxes, iou_threshold=0.5)

# Build confusion matrix
confusion_matrix = [[tn, fp], [fn, tp]]

# Print confusion matrix
print("Confusion Matrix:")
print(f"       Predicted Non-Violation  Predicted Violation")
print(f"Actual Non-Violation     {tn}                {fp}")
print(f"Actual Violation         {fn}                {tp}")

# Calculate precision, recall, and accuracy
precision = tp / (tp + fp) if (tp + fp) > 0 else 0.0
recall = tp / (tp + fn) if (tp + fn) > 0 else 0.0
accuracy = (tp + tn) / (tp + tn + fp + fn) if (tp + tn + fp + fn) > 0 else 0.0

print(f"Precision: {precision:.2f}")
print(f"Recall: {recall:.2f}")
print(f"Accuracy: {accuracy:.2f}")
```

```
manognareddyvoladri@Manognas-Air SocialDistanceDetection % python3 image.py
Confusion Matrix:
      Predicted Non-Violation  Predicted Violation
Actual Non-Violation    0            1
Actual Violation        1            11
Precision: 0.92
Recall: 0.92
Accuracy: 0.85
 * Serving Flask app 'image'
 * Debug mode: off
```

Factors affecting the results

- Weak Resolution images affect the results.
- The size of the object that is the size of the human if tiny can be a problem for detection. For example, children.
- If the parameters for camera calibration are improper that may lead to wrong results.

Future work

Enhancing the pedestrian detection algorithm can lead to more accurate detection of individuals in various environmental conditions such as different lighting conditions, occlusions, and varying pedestrian densities.

Conclusion

- The Social Distance Detection System offers a comprehensive solution for monitoring and enforcing social distancing measures in various environments.
- With adherence to quality standards, robust testing procedures, and a well-defined deployment and maintenance strategy, the product is poised to deliver significant value in promoting public health and safety.

References

- Github Link: **https://github.com/manogna27/Social_Distance_Detection**
- [1] K. He, X. Zhang, S. Ren, J. Sun, "Deep residual learning for image recognition", In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 770-778, 2016. https://ieeexplore.ieee.org/document/7780459
- [2] J. Redmon, S. Divvala, R. Girshick, A. Farhadi, "You only look once: Unified, real-time object detection", In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 779-788. 2016. https://ieeexplore.ieee.org/document/7780460
- [3] J. Redmon, A. Farhadi, "Yolov3: An incremental improvement", arXiv preprint arXiv:1804.02767, 2018.