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A Review on Automatic Social Distancing Rule Violation Detection

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***Abstract*— Social distancing implies remaining at home and away from others as much as possible to prevent the spread of COVID-19. It encourages online communication instead of in-person contact. With communities reopening, the term "physical distancing" reinforces maintaining at least 6 feet of distance from others and wearing face masks. This paper reviews various research works on automatic social distancing detection in public places using computer vision techniques. Several studies utilize machine learning, deep learning, CNNs, and object detection frameworks to detect and alert social distancing violations.**

***Keywords*— Social Distancing Rule Violation Detection, Physical Distancing, Machine Learning, Coronavirus, Computer Vision, Artificial Neural Network, TensorFlow.**

I. INTRODUCTION

"Social distancing" is best practice toward endeavors through an assortment of means, intending to limit or intrude on the transmission of Coronavirus. It targets diminishing the actual contact between perhaps tainted people and sound people. According to the WHO standards [1] it is endorsed that individuals ought to keep up with something like 6 feet of distance among one another to follow social distancing. A new report demonstrates that social distancing is an important regulation measure and fundamental to forestall SARS CoV-2, since individuals with gentle or no indications may fortuitously convey crown disease and can taint others [2]. Various model demonstrates that legitimate social distancing is the most ideal approach to lessen irresistible actual contact, consequently decreases the disease rate [3], [4]. This diminished pinnacle may without a doubt coordinate with the accessible medical care framework and help to offer better fact tiles to the patients engaging against the Covid pandemic. The study of disease transmission is the investigation of variables and purposes behind the spread of irresistible infections. To examine epidemiological wonders, numerical models are consistently the most favored decision. Practically all models drive from the traditional SIR model of Kermack and McKendrick set up in 1927. Different examination works have been done on the SIR model and its augmentations by the deterministic framework, and thusly, numerous scientists contemplated stochastic organic frameworks and scourge models [5].

Fig. 1. Social Distancing Detection

Social distancing (SD) is a powerful measure to forestall the spread of the irresistible Covid Sickness 2019 (Coronavirus). In any case, an absence of spatial mindfulness may cause accidental infringement of this new measure. Against this background, we propose a functioning reconnaissance framework to moderate the spread of Coronavirus by notice people in a district of-premium. Our commitment is twofold. In the first place, we present a dream based ongoing framework that can identify SD infringement and send non-meddling general media signs utilizing cutting edge profound learning models. Second, we characterize a novel basic social thickness worth and show that the possibility of SD infringement event can be held almost zero if the walker thickness is held under this worth. The proposed framework is additionally morally reasonable: it doesn't record information nor target people, and no human manager is available during the activity. The proposed framework was assessed across genuine world datasets.

II. RELATED WORKS

Narinder Singh Punn et al. [6] proposed an effective real-time deep learning-based system to automate the monitoring of social distancing through object detection and tracking methodologies. Each individual is recognized continuously using bounding boxes, which further assist in identifying clusters or groups of people satisfying the proximity property computed through a pairwise vectorized approach. The number of violations is determined by calculating the number of groups formed, while the violation index is computed as the ratio of the number of people to the number of groups. Extensive experiments were conducted using popular state-of-the-art object detection models, namely Faster R-CNN, SSD, and YOLOv3, with YOLOv3 demonstrating the most efficient performance by balancing FPS and mAP scores. However, since this approach is highly sensitive to the spatial placement of the camera, it can be fine-tuned to better adapt to the corresponding field of view.

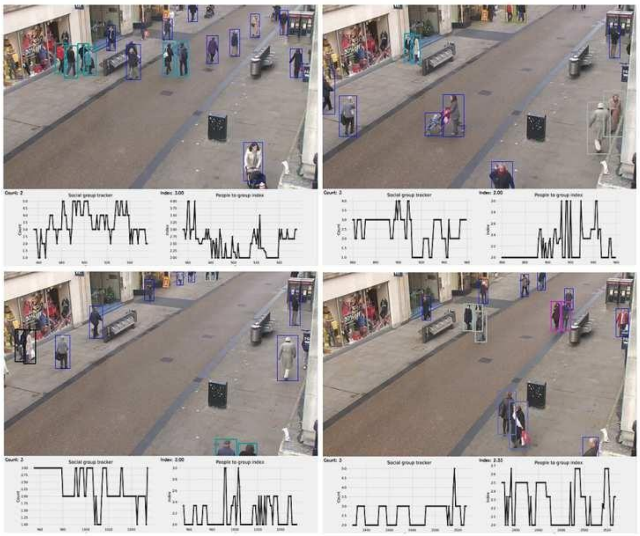


Fig. 2. Frame Work Architecture [6]

Sreetama Das et al. [7] proposed a framework emphasizing the execution of social distancing in public places as a critical strategy to ensure individual safety and workplace security until vaccines and medications become widely available for mass use. Their work introduced a computer vision-based approach for social distancing monitoring, incorporating an automated camera calibration technique to simplify large-scale deployment. The framework employed time-based thresholds to distinguish between transient and persistent violations of social distancing policies and used metrics such as violation clusters to assess risk. The system was deployed in real-time and achieved satisfactory performance under varying lighting, crowd density, and occlusion conditions. Future improvements suggested by the authors include integrating single-shot trackers or density-based trackers, retraining the model with annotated video feeds from deployment regions, and testing newer detection algorithms such as EfficientDet and YOLO. Additionally, they highlighted the potential of multi-camera multi-object tracking to enhance detection accuracy across different camera perspectives. Hendra Adinanta et al. [8] proposed a method to identify individuals and assess physical distancing violations based on their spatial separation. While most researchers relied on object detection techniques such as Faster R-CNN, YOLO, and SSD, which require GPUs to handle computationally intensive processes, this study explored an alternative approach. The authors applied background subtraction techniques based on Gaussian Mixture Models (GMM), such as Geometric Multigrid (GMG), k-Nearest Neighbor (KNN), Mixture of Gaussian (MOG), and Mixture of Gaussian 2 (MOG2), to filter people from frames with reduced computational demand. A performance evaluation of these methods revealed that KNN, MOG, MOG2, and GMG were ranked in descending order of effectiveness, with KNN emerging as the most suitable for efficient social distancing monitoring.

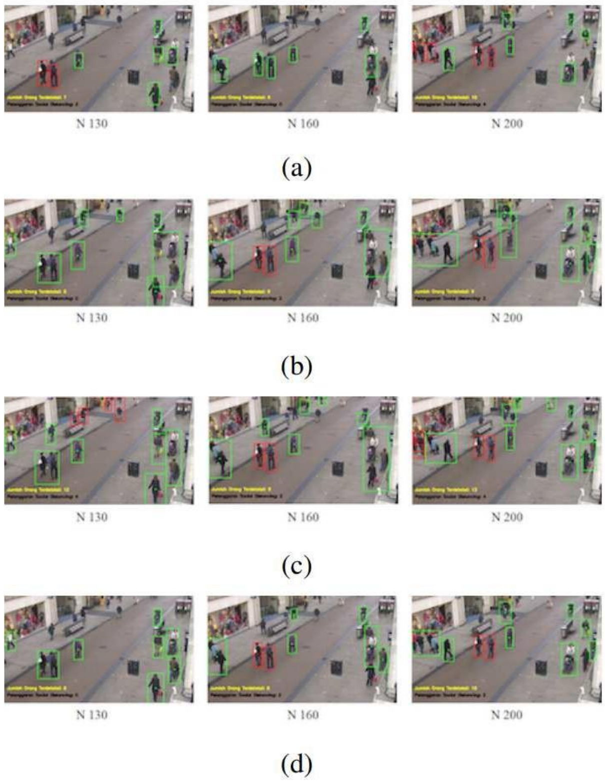


Fig. 3. The output of physical distancing monitoring using (a) MOG, (b) MOG2, (c) GMG, (d) KNN [8]

Zhenfeng Shao et al. [9] proposed a lightweight pedestrian detection network capable of accurately identifying individuals by detecting human heads in real-time from UAV imagery, followed by calculating social distancing among them. The network architecture consists of three main components: PeleeNet, a multi-scale spatial attention module, and a detection layer. To effectively capture the features of small-sized objects such as human heads, the approach combines three feature maps (19 × 19, 38 × 38, 76 × 76) through deconvolution and concatenation. The spatial attention module enhances relevant feature information while suppressing irrelevant details, and the detection layer predicts head locations. Comparative experiments with state-of-the-art detection methods (SSD and YOLOv3) on a combined human head dataset demonstrated superior performance, achieving 92.22% AP and 76 FPS, indicating both accuracy and real-time efficiency. Further ablation studies confirmed that multi-scale features and spatial attention significantly improved detection performance. On the UAV Head dataset, the method achieved 88.5% AP and 75 FPS, successfully detecting individuals under varying viewpoints, illumination, and scales. Additionally, an accuracy calibration experiment was conducted to map coordinates from transformed UAV images to real-world spatial coordinates, thereby enabling reliable automatic distance sensing for effective social distancing monitoring in real-world scenarios.

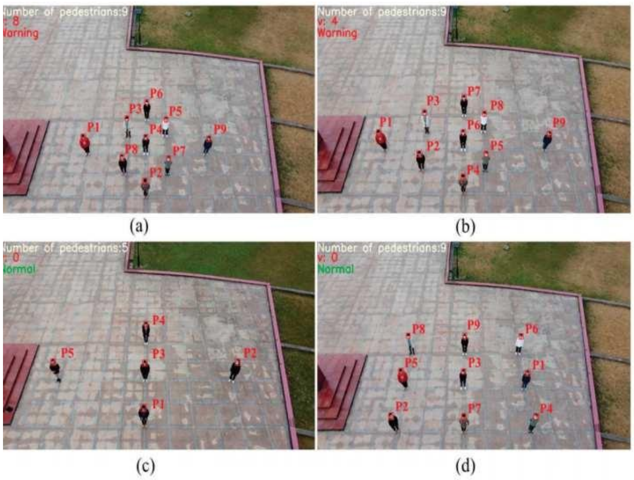


Fig. 4. The results of social distancing monitoring on tilted images with four different pedestrian position patterns [9]

Afiq Harith Ahamad et al. [10] proposed a system for monitoring social distancing as a precautionary measure to reduce physical contact between individuals. Their study focused on detecting people in areas of interest using the MobileNet Single Shot Multibox Detector (SSD) object tracking model in combination with the OpenCV library for image processing. The system calculates the distance between detected individuals in captured video frames and compares it against predefined pixel thresholds. Distances are measured between key points and overlapping boundaries of individuals within the segmented tracking region, and when unsafe distances are identified, alerts are triggered to enforce safe spacing. In addition to social distance monitoring, the framework also incorporates a feature for detecting the presence of individuals in restricted areas, which can likewise activate warning signals. Experimental evaluations demonstrated that the distance tracking system achieved an accuracy between 56.5% and 68% on outdoor and uncontrolled test videos, while achieving 100% accuracy in controlled indoor environments. Furthermore, the restricted-area violation alert feature showed high effectiveness, attaining an accuracy between 95.8% and 100% across all tested video inputs.

Fig. 5. Proposed System [10]

Savyasachi Gupta et al. [11] proposed a system that leverages the Mask R-CNN deep neural network to detect individuals in video frames and monitor compliance with social distancing guidelines. To ensure consistent identification across frames, a centroid tracking algorithm was employed to follow individuals throughout the recording. By applying reliable computational methods for estimating both the distance of individuals from the camera and the distance between them, the system determined whether social distancing protocols were being maintained. Experimental evaluation on the Custom Video Frame Dataset (CVFD) and the Custom Person Images Dataset (CPID) demonstrated high accuracy with a low false alarm rate, validating the framework's effectiveness in assessing adherence to social distancing measures.

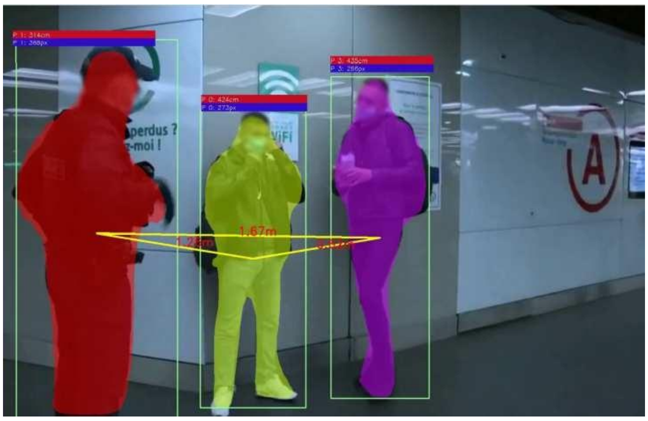


Fig. 6. Visualisation of the results obtained by SD-Measure framework [11]

Yew Cheong Hou et al. [12] proposed a social distancing detection system based on a deep learning model combined with computer vision techniques to estimate the distance between individuals. Any pair of individuals violating distancing guidelines was highlighted with a red bounding box and a connecting red line, enabling clear visual representation of non-compliance. The proposed method was validated on video sequences of pedestrians walking along a street, and the results demonstrated its effectiveness in determining social distancing measures. The authors suggested that the framework could be extended for use in diverse environments such as offices, restaurants, and schools. Furthermore, they highlighted potential improvements, including enhancing pedestrian detection algorithms, integrating additional detection modules such as mask detection and human body temperature measurement, upgrading hardware computational power, and refining camera viewpoint calibration to achieve better accuracy and adaptability.

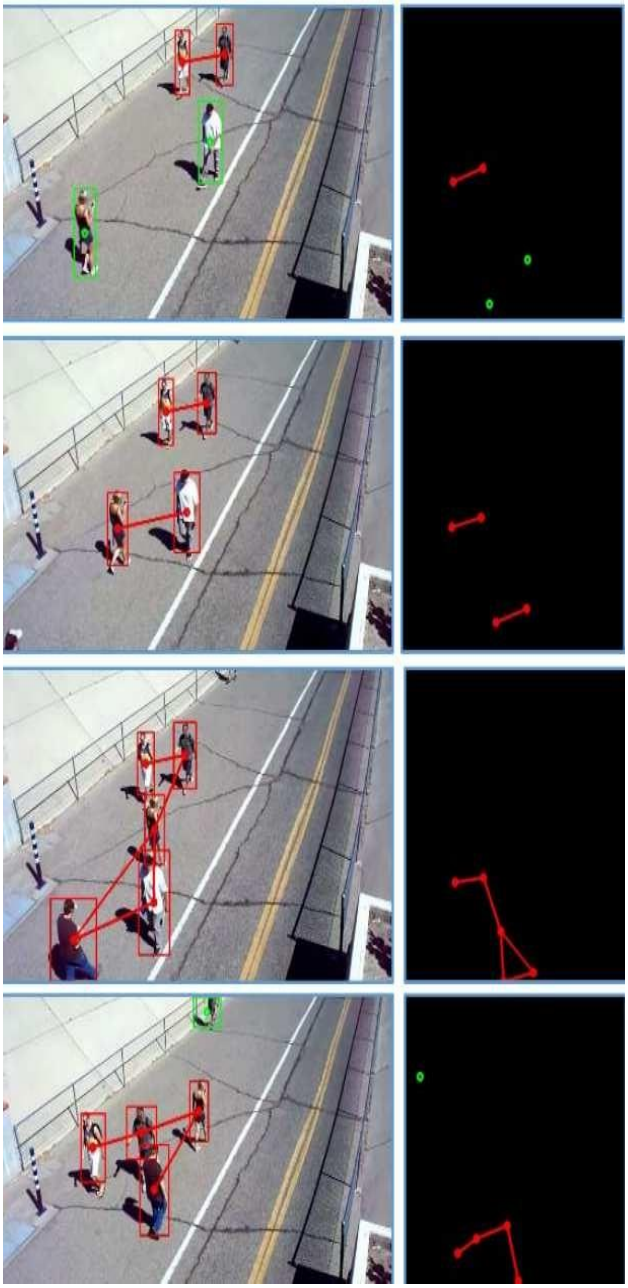


Fig. 7. Social distancing detection in video frame (left) and in topdown view (right). The sequences are depicted from top to bottom [12]

Mohd. Aquib Ansari et al. [13] proposed a deep learning–based human detection approach to monitor social distancing in the current environment. Their method employs deep convolutional networks with a sliding window concept as a region proposal mechanism and integrates a social distancing algorithm to estimate the distances between individuals, determining whether distancing norms are being followed. Extensive experiments using CNN-based object detectors demonstrated higher accuracy compared to other models, although occasional false positives occurred in real-time video sequences. To improve detection accuracy and reduce false positives, modern object detectors such as RCNN, Faster RCNN, SSD, RFCN, and YOLO could be applied using a custom dataset. Additionally, relying on a single camera view may not provide optimal results, so deploying multiple cameras from different perspectives in the future could enhance the overall accuracy of the system.

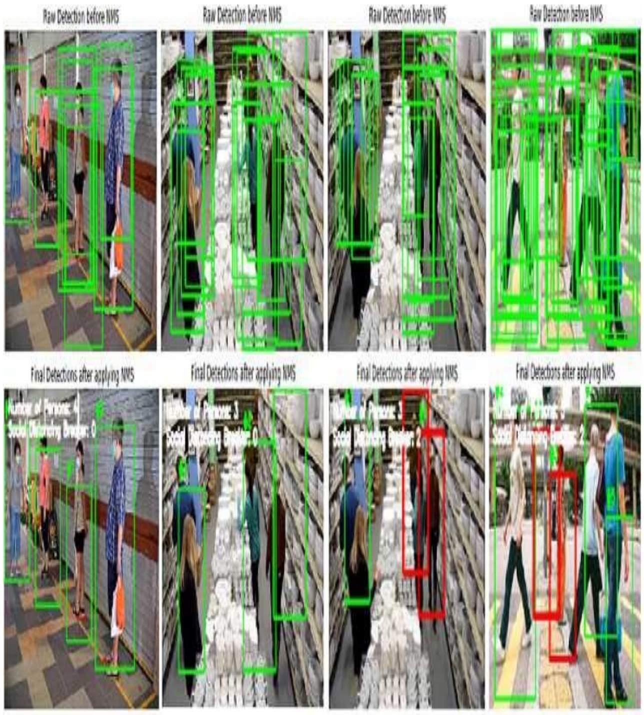
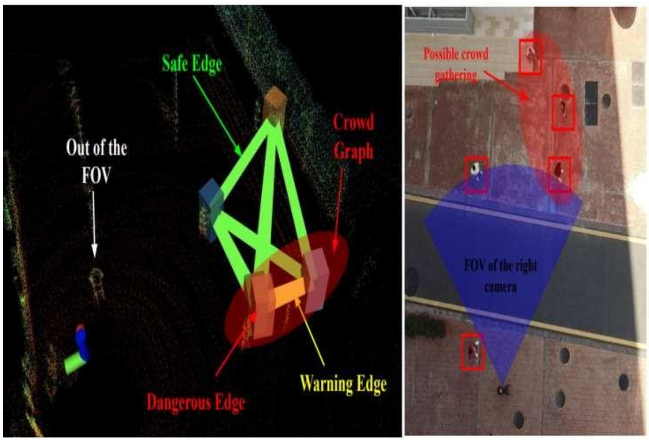


Fig. 8. Outcomes of Model 2 for practicing social distancing [13]

Here, CNN-based object detectors are utilized to identify human presence, and their outputs are used to calculate distances between detected individuals. The proposed social distancing algorithm highlights people who come closer than a predefined threshold, and experimental results show that CNN-based detectors combined with this algorithm provide promising outcomes for monitoring social distancing in public areas. Zhiming Chen et al. [14] proposed an autonomous monitoring robot system to enforce social distancing amid the Coronavirus pandemic. The robot integrates social distance detection, urban navigation, and intelligent voice interaction, and its legged design allows it to adapt to diverse environments effectively. Real-world tests demonstrated that the robot can successfully maintain social distancing, and the system has been deployed to prevent virus spread. However, improvements are possible, such as analyzing social relationships to avoid penalizing family members who intentionally stay close. Future work will focus on identifying pedestrians' social relationships from historical behavior and equipping the robot with temperature sensors and disinfection tools to monitor health and assist in routine sanitation. Beyond pandemic applications, this versatile legged platform can serve in everyday human interactions, such as acting as a local guide in parks, replacing human operators in routine navigation and inspection tasks, and assisting elderly individuals.



(a) Visualization of the social distancing detection (b) Bird view of the scenario

Fig. 9. Illustration of the crowd gathering detection [14]

Meirui Qian et al. [15] proposed a social distancing included keeping a distance of 1.5 m between individuals, which can forestall the spread of most respiratory irresistible sicknesses. Social distancing is perhaps the best measures to diminish the spread of the infection, which is communicated via air drops. The drops created by hacking, sniffling or constrained talking have a specific transmission distance. By maintaining this separation, we can decrease the spread of the infection. Wearing veils, washing hands often and cleaning with liquor likewise help to keep the infection from spreading starting with one individual then onto the next. To control the illness, the World Wellbeing Association suggested that nations ought to reinforce case identification, track and screen contacts, practice detachment from close contacts and segregate cases just as execute traffic light and suspend huge social occasions. An epic Covid pneumonia forecast model was set up by utilizing the enormous information of the College of Washington Wellbeing File and Assessment Center (IHME) (IHME 2020). Investigation of the plague circumstance in seven secured down urban communities Wuhan, Italy and Spain showed that keeping up with social distancing truly accomplished outcomes. Since these urban areas executed lockdowns, the plague immediately arrived at a pinnacle, so far not climbing once more. Erin Mordecai, a scientist at Stanford College, and a group of specialists fostered an intelligent test system to mimic the spread of Coronavirus over the long haul, showing the part of social disconnection and social distancing in pestilence control (Erin 2020). Remarkably, the public authority immediately received the right system, e.g., social distancing, accordingly controlling the pace of the increment of cases and winning more opportunity for specialists. On the off chance that this had not been the situation, it would have been unthinkable for clinical staff from another areas to go to Wuhan for help, and Wuhan gave off an impression of being the solitary flare-up city. As far as cost, social distancing additionally saves clinical assets, like veils, hand sanitizers, liquor based sanitizer, and so on This gives our medical care experts, emergency clinics and different foundations more important chance to plan, forestall the sickness and assist with peopling who have been determined to have Covid. There were 50,633 affirmed cases in Hubei on February 18, 2020, in view of a top after the conclusion of the city. Then, at that point, the quantity of cases started to decay. As of April 13, the quantity of affirmed cases in Hubei Region was 244.

III. Conclusion & Future Scope

This paper reviewed various implemented systems that detect social distancing rule violations using CNN, DNN, SSD Filtration and many more. Most of the system uses CNN and a training model for creating templates that later match for nearest classification. But there is no appropriate model for actual feature extraction, instead of that it can be achieved through Tensorflow or any object classifier along with various pre-processing models. The system can be enhanced in future by implementing it with different techniques and filters, which may acquire good accuracy and minimal false alarm rate. Because as per the ideal system, accuracy is an important parameter, that is why accuracy of system can be enhanced in future with different techniques or filters.

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