SOCIAL DISTANCE MONITORING SYSTEM

19EEE381 – Open Lab

Report

Submitted by

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Amrita School of Engineering

Department of Electrical and Electronics Engineering

Program Educational Objectives (PEOs)

PEO1: Graduate can demonstrate electrical and electronics engineering problem solving skill along with proficiency in communication and professional excellence in project management and execution.

PEO2: Graduate can be employable in engineering services including ICT enabled sectors and also motivated for entrepreneurship.

PEO3: Graduate will be competent for higher studies in world class universities and research in industrial organizations.

PEO4: Graduate will manifest social commitment, environmental awareness and moral and ethical values in professional and other discourses.

Program Specific Outcomes (PSOs)

PSO1: Build and manage electro dynamic systems using Knowledge on electrical technology and

PSO2: Awareness of Future Technology: Develop solutions for future systems using smart technologies.

PSO3: Research and Innovation: Identify engineering challenges, approach using cutting edge research tools and execute innovative solutions.

BONAFIDE CERTIFICATE

This is to certify that the open lab project report entitled **"Social Distance Monitoring System",**

submitted by

Roll Nos.	**Student Names**
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is in partial fulfillment of the requirements for the award of the **Degree of Bachelor of Technology** in **"Electrical and Computer Engineering"** is a bonafide record of the work carried out at Amrita School of Engineering, Coimbatore.

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ABSTRACT

The Social Distancing Monitoring System is an advanced solution designed to address the need for effective enforcement of social distancing measures using a combination of image processing and deep learning techniques. This system utilizes the powerful capabilities of the OpenCV library and leverages pre-trained deep learning models to detect, track, and calculate distances between individuals in real-time video streams. By providing visual alerts for social distancing violations, the system aims to promote public safety and curb the spread of contagious diseases.

The project commences by employing a state-of-the-art MobileNetSSD deep learning model, which has been trained on extensive datasets, to achieve accurate and reliable person detection. This model is capable of identifying individuals with high precision, even in complex and crowded scenarios. By analyzing the generated bounding boxes around the detected persons, the system extracts crucial spatial information necessary for subsequent analysis.

To ensure compliance with social distancing guidelines, the system applies sophisticated image processing techniques to calculate the distances between pairs of detected individuals. By utilizing the Euclidean distance between the centroids of their respective bounding boxes, the system quantifies the proximity between individuals. This distance calculation enables real-time monitoring of social distancing compliance and facilitates the identification of potential violations.

To optimize the accuracy of distance measurements, the system incorporates non-maximum suppression, a technique that effectively filters out redundant and overlapping bounding boxes. By retaining only the most relevant and distinct person detections, the system ensures accurate and reliable distance calculations.

To track individuals across frames, the system integrates a centroid tracker algorithm. Each person is assigned a unique identifier, allowing the system to maintain a consistent tracking record. By continuously updating the positions of individuals, the system ensures reliable distance calculations and promptly alerts when social distancing thresholds are violated.

The output of the system is a real-time visualization of the video stream, which includes bounding boxes around individuals and their corresponding unique IDs. Social distancing violations are visually highlighted, providing clear indications of areas that require attention and corrective measures.

The Social Distancing Monitoring System presents an effective and automated solution for monitoring and enforcing social distancing guidelines in various settings, including public spaces, workplaces, and events. By leveraging the capabilities of image processing and deep learning, this system aims to promote public safety, support public health initiatives, and contribute to the overall well-being of communities.

INTRODUCTION

The Social Distancing Monitoring System using Image Processing and Deep Learning is an innovative solution designed to address the pressing need for ensuring compliance with social distancing guidelines in various public spaces. The system leverages the power of computer vision techniques, specifically image processing and deep learning, to detect, track, and analyze individuals in real-time video streams. By accurately measuring the distances between individuals, the system can identify and alert potential violations, thus promoting public safety and reducing the risk of disease transmission.

The COVID-19 pandemic has necessitated the adoption of social distancing measures to prevent the spread of contagious diseases. However, manually monitoring and enforcing these guidelines can be challenging, labor-intensive, and subject to human error. To overcome these limitations, automated systems that utilize advanced technologies have emerged as effective solutions.

The Social Distancing Monitoring System integrates cutting-edge technologies such as OpenCV, a powerful computer vision library, and pre-trained deep learning models for person detection and tracking. By employing a pre-trained MobileNetSSD model, the system achieves high accuracy in identifying individuals in real-time video streams. The model's ability to handle complex environments and crowded scenarios enables it to perform robust detection, even in challenging situations.

To ensure compliance with social distancing guidelines, the system utilizes image processing techniques to calculate the distances between pairs of detected individuals. By employing the Euclidean distance between the centroids of their bounding boxes, the system quantifies the proximity between individuals. This distance calculation enables real-time monitoring of social distancing compliance and facilitates the identification of potential violations.

The system further enhances its accuracy by incorporating non-maximum suppression, which eliminates redundant and overlapping detections. By selecting only the most relevant and distinct person detections, the system optimizes the accuracy of distance measurements and reduces false positives.

Tracking the movement of individuals across frames is a crucial aspect of the system. To achieve this, a centroid tracker algorithm is integrated, assigning unique identifiers to each person and updating their positions based on the centroids of their bounding boxes. This enables the system to maintain a consistent tracking record, ensuring reliable distance calculations and accurate violation alerts.

The output of the system is a real-time visualization of the video stream, where bounding boxes are drawn around individuals, and their corresponding unique identifiers are displayed. Violations of social distancing guidelines are visually highlighted, providing immediate and actionable information for intervention.

The Social Distancing Monitoring System offers numerous benefits, including increased efficiency, reduced manual intervention, and improved accuracy in monitoring social distancing compliance. It finds applications in a wide range of settings, such as public spaces, workplaces, retail environments, transportation hubs, and event venues. By automating the monitoring and enforcement of social distancing guidelines, the system plays a vital role in curbing the spread of contagious diseases, ensuring public safety, and protecting the well-being of communities.

PROBLEM STATEMENT

The problem at hand is the effective monitoring and enforcement of social distancing guidelines in public spaces, workplaces, and events to mitigate the spread of contagious diseases, particularly in the context of the COVID-19 pandemic. Manual monitoring of social distancing compliance is labor-intensive, time-consuming, and prone to human error, making it challenging to ensure consistent adherence to guidelines. There is a need for an automated system that can accurately detect and track individuals in real-time, calculate distances between them, and provide alerts for social distancing violations.

The main objective of this project is to develop a Social Distancing Monitoring System using image processing and deep learning techniques. The system should be able to:

1. Detect and Track Individuals: Utilize computer vision algorithms to detect and track individuals in real-time video streams. This involves the accurate identification of people in various environmental conditions and handling occlusions or crowded scenarios.

2. Measure Distances: Calculate the distances between pairs of detected individuals based on their positions in the video frames. This distance measurement should be reliable and accurate to determine if social distancing guidelines are being followed.

3. Identify Social Distancing Violations: Analyze the calculated distances and identify instances where social distancing violations occur. The system should be able to distinguish between individuals who are within a safe distance and those who are in close proximity.

4. Provide Real-time Alerts: Generate real-time alerts or notifications when social distancing violations are detected. These alerts can be in the form of visual indicators, audio signals, or notifications sent to relevant personnel for immediate action.

5. Visualize and Monitor Compliance: Provide a user-friendly interface that visualizes the real-time video stream, highlighting detected individuals, their positions, and social distancing violations. This interface should enable easy monitoring and intervention by authorized personnel.

The successful implementation of the Social Distancing Monitoring System will contribute to the effective enforcement of social distancing guidelines in various settings. It will assist authorities, organizations, and individuals in promoting public health and reducing the risk of disease transmission. The system's automation and accuracy will enhance efficiency, reduce the burden of manual monitoring, and provide a reliable solution for ensuring compliance with social distancing measures.

METHODOLOGY

1. Import libraries:

   The code begins by importing the required libraries including

   - Open(`cv2`)
   - imutils
   - datetime
   - numpy
   - combinations
   - math
   - Scipy.

2. Load the model:

   The MobileNet SSD model is loaded using the `cv2.dnn.readNetFromCaffe` function. The model files

   - `MobileNetSSD_deploy.prototxt` containing the network layers
   - `MobileNetSSD_deploy.caffemodel`containing the model weights are passed as arguments.

3. Defining classes:
   - A list of classes is defined, including "person" and other objects that the model can detect.

4. Implementing a centroid tracker:
   - Define a class called "Centroidcode" that acts as a centroid tracker. It keeps track of object IDs, centroids, bounding boxes, and the number of frames an object has disappeared. It provides methods for registering, deregistering, and updating object information.

5. Implementing non-maximum suppression:
   - Define a function called "non_max_suppression_fast" that performs non-maximum suppression on a set of bounding boxes to eliminate overlapping detections.

6. Define the main function:
   - The main function is defined, which contains the main logic of the program. It initializes a video capture object, sets up frame rate parameters, and starts reading frames from the video.

7. Process video frames:
   - The program enters a loop to read frames from the video file. It performs the following steps for each frame:
     - Resize the frame using `imutils.resize`.
     - Create a blob from the frame using `cv2.dnn.blobFromImage`.

- ➢ Set the input to the detector model and detect persons in the frame using `detector.setInput` and `detector.forward`.
- ➢ Store the bounding boxes of detected persons in a list called `rects`.
- ➢ Apply non-maximum suppression to filter out overlapping bounding boxes using the `non_max_suppression_fast` function.

8.Object tracking:

- The program uses the centroid tracker to track objects over consecutive frames. The tracker updates the object information based on the centroids and bounding boxes.

9. Social distancing monitoring:

- The program calculates the distance between each pair of objects and determines if they violate social distancing rules. It keeps track of objects that are in the "red zone" (too close to each other) and draws bounding boxes accordingly.

10. Displaying and saving results:

- The program displays the processed frames with bounding boxes and text indicating the object IDs, risk level, and frame rate. It also saves frames where a violation is detected.

11. Overall FPS calculation:

- The program calculates the frames per second (FPS) by dividing the total number of frames by the time difference between the start and end of the processing.

12. User interface:

- The script uses the cv2.imshow function to display the frames in a window named "Application". It waits for a key press and continues processing until the user closes the window.

BLOCK DIAGRAM:

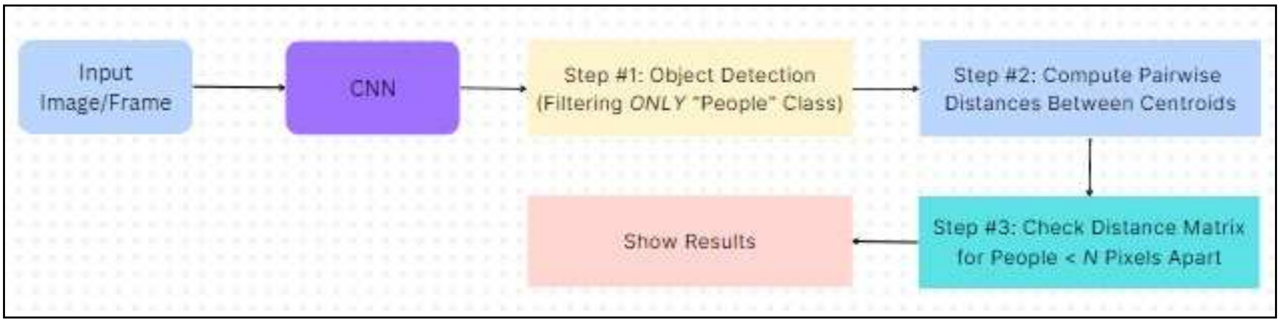

Figure 1:Block diagram for program

Importing video as input and applying CNN. Detecting objects and filtering the people, computing the distance between centroids. If the distance is less than the user input value. It is in a red Colour.

RESULTS

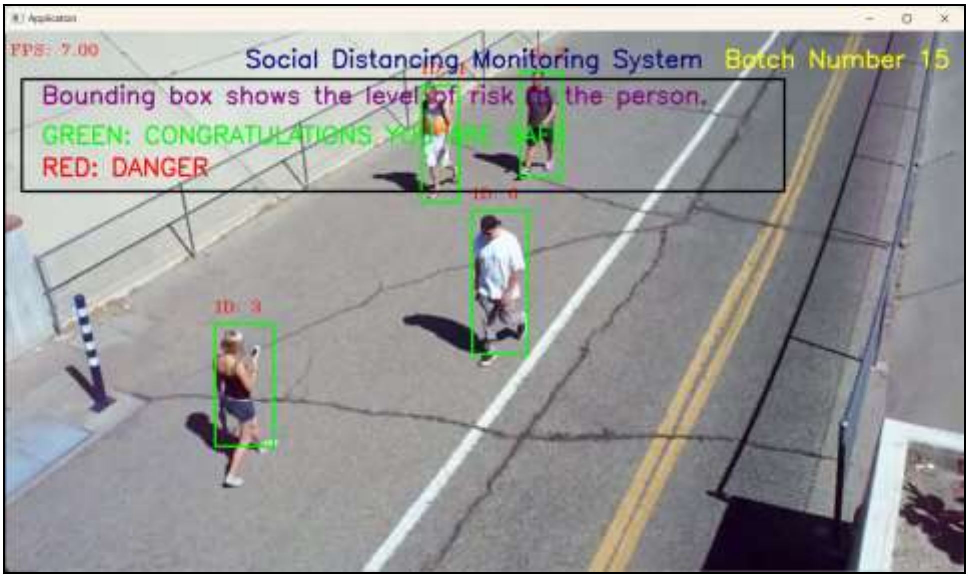

Figure 2:Output Frame

Representation of people who are in safe zone with ID numbers.

Figure 3:Output Frame

Representation of people who are in safe zone with ID numbers and Danger Zone with ID numbers.

```
P 4 - P 5 = 50.24937810560445
Person 4 and Person 5 are not following social distancing
P 4 - P 6 = 287.22116913625985
P 5 - P 6 = 275.35613303502066
P 4 - P 5 = 47.265209192385896
Person 4 and Person 5 are not following social distancing
P 4 - P 6 = 288.87713651308576
P 5 - P 6 = 276.72368890284764
P 4 - P 5 = 48.16637831516918
Person 4 and Person 5 are not following social distancing
P 4 - P 6 = 292.76953393411685
P 5 - P 6 = 281.64161624305456
P 4 - P 5 = 49.25444142409901
Person 4 and Person 5 are not following social distancing
P 4 - P 6 = 298.564900817226
P 5 - P 6 = 285.84786163272236
P 4 - P 5 = 50.24937810560445
Person 4 and Person 5 are not following social distancing
P 4 - P 6 = 302.6879581351065
P 5 - P 6 = 289.836160614924
FRAME 12    People Count : 2   RL : 1
```

Figure 4:Distancing

Representation of the distance between person to person and persons who are violating the social distance.

```
P 5 - P 6 = 606.1765419413721
P 5 - P 7 = 83.16850365372699
Person 5 and Person 7 are not following social distancing
P 6 - P 7 = 688.8200055166807
P 5 - P 6 = 618.9903068707943
P 5 - P 7 = 81.93289937503738
Person 5 and Person 7 are not following social distancing
P 6 - P 7 = 700.5426468103137
P 5 - P 6 = 629.6896060758825
P 5 - P 7 = 80.95677859203639
Person 5 and Person 7 are not following social distancing
P 6 - P 7 = 709.9105577465375
P 5 - P 6 = 632.3701447728221
P 5 - P 7 = 76.6550715869472
Person 5 and Person 7 are not following social distancing
P 6 - P 7 = 707.5874504257407
P 5 - P 6 = 632.8111882702455
P 5 - P 7 = 74.46475676452586
Person 5 and Person 7 are not following social distancing
P 6 - P 7 = 705.8222155755655
FRAME 16    People Count : 3   RL : 1
```

Figure 5:Distancing

Representation of the distance between person to person and persons who are violating the social distance.

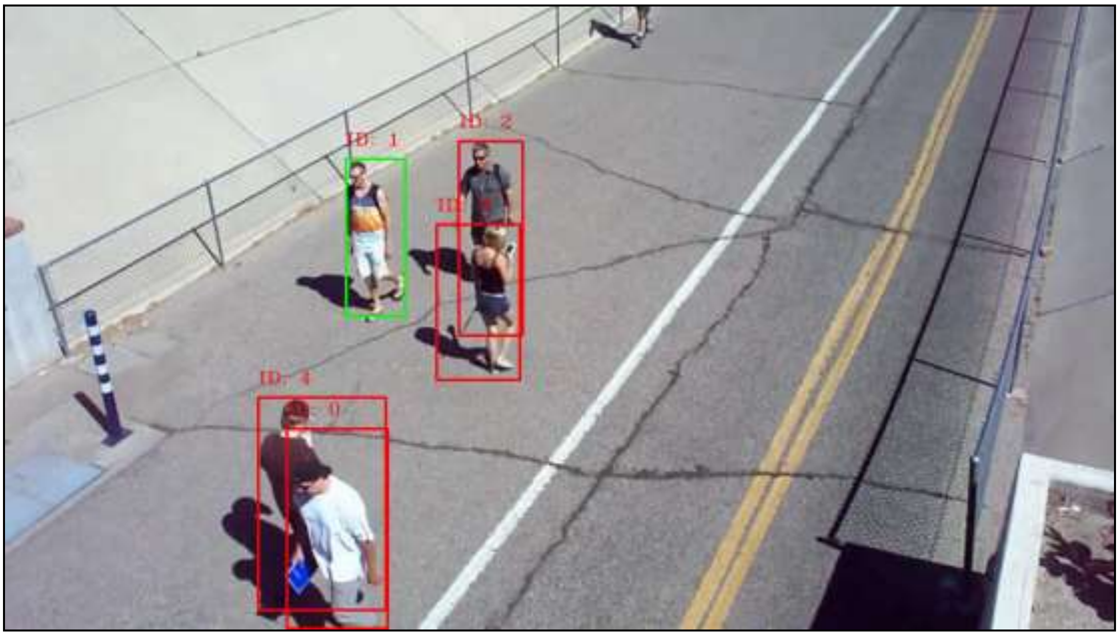

Figure 6:Violated Frame

Frame that stores the people who are violating the social distance.

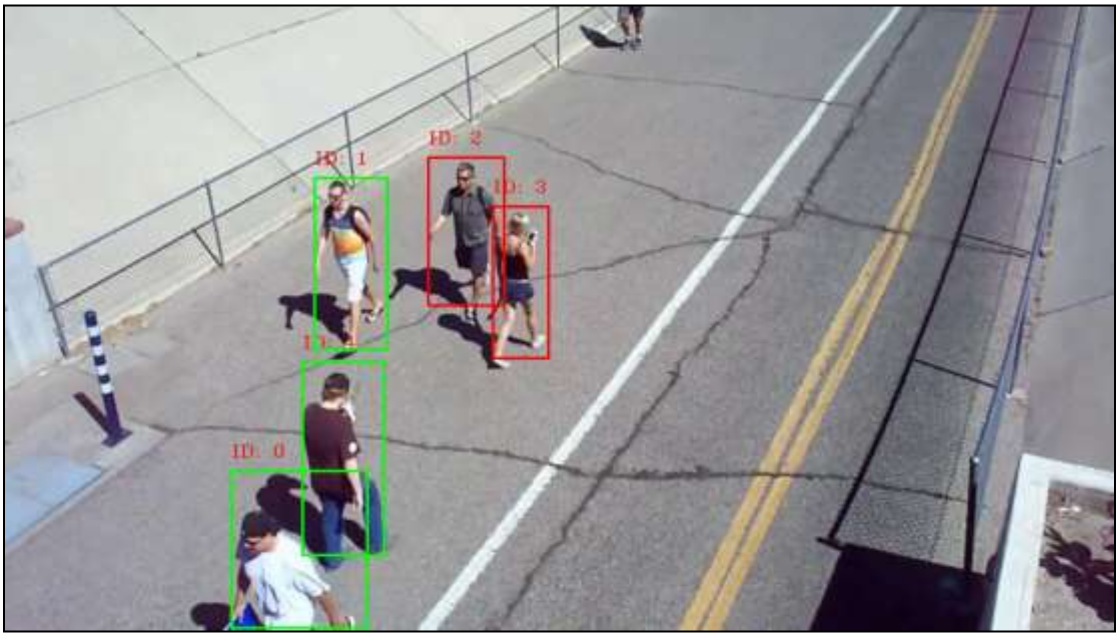

Figure 7: Violated Frame

Frame that stores the people who are violating the social distance.

CONCLUSIONS & FUTURE WORK

In conclusion, the Social Distancing Monitoring System developed using image processing and deep learning techniques provides an effective solution for enforcing social distancing guidelines in public spaces, workplaces, and events. By leveraging computer vision algorithms, the system can accurately detect and track individuals in real-time video streams, calculate distances between them, and identify social distancing violations.

The implementation of this system addresses the challenges associated with manual monitoring, such as labor-intensive efforts, potential human error, and the need for continuous supervision. It automates the process of monitoring social distancing compliance, enabling efficient and consistent enforcement of guidelines to mitigate the spread of contagious diseases.

The Social Distancing Monitoring System offers several key advantages. Firstly, it provides real-time monitoring and alerts, allowing authorities and relevant personnel to take immediate action when violations occur. This proactive approach helps maintain a safe environment and prevent potential outbreaks. Secondly, the system reduces the reliance on human resources, saving time and effort in monitoring large crowds or areas. Thirdly, the accurate distance calculation and violation detection enhance the reliability and accuracy of social distancing enforcement.

Furthermore, the user-friendly interface of the system facilitates easy visualization and monitoring of compliance. Authorized personnel can access a visual representation of the video stream, highlighting detected individuals, their positions, and social distancing violations. This visual feedback enables efficient intervention and ensures adherence to guidelines.

The Social Distancing Monitoring System can be applied in various settings, including public transportation, retail stores, offices, schools, and event venues. It serves as a valuable tool for promoting public health and safety, particularly in times of infectious disease outbreaks like the COVID-19 pandemic.

Overall, the development and implementation of the Social Distancing Monitoring System contribute to the effective enforcement of social distancing guidelines, providing a reliable and automated solution for maintaining safe and healthy environments.

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