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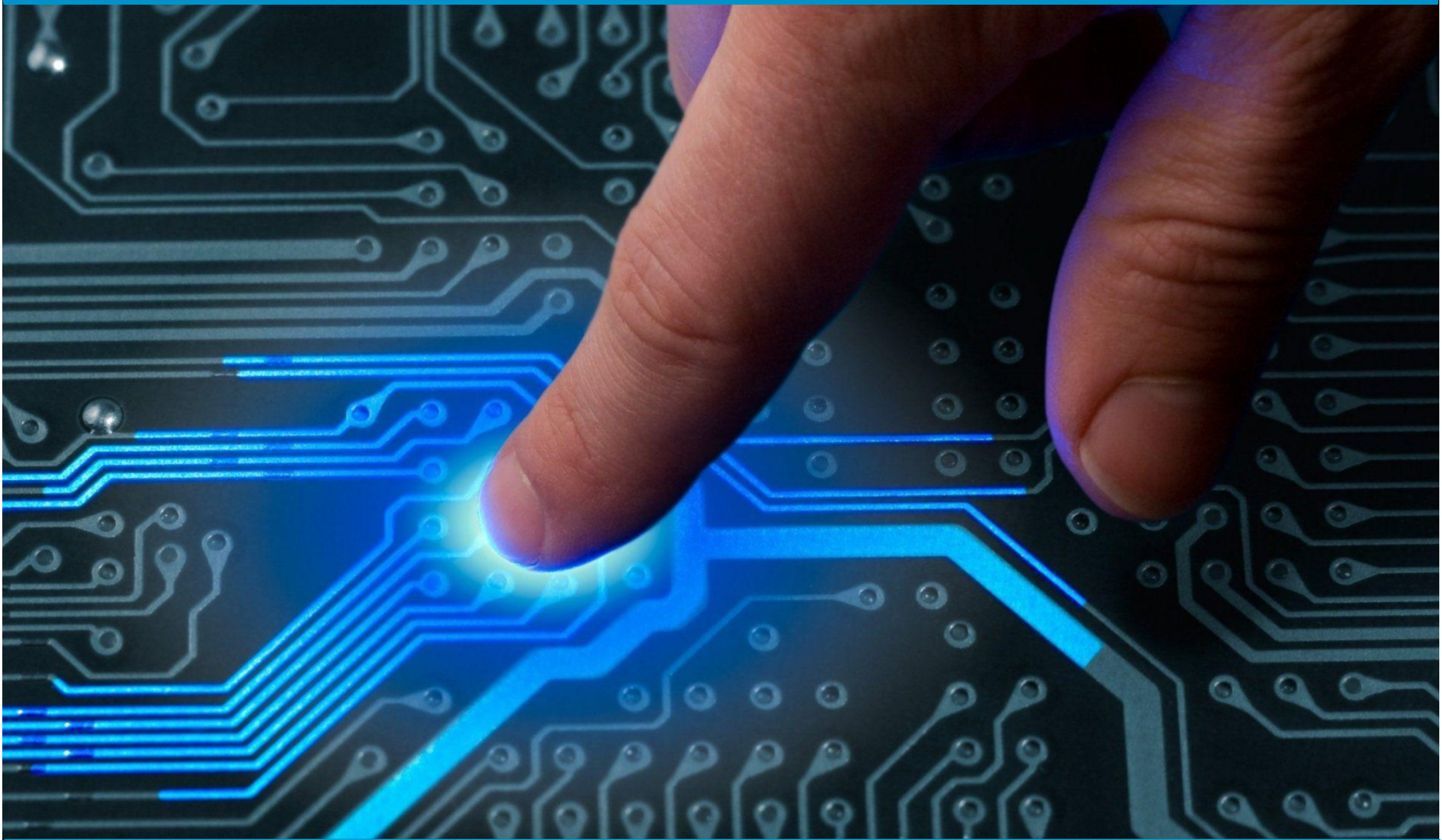

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# Artificial Intelligence for social distancing in COVID 19

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**ABSTRACT**:In today world data from mobile phones are being used around the world as part of the COVID-19 response, to map population movement, set parameters for disease transmission models, and inform resource allocation.1, 2, 3 When anonymised and aggregated, these data do not reveal information about individuals but provide epidemiologically relevant estimates about population mobility—ie, the extent to which people are sheltering in place, congregating at parks, grocery stores and transit hubs, and generally moving less (or more) than usual.3, 4, 5 These data also provide vital insights into travel patterns to help better understand the effect of travel restrictions and the risk of importation from other locations and to inform spatial epidemiological models.6, 7, 8 These analyses can be used to identify neighbourhoods or communities that could become hotspots for community transmission or that might need additional support to practise physical distancing, or as part of surveillance more generally.9The present universal challenge of COVID-19 pandemic has exceeded the regional, essential, theoretical, mystical, communal, and pedagogical boundaries. The enhanced spread of COVID-19 has increased many operational problems in the governments' health response systems. All these problems point to an incapability to scale the solution with the growth of the outbreak. Data providers are governed by national regulators who determine what CDRs (and sometimes GPS trace data) can be used for, and whether aggregated data can be shared with researchers or policy makers. For example, in most European countries, location data can only be used by the operator when they are made anonymous or with the consent of the individual, in accordance with General Data Protection Regulations. COVID-19 —Social distancing measures are necessary for many infectious diseases that spreads through droplets and microdroplets. According to WHO, the preventive measure for COVID-19 is to follow strict social distancing. It is not easy to enforce social distance easily in a crowded region and people often not maintain sufficient distance with neighbors. Driven by the need for energy-efficient and cost-effective social distancing monitoring, this paper proposes Smart Social Distancing (SSD) mobile application-based monitoring, which can predict the social distancing between two people assisted by mobile bluetooth and mobile camera. SSD involves two major steps to predict the social distance: first the pedestrian in the video frames is identified with the aid of Deep Learning (DL) and in the second step, distance between the two pedestrian is estimated through image processing techniques. The application can also be configured to calculate the distance using Bluetooth Low Energy (BLE) by calculating its received signal strength. The application demonstrates 85% accuracy on predicting the social distancing and alert the user using beep sound or alert message.

**KEYWORDS**: Data mining techniques ,MachineLearning; Android App Development; Social Distancing.

## I. INTRODUCTION

The COVID-19 pandemic has accelerated the use of aggregated mobility data from mobile devices, although without a universal governing framework for its application. Such data provide valuable insights, but without expertise and diligence it is easy to misinterpret these data, or cause harm, even if inadvertent.As the COVID-19 pandemic continues, the metrics of interest and how they are used will also change. For example, our threshold of an optimal change in radius of gyration in response to a non-pharmaceutical intervention will be different now than when monitoring the same region for spikes in mobility 3 months from now.Coronavirus case was discovered in Wuhan, China.. As a search engine giant, Google launched a COVID-19 portal (www.google.com/covid-19) where we can find useful information, such as coronavirus map, latest statistics, and common questions on COVID-19. In addition to that IBM, Amazon, Google and Microsoft with White house developed a supercomputing system for researchers relevant to Coronavirus. This is the time to turn technology and ensure the cutting edge research in artificial intelligence (AI), Machine learning and health informatics are part of our pandemic response. New wave of investment and research in wake of the coronavirus crisis could spur even more innovation. Numerous new tech companies, universities, and researchers are stepping up to apply AI technology to pandemic response. The proposed system has two methods for monitoring social distancing and alerting the smart phone users. The first method was developed using smart phone camera which will get the feed and processed with on-device deep learning algorithm deployed in the mobile to predict the social distancing. The implementation and result of this surveillance method are discussed in below sections. The second method measures the social distance between two smart phones using Bluetooth Low Energy technique. When the user scan for nearby devices, the Received Signal Strength Indicator (RSSI) value is received during the scan callback. The distance between the other device can b e calculated using the received RSSI value, the formula and algorithm used for distance calculation is discussed in below sections. If the user violates social distancing, the app is designed to alert the users by a beep sound and displaying alert message. The experiment was conducted on various places such as College entrance, Office premises, Government office, Cafeteria andso on. 85% of accuracy is obtained on detecting the real time social distance by these two methods.

## II. PROPOSED SOLUTION

**Fig. 1: The interconnected digital technologies used in the public-health response to COVID-19.**


In this section, three types of techniques are reviewed which is used in the proposed system: (A) Pedestrian Prediction Method, (B) Distance Calculation by Image Processing Method, (C) Bluetooth Distance Estimation Method A. Pedestrian Prediction Method Various methods have been developed by various authors for pedestrian detection in both 2D and 3D image space. Pedestrian prediction using Deep Neural network which can be used in traffic management and to avoid collision in autonomous vehicle. The authors trained the model using monolithic neural network via reverse reinforcement learning. Deep learning based pedestrian trajectory considering the location relationship between the people. The displacement between neighboring frames for every pedestrian in the sequential video frames are calculated. The motion information is encoded using LSTM (Low Short Term Memory) and uses MLP (Multilayer perceptron) to map the location. B. Distance Calculation by Image Processing Method The distance between two objects in 2D image can be calculated by different image processing techniques and mathematical formulations like Euclidean and Manhattan distance formula. The distance of the object is calculated using Euclidean distance between centroid of the bounding box and the camera and they obtained the result with 2.08 average error detect pedestrian and distance estimation using smart phone based thermal cam- era which can run in low light environment. The detector was created using multi-stage cascade learning and distance is estimated by calculating the position of the pedestrian in the 2D thermal image. On their experiment they obtained 92% accuracy indetecting pedestrian and 86% in distance estimation.. They developed latent metric learning method using effective metric matrix. C. Bluetooth Distance Estimation Method Bluetooth low Energy (BLE) is a low cost, lost power portable technology which is growing exponentially. Moving object using BLE. They Received Signal Strength Indicator (RSSI) from the noisy environment and overcome by using Kalman Filter (KF) to smooth the RSSI measurement. The filtered RSSI value is trained by Support vector machine using non-linear kernel function to estimate the distance. The mobile users received limited rate for distance estimation and there is some delay on calculating the distance.

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### III. SOCIAL DISTANCE MONITORING

For social distance two methods are proposed, one is using mobile camera which can process the video frames and calculate the distance. Next method uses smart phone Bluetooth low energy BLE (Bluetooth Low Energy) hardware and calculates distance by its signal strength. Step by step process of both the methods in the below section. A. Camera Surveillance Method The smart phone camera captures the video frames to track the social distancing. Image rendered frame by frame are passed in loop in the image detection algorithm. Image processing are done for noise removal and passed to the pedestrian trained model. The outcome image will draw a rectangular bounding box when any persons are identified in the image. The classified image with person is feed to calculate distance using Euclidean algorithm. The whole working process of the system is explained in the Fig 1. I. Predicting Pedestrian The pedestrian prediction training model is trained by Tensorflow environment. The following steps are required in order to train the model. • Gathering Images and Labeling data • TF Records Creation • Training and Exporting modelFor gathering the data set, the images are downloaded from INRIA Person data set and Penn-Fudan database which different image formats are converted to JPEG format. Maintained 80% of images to training and 20% to test testing folder. The tensor flow needs more number of images in various background to train the model with good precision

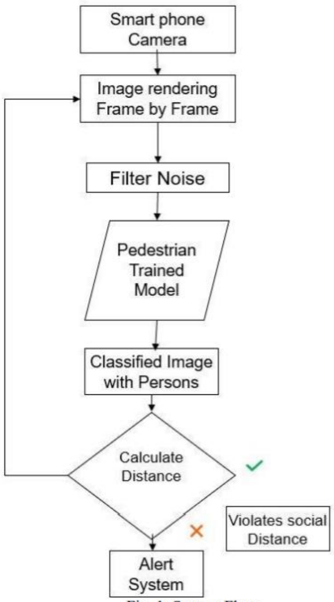

Fig. 1: System Flow

**Algorithm 1** Person Detection Algorithm

**Input:** Test Image from Camera feed
**Output:** Image with person indicators as Bounding Boxes

```
for iterator1 = [ 1: num of frames in Camera Feed] do
  Apply filter to image
  Compute integral image
end for
for iterator2 = [ 1: num of shift steps] do
  for iterator3 = [ 1: num of stages in classifier] do
    for iterator4 = [ 1: num of filters in iterator3]
        Filter Detection
    Accumulate filter outputs
    end for
    if accumulation fails per stage threshold then
    Reject sub-window as Person
    end if
    end for
    if sub window passed all three stages then
    Accept sub-window as Person
    end if
end for
```

After downloading the data set, the labelling of all the images are done by creating a rectangle box on the target object using the tool called labelImg. The TFRecord file is tensor flow format used for storing a sequence of binary records. After labelling process and saving all the image rectangle box as xml file, the tffile are generated for both train and test folder by exporting all the xml files into csv file. With the help of tensor flow api, the csv file is converted into tfrecord file. The transfer learning is used for training the model which is technique of applying already trained model for training another model which can take less time to train and yields better results. For example knowledge gained for

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training cars can be transfered to recognize trucks. The Single Shot Detection(SSD) with MobileNet pretrained model is used to train with COCO dataset called SSD model. Once the model is trained with above configuration, the model is evaluate with COCO evaluation technique by downloading COCO API. Fig 3 is the sample image used for training the pedestrian model. Single Shot Detection (SSD) is the object detection algo- rithm in real time. The Faster R-CNN uses region proposal network to create a bounding boxes and utilize the box to classify object.

II. Calculating Distance

Image of pedestrian detection, the list of bounding boxes that covers every persons are retrieved. With the help of bounding boxes the center point of each is calculated using the top, left, right and bottom pixel values of bounding boxes. Then the center point of each bounding boxes are passed to distance calculation algorithm to calculate the distance between them. From the algorithm two lists of persons who maintain safe social distance and list of persons who are at unsafe distance are derived. For instance, if there is 6 persons bounding boxes in one frame as given in the Fig 4. The first person is compared with remaining all five persons distance. If the first person maintains safe distance, then the point is added in safe list. Followed with second person will be compared with other

**Algorithm 2** Social Distance Measurement Algorithm

**Input:** An array of point (x, y) such that x is the x-oordinate of the point and y is the y-coordinate of the point
**Output:** Array of points with unsafe distance

```
if P.length < 2 then
    return nil
end if
for iterator1 = [P.length : 1] do
    for iterator2 = [1 :< iterator1] do
    D=ComputeEuclideanDistance(P[iterator1],
            P[iterator2]) / AvgPersonWidth
    if (D < safeDistance) then
    addUnsafePair(P[iterator1], P[iterator2])
    end if
    end for
return unsafePair
```

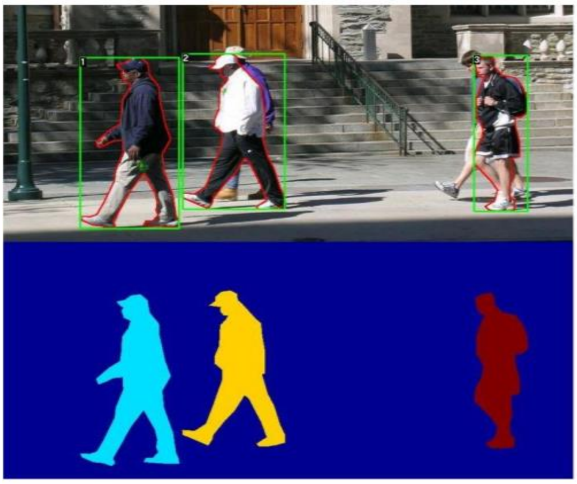

Fig. 3: Pedestrian Detection

## IV. PERCENTAGE CALCULATION

**Algorithm 3** Percentage and Zone Calculation

**Input:** An array of safe and unsafe Points
**Output:** Percentage and Zone of Social Distancing

```
if unSafeList.length < 0 then
  return nil
end if
percentage = calculatePercent(safeList, unSafeList)
if percentage in safeThersold then
  color = Green
else if percentage in averageThersold then
  color = Orange
else if percentage in dangerThersold then
color = Red
end if
```

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Distance of every bounding boxes are calculated, the list of safe and unsafe distance are obtained. The pedestrians who doesn't follow social distancing, the alert window mentioning the percentage of people following safe distance and color indication of zone whether the region is in safe zone area which is likely to safe and danger which means average group will fall under this category and finally unsafe zone where most of the people doesn't maintain social distance are displayed in order to create alertness and awareness to the users. Algorithm 3 explains the algorithm for percentage calculation based on the safe and unsafe distance determined. The app user is alerted by displaying various color zone whether the peoples are maintaining safe or unsafe distance. B. Bluetooth Module Another proposed method of calculating the distance between the two persons using smart phone is Bluetooth low energy technique. When the two persons installed this app with the help of Bluetooth low energy support the approximate distance can be calculated. RSSI (Received Signal Strength Indicator) is the strength of the beacon signal received at smart phone.

## V. IMPLEMENTATION AND RESULT

A. SetUpFor Pedestrian prediction and distance calculation experiments were conducted in Windows 10 machine (2.60 GHz, i7 processor, 16 GB RAM and 2GB Graphics Card) for training the model and exporting the model in smart phone. Following tools like TensorFlow, OpenCV and other libraries are installed for training the model. Once the model is trained and exported to tensor flow lite model with the help of use Android Studio developed the android application. After developing the app it is tested in Android device with Oreo supported. The results of the camera surveillance method are discussed in below sections. For the Bluetooth distance calculation, developed and installed the app in different smart phones with BLE (Bluetooth Low Energy) supported.

C. Pedestrian Prediction Result The TensorFlow lite model is exported for Android mobile app development, with the help of TensorFlow SDK and API the object detection are predicted in live camera feed. Once the persons are identified with their bounding boxes it is passed to distance calculation algorithm module. The Fig 6 displays the persons predicted from the trained model along with the distance calculation determining whether they are safe or risk position. The experiment was conducted with group of people with using the model, it detects the pedestrian with 91% of accuracy. The limitation of using mobile phone camera is that it is capable of only covering small distance.

*D. Distance Calculation Result*

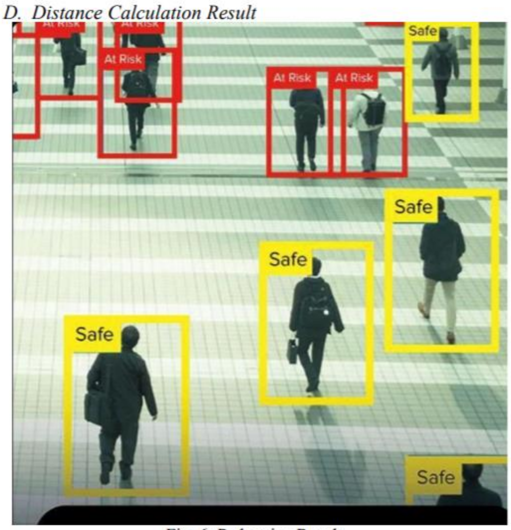


Fig. 6: Pedestrian Result

## VI. CONCLUSION AND FUTURE WORK

The paper presents methods of monitoring social distancing for smart phone users. In surveillance method, pedestrian detection is implemented using deep projectlearning algorithm and distance between two persons using euclidean formula. In Bluetooth distance calculation, calculated the real time distance by receiving its signal strength between two android devices. It is cost effective approach since this system is implemented in mobile app people don'twant to spend cost for other infrastructure for surveillance and monitoring. Developed this model in Android mobile, as a future work it will be extended in iOS environment as well for supporting iPhone users. As discussed, the smart phone camera are capable of covering only small distance, the first approach can be leveraged in all public surveillance camera for social distance monitoring.

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