Artificial Intelligence Integrated Social Distancing Analyzer using Deep Neural Nets

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Abstract—Corona Virus Disease (COVID) has so far infected millions of individuals, claiming the lives of tens of thousands. Italy and the United States, two major international powers, are particularly hard hit, with millions of people dead per day. For nations like India, France, Germany and Spain, Corona has wreaked havoc on the global economy. Throughout the globe, this devastation has been inflicted by this catastrophic virus. After the lockdown limitations have been relaxed, it is necessary to guarantee that social distance is practiced at the locations since no treatment has been identified thus far. After the lockdown restrictions were relaxed in countries like India, where fewer instances were recorded, the nation saw an increase in cases. Implementation of social distancing systems is the topic of this study, which employs sophisticated libraries to keep track of the distance between people in real-time and implement the system. Deploying deep learning and Raspberry Pi, we want to change the system of social distance by using a small number of sensors to acquire real-time data.

Keywords—Artificial Intelligence, COVID-19, social distancing, social distance using deep learning

1 Introduction

Beginning in Wuhan, China in December 2019, the COVID-19 pandemic has spread fast around the world [1]. A pandemic alert was issued by the WHO (Globe Health Organization) in June 2020, and the whole world was left reeling. More than 10,021,000 individuals have been affected by this pandemic, and the virus has killed more than 499,900 people (www.who.int) [2, 3]. In an effort to limit the spread of the flu virus, several nations have implemented social distancing measures such as closing schools, retail stores, and restaurants [4].

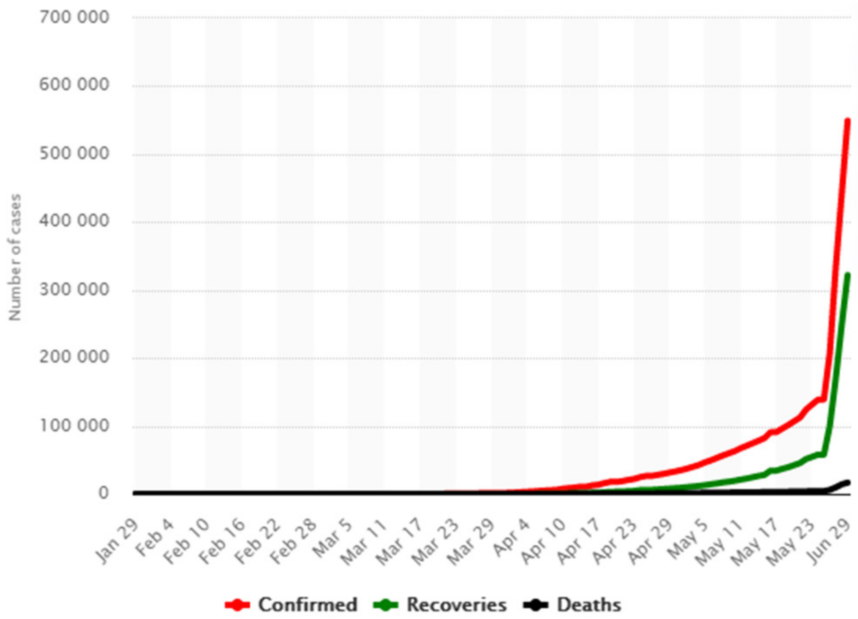

Fig. 1. Elevation records of COVID instances

In the fight against illnesses like COVID-19, which has a direct effect on the respiratory system, each of these procedures might be termed as "social distancing." Lockdowns have been implemented in several nations throughout the world, however, the Netherlands, Sweden, the United Kingdom, and the United States have taken less rigorous steps to separate themselves from society. It's hard to say how long social distance treatments [5] will endure since that we don't have any experience with them. Event attendance is significantly increased by programs aimed at reducing social isolation. It is common for people to fear social engagement when there are no social distancing mechanisms in place [6].

2 Problem towards violation of social distancing

CoV-19 spreads when people come into close touch with each other. When an infected person sneezes, coughs, or speaks, droplets of the disease are dispersed into the atmosphere. The lungs of others may be infected by these little drips. If the infected individual has no symptoms or only has the beginnings of symptoms, it is possible for this to occur.

The virus can't spread as far when people keep a safe distance from each other. This also helps the healthcare system be ready for patients who require care when many individuals do it. Social distance, sometimes known as physical separation, is a public health issue. It integrates is a series of non-pharmaceutical actions or procedures aimed at decreasing the amount of times individuals are in close proximity to one other in order to prevent an infectious disease from spreading. To practise it, one must avoid congregating in big crowds and maintain a particular distance from others (the distance stated varies from nation to country and can alter over time).

It is possible to reduce the spread of illness and the number of people who die by reducing the likelihood that an uninfected person would come into direct contact with an infected individual.

They can be used in conjunction with other measures, such as respiratory hygiene and face masks and hand washing. Several social-distancing measures are used, particularly during a pandemic, to slow the spread of infectious diseases and avoid overburdening healthcare systems, including the closure of schools and workplaces, isolation, quarantine, restricting people's movement and the cancellation of mass gatherings. Loneliness, decreased productivity, and the loss of other advantages associated with human connection can all result from social isolation.

Direct physical contact, such as kissing or touching a contaminated surface, as well as droplet contact (coughing or sneezing) and airborne transmission are the most efficient means of spreading an infectious illness; social distancing strategies are most successful in these situations (if the microorganism can survive in the air for long periods). When an infection is spread predominantly by contaminated water or food or by vectors such as mosquitoes or other insects, the precautions are less successful than in most cases. Since the COVID-19 epidemic, authorities have advocated or legislated social isolation as a key strategy of controlling the spread. When it comes to COVID-19's distribution, small distances are more common than long ones. However, in confined, poorly ventilated spaces, and with extended exposure, it may spread over distances of more than 2 metres.

Distancing tactics stretch back to at least the 5th century BC, even though the word "social distancing" was not used until the 21st century. It is mentioned in Leviticus 13:46, one of the Bible's oldest documented mentions of it. In addition, the plague-bearing leper is to be left alone, and his residence is to be outside the camp. The plague of Justinian in 541 to 542 saw Emperor Justinian impose an unsuccessful quarantine and throw victims into the sea; he blamed the broad epidemic on "Jews, Samaritans, pagans, heretics, and homosexuals" mostly. Several epidemics have been effectively contained with the use of social distancing tactics in more recent times. School closures, gathering prohibitions, and other social-distancing measures were instituted in St. Louis immediately after the first instances of influenza during the 1918 flu pandemic were discovered in the city. More people died in St. Louis than in Philadelphia, which had fewer instances of influenza but allowed a large procession to continue and didn't impose social separation until more than two weeks after its initial cases.

Since physical separation inhibits transmission and there is no stay-at-home order, WHO recommends adopting the term "physical distancing" instead of "social distancing." People can remain socially linked by meeting outdoors at a safe distance and by connecting via technology.

American Centers for Disease Control and Prevention has defined social distance as "methods for decreasing frequency and closeness of contact between persons to lower the risk of disease transmission".

It was during the 2009 swine flu pandemic that the World Health Organization (WHO) defined social distancing as "maintaining at least an arm's length distance from people, and reducing gatherings". "Remaining out of congregate settings and avoiding large meetings, as well as keeping distance (about six feet or two metres) from people when feasible" were the CDC's definitions of social distancing during the COVID-19 pandemic period.

Pandemics can be slowed or even stopped by a combination of social isolation, the use of face masks, proper respiratory hygiene, and frequent hand washing. The spread of infectious diseases is controlled by a variety of social distancing strategies. According to research, effective interventions must be implemented quickly and rigorously.

Avoiding any kind of physical touch at all costs integrated. New Zealand's graphic shows eight alternatives to the traditional handshake, embrace, or hongi; these are all examples of social separation.

When epidemics of infectious respiratory disorders, the risk of infection can be reduced by maintaining a specified distance from each other and avoiding hugs and other physical contact (for example, flu pandemics and the COVID-19 pandemic of 2020.)

In addition to personal hygiene practices, these separation intervals are also advised for workplaces. Working from home is an option that should be considered whenever feasible.

Authorities' recommendations on how far to go vary. World Health Organization guidelines for the COVID-19 pandemic state that a distance of at least 1 m (3.3 ft) or greater is safe. The policy of 1 m social separation was implemented by China, Denmark, France, Hong Kong, Lithuania, and Singapore. 1.4 million South Koreans were re-adopted (4.6 ft). It was agreed that 1.5 m would be the standard for countries in Europe (4.9 ft). Both the US and Canada have adopted 6 feet (1.8 meters). On July 4, 2020, the United Kingdom decreased this to "one meter plus" if additional mitigating strategies like face masks were in place.

A study by William F. Wells discovered that droplets created by exhalation, coughs, or sneezes landed an average of 3 ft (0.9 m) from where they were ejected. The WHO's one-meter guideline is based on this research.

New England Journal of Medicine's research on SARS transmission aboard a flight may have inspired the CDC's adoption of 6 feet (1.8 meters), according to Quartz. However, when contacted, the CDC was unable to give any further details.

Distances of more than 1–2 m (3.3–6.6 ft) have been recommended by some. As many as 7 million SARS-CoV-2 viruses per milliliter can be released into the air during a single minute of loud speaking, a length of time during which many individuals could enter or remain in the region. Sneezing can spread these droplets as far as 7 m or 8 m. Facial masks are more successful in stopping the development of COVID-19 than social isolation.

3 Goals

- To develop and deploy an effectual architecture towards dynamic social distancing for social cause and cumulative performance
- To integrate the Internet of Things and open-source hardware so that real-time analysis on social distancing with Artificial Intelligence can be done.

The custom of shaking hands has been challenged by several different ideas. One non-touch option is the namaste gesture, which involves placing one's palms together, fingers pointing upwards, and bringing the hands to the heart. The WHO's Dr. Tedros Adhanom Ghebreyesus and Israel's Prime Minister Benjamin Netanyahu both advised this handshake as a way to greet visitors at a reception during the UK's COVID-19 pandemic. Additionally, the thumbs-up motion, the "hang loose" sign, the wave, and the shaka (or "hang loose") sign are also options.

As a result of increasing trends such as working from home, online learning, and fewer public meetings at events, the need to travel may be decreasing. During peak hours, traffic and crowds might be decreased as a consequence. As a result, customers are making fewer excursions to the store since they are opting for home delivery of things purchased online. Travel mode may also be affected by a person's social distance. As a means of viral transmission, public transportation should be avoided at all costs [7].

Where it is nearly impossible to avoid making touch with other passengers. Public transportation is the only choice for many people, therefore they should try to travel off-peak hours if they can. Public transportation networks may have a tough time reducing capacity or frequency due to low traffic. For some people, having access to a car means they can "shield" themselves from traffic jams for extended periods [8]. There isn't enough demand for vehicles in the travel industry to justify a large share of the total market share [9].

It is possible to foresee a decrease in driving and a decrease in congestion. For people who are accustomed to taking public transportation, the usage of taxis and ride-hailing services is likely to increase. In addition, walking and cycling can grow, as social interaction during physical transport can be (largely) avoided in the event of short journeys, which is a benefit. Due to the drop in out-of-home activities, people may be calmer while walking and riding [10].

When an individual is suspected of being infectious but has not yet been separated, "social distancing" is used to prevent others from interacting with each other. Distancing people from one other might reduce the spread of respiratory droplet-borne infections. In situations where it is thought that group transmission has occurred, but the linkages between the causes are unknown and constraints put merely on those who are known to have been exposed are not regarded adequate to prevent future transfer [11], social distancing is especially beneficial.

In order to keep the virus from spreading across the community, methods of social distance are beneficial to the individual's well-being. Sports, on the other hand, are popular among those who engage in physical training or other activities that take place outside of the house. Distancing oneself from others might result in a dramatic decrease in physical activity. In order to avoid weight gain in adults, it is recommended that they engage in at least 150 minutes of physical exercise every week [12]. This includes regular, recreational, or practical walking and cycling.

'Community-wide containment' may be essential if these efforts are deemed insufficient. The goal of a community-wide confinement approach is to reduce human connections, save for minimum communication to secure crucial supplies. This is a vicious cycle that starts with social exclusion and culminates with strict quarantine of the entire community. It's far more difficult to implement mitigation strategies for the entire community because of the larger number of people that are affected.

After the lockdown limitations were lifted, the number of confirmed cases in the United States was (68334) lower than the number of confirmed cases before the lockdown limits were lifted (2367064). Since lockdown limitations were lifted in India, the number of confirmed cases (724) was lower than it had been before (490401).

After the lockdown limitations were relaxed, the number of instances has increased. That's because there weren't any safeguards in place to keep social distance in mind. Many countries in the world, like India, have populations that can be as large as the whole continent of Europe in a single state. Look at the statistical analysis of the total number of confirmed cases during and after the lockdown [13] to see how they differ.

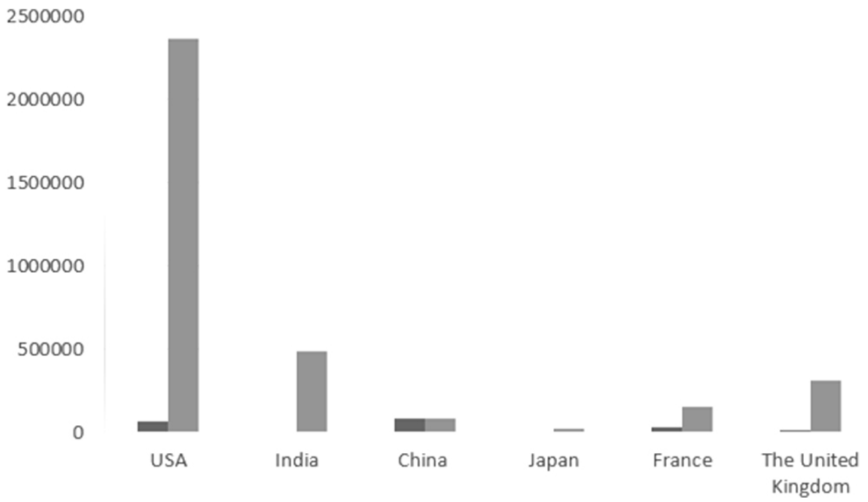

Fig. 2. Effect of COVID in assorted countries

The total number of confirmed cases before lockdown is shown in blue, and the total number of confirmed cases after lockdown is shown in orange, both of which are positioned vertically on the X-axis. In the same way, the name of the nation is also included here for the same reason. According to the data, there were 14 verified instances on the Y-axis.

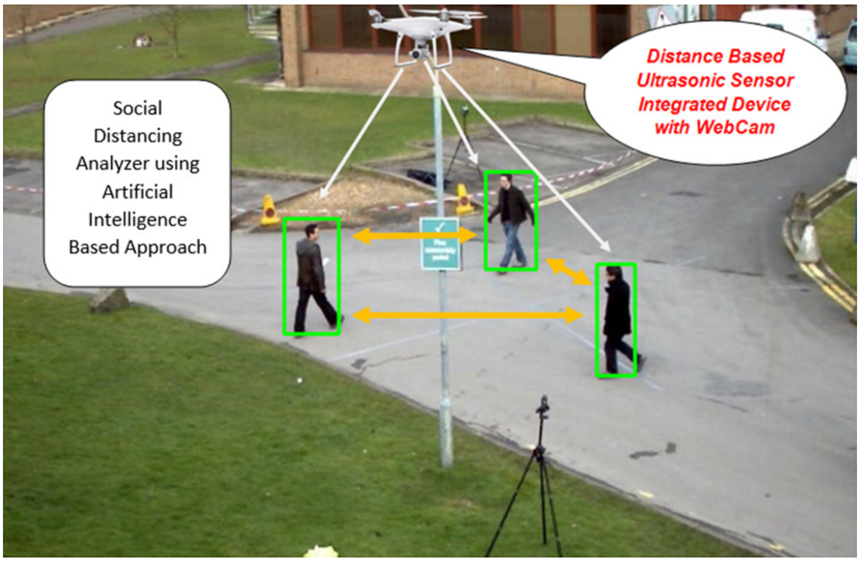

Fig. 3. Model for analyzing social distancing

To observe how quickly overall conformation instances have risen implies that social distancing isn't being properly implemented in the nations based on these numbers. The information presented here was gleaned from WHO reports [14, 15].

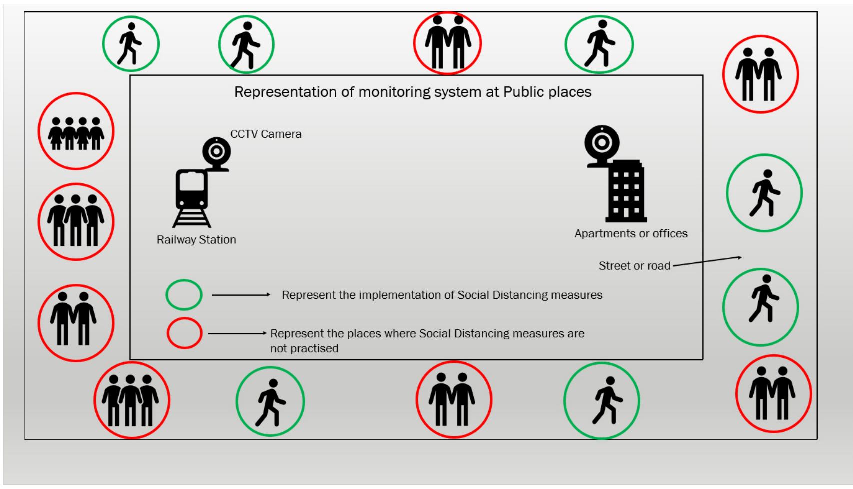

Fig. 4. Model for analyzing social distancing

Second, social isolation. The Raspberry Pi and Deep learning have changed the monitoring system [16, 17]. There is a need for technology or some other system that can detect social distance and emphasize [18, 19] the person in the video if it is not being followed, as stated above.

4 Methodology

It is possible to identify a person or group of individuals using a camera and the power of deep learning in any location. As soon as calculation results are created using the input image, the software displays the precise conclusions concerning when and where the social distance is not being respected [20–24].

Following is the flow diagram of the projected approach

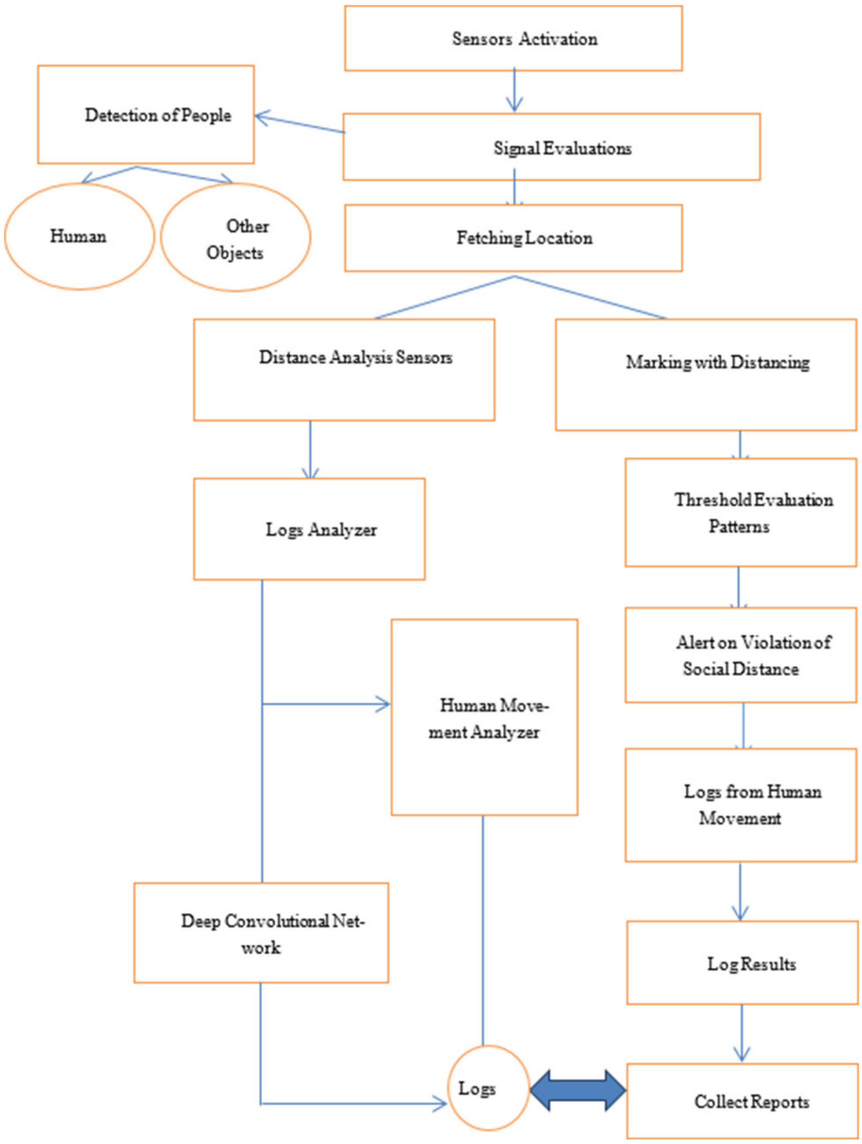

Fig. 5. Flow approach towards projected integration with Artificial Intelligence

Input images or video frames are placed into the system as shown in Figure. To begin, items are recognized and categorized as "people" using Deep Learning and Raspberry Pi. Once this is done, we can figure out how far apart the pairs of centroids are. Once the distance between the centroids has been correctly determined, we validate the distance between people using specific validation factors.

5 Results

The integration of Open Source Hardware with Deep Learning is presented so that the dynamic view on social distancing can be analyzed. The results and analytics are integrated with open source programming frameworks for a higher degree of effectiveness and compatibility.

The system generates the final findings if the validations are successful.

Below is the line of code –

```
# loop over each of the layer outputs
for output in layerOutputs:
    # loop over each of the detections
    for detection in output:
        # extract the class ID and confidence (i.e., probability)
        # of the current object detection
        scores = detection[5:]
        classID = np.argmax(scores)
        confidence = scores[classID]
        # filter detections by (1) ensuring that the object
        # detected was a person and (2) that the minimum
        # confidence is met
        if classID == personIdx and confidence > MIN_CONF:
            # scale the bounding box coordinates back relative to
            # the size of the image, keeping in mind that YOLO
            # actually returns the center (x, y)-coordinates of
            # the bounding box followed by the boxes' width and
            # height
            box = detection[0:4] * np.array([W, H, W, H])
            (centerX, centerY, width, height) = box.astype("int")
            # use the center (x, y)-coordinates to derive the top
            # and left corner of the bounding box
            x = int(centerX - (width / 2))
            y = int(centerY - (height / 2))
            # update our list of bounding box coordinates,
            # centroids, and confidences
            boxes.append([x, y, int(width), int(height)])
            centroids.append((centerX, centerY))
            confidences.append(float(confidence))
```

Fig. 6. Line of code to validate the distance between centroids

Once the above code is executed successfully, the results are displayed as

Fig. 7. Plotting analyzer with A.I. on social distancing

People that don't use social distance had their centroids and circles colored red, according to the research. Distancing yourself from others has become more commonplace as seen by the green centroid and surrounding circles.

The figure displays the social distance measurement in relation to the real-time items in the vicinity of the diagrammatic view. Using this method, everyone who approaches from beyond a predetermined distance is detected and tagged. Social distancing measurement and analytics benefit greatly from the technique that has been described.

Fig. 8. Dynamic analyzer of social distancing with deep neural nets

Real-time study of dynamic social distancing methods will be extremely beneficial to the users or authorities depicted in Figure. According to the data above, the system does count the number of heads that are not separating themselves from each other. Such centroids will be highlighted in red and authorities will be informed if the social distancing is not followed in these areas.

6 Conclusion

Social distancing is implemented in real-time utilizing complex libraries that are necessary for real-time implementations of distance tracking. Deep learning and the Raspberry Pi are being used to gauge the distance between people in social situations. The Social Distancing may be used to implement the Raspberry Pi-based solution in addition to Arduino. Mistakes such as not adhering to social separation can lead to mass human deaths. People who aren't following social distancing might be limited by government restrictions. In this section, manual monitoring of people cannot guarantee 100% accuracy in social distancing measures. The social distance monitoring system with real-time centroids tracking can address this shortcoming. Because it requires so little effort, the technology eliminates the need for manual monitoring, in which an official observes how far a person is physically separated from others in social situations. The system is adaptable enough to meet the needs of the project, and only minor adjustments are necessary for maintenance. The traffic camera may be used to obtain and monitor the results of the system's code, which can be centralized on a computer or server. By eliminating the need for additional hardware, this solution is both more affordable and less expensive.

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