

# Studying the effects of corona and the proposed methods for monitoring social distancing using artificial intelligence: a review

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**Abstract:** Since its appearance, the Coronavirus has affected millions of people all over the world, and the number of people infected with it has increased with the emergence of new waves of it. The Corona epidemic is one of the few viruses that the world has not yet been able to completely resist, so most countries have used different solutions to reduce its spread. All society must adhere to preventive measures, including wearing masks, not shaking hands, and adhering to social distancing among themselves, because it is one of the most important solutions to confront the emerging virus. Several systems that use artificial intelligence and deep learning in various aspects of life have been developed in the past and are now being exploited and developed more to confront the virus. This review paper presents how that can track and monitor people using artificial intelligence and deep learning, which includes monitoring and detecting people as well as measuring the distance between them to find out their social distancing using deep learning, and using computer vision. The distance between people had calculated to know that they are maintaining a safe distance between them using the social distancing detection tool by analyzing images and video streams in real-time from the camera to ensure adherence to social distancing in public places. In short, deep learning techniques with computer vision are studied and some of their algorithms that have been applied to social distancing protocols are presented in our research paper.

**Key words:** *Coronavirus, Social Distancing, Deep learning, R-CNN, YOLO.*

## 1. Introduction

Mankind, throughout the ages, has faced various disasters and diseases, and almost every century there is an epidemic or disease that spreads on the globe, which makes the focus of scientists to find different solutions to control the spread of epidemics and find a vaccine and treatment for them. In the 21st century, specifically in early December 2019, the Coronavirus appeared, which began in the Chinese city of Wuhan, and the World Health Organization announced on January 30 that the virus had spread widely and declared a public health emergency [1,2]. This disease has infected 141 million people registered as patients with 3 million deaths in 200 countries, according to figures issued on April 18, 2021, by the World Health Organization [3]. The number of patients is increasing due to the lack of a cure for infection or a vaccine that prevents infection definitively, despite the continuous attempts of doctors and health care organizations to find an effective treatment and its official approval. As a result of all these things, governments around the world were forced to find effective solutions that give good results and can be applied in different countries, and one of these solutions, in addition to wearing a mask, is social distancing, which has proven its effectiveness and the need to adhere to it to prevent the transmission of the disease. According to the guidelines of the World Health Organization, the distance between one person and another is at least 6 feet (1.8 meters) and this is considered the safe distance that must be adhered to [4]. Many studies, such as [5,6,7] have shown the effectiveness of social distancing in reducing the spread of infectious diseases such as Covid-19. The Fig. 1

shows the relationship between reducing the rate of infection spread while adhering to social distancing measures [8,9]. Among the social distancing measures that governments have used are banning movement, controlling and closing borders in some countries, closing public places and even schools, and obligating society to maintain a distance of 1.6 to 2 acquaintances [10], but on the other hand, monitoring these measures faces a challenge Difficult as people need to go out to get their basic needs such as food, treatment, and other activities. As a result of all these difficulties, there has been a tendency to turn to technology and the use of technologies based on it[11,12], as well as the use of artificial intelligence in diagnosing the patient and locating the patient and others to help health and medical communities in dealing with COVID-19 [13,14,15]. Studies and experiments have proven the effectiveness of computer vision, as a branch of artificial intelligence, in detecting and identifying people to monitor the social distance between them.

This article presents some methods and algorithms that have been used to monitor social distancing and the extent of society's commitment to it. Most of these methods depend on Artificial Intelligence AI.

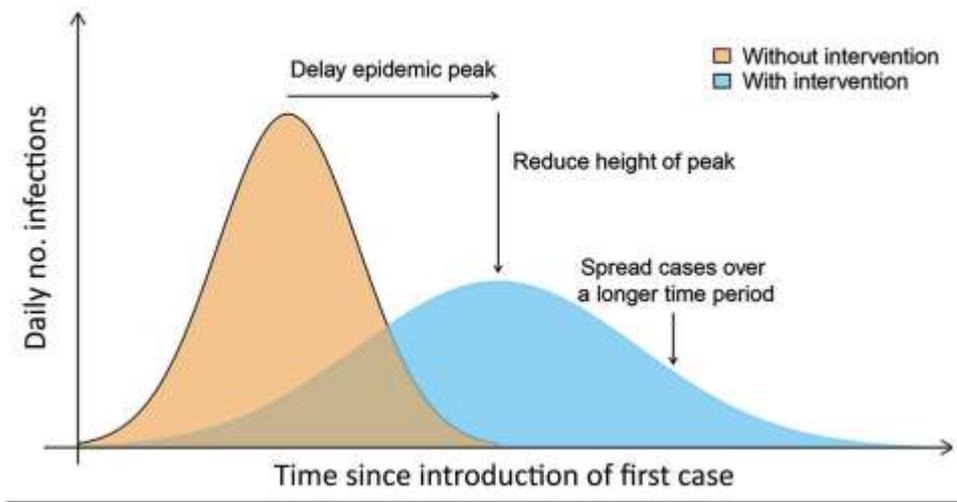


Figure 1: The impact of social distancing on the spread of COVID-19[8].

### 1. corona and its impact on society

Coronavirus, which is also called Covid-19, is a respiratory disease whose symptoms are fever, cough, and sore throat, in addition to difficulty breathing and affects the health of the individual in general. The measures to contain the virus pose a challenge to society, as it is based on social relations, communication, and visits between people, but the measures of social separation and isolation have greatly affected these relations, and the interruption of these relations leads to loneliness, anxiety, health problems and other matters that affect the People, their lives, and society in general, and this is one of the side effects of isolation [16]. Corona has affected various aspects of society's life, such as the economy, education, the medical field and its devices, and even studies.

#### 1. The impact of COVID-19 on the economy

The Coronavirus caused disruptions in the global economy on a very large scale that it had not witnessed before, as it did not only cause deaths and injuries, meaning that its impact was not limited to human health only [17]. The economies, no matter how developed or in the stage of growth, small or large, have been exposed to danger due to the virus and are still suffering so far because it is not known when this epidemic will end, so solutions must be found from now and we should not wait until the epidemic ends because it will have already It is too late for the economy to reach a recessionary stage [18]. Companies have worked from home as a result of implementing the social distancing imposed by governments and the danger of roaming, as it is the only solution to confront Corona, especially at its inception and the beginning of its spread, as there is no treatment or vaccine. Before the epidemic, the focus was on increasing and maximizing profit by economic organizations, but in light of the outbreak of the epidemic, the focus became on business continuity. Companies tended to find the latest solutions to continue their work and not to collapse the economy further, and among these solutions are the use of artificial intelligence and the adoption of analyzes and business intelligence [19]. Two researchers suggested the use of business intelligence BI and that it can help in auditing and tracking the virus, as it can be used to know the sick people and when they traveled to implement best practices by administrative decision-makers [19]. On the other hand, dealing in cash has become one of the causes of disease transmission, so it has become necessary to rely on non-contact banking services as well as non-cash transactions to enhance social distancing between people [20]. One of the solutions that have been proposed to this problem is the use of FinTech, which provides financial solutions through the use of technology, which is a short form of business technology, while RegTech is intended for technological solutions that lead to the improvement of organizational processes. The researchers also referred to relying on contactless payment to adhere to social distancing, where shopping and payment are done via the Internet, and even if this method faces some challenges, it is considered the safest way to confront Corona and not contact between people [20].

#### b Corona's impact on education

One of the important aspects of life that have been greatly affected by the epidemic is education. To limit the spread of the virus, colleges, schools, institutes, and other educational institutions have been closed in many countries. As of March 25, 2020, 150 countries closed various educational institutions in the country, and this affected more than 80% of the number of students in the world [21]. As a result, universities were forced to close and postpone all campus activities, transfer education via the Internet, and dispense with face-to-face teaching [22,23]. One of the challenges faced by online education is that some students do not have access to equipment and the Internet to receive education, in addition, that some teachers do not have sufficient experience to deal with technology, but there is no alternative to this method because it is the best way to prevent the spread of the virus and to implement social distancing [24]. The epidemic has forced educational institutions to adopt and invent new methods of education and development of methods based on modern technology, especially in South Asia, because if the epidemic did not exist, they would not have turned to these methods until after 5-10 years [25].

## Corona's impact on the field of medicine and medical devices

Doctors and health workers are the most vulnerable to infection with the virus because they are close to patients where they take care of them and often cannot adhere to social distancing, in addition, that, there is a shortage of medical equipment and protective equipment that doctors must wear while working, especially in developing and crisis-stricken countries [26]. Therefore, it is necessary to use technology-based methods of prevention that promote social distancing in the health care sector. The coronavirus has given a powerful incentive to find and use telehealth [27]. One of the suggestions was to make human-friendly robots that are used during isolation in care homes, especially the elderly so that they do not feel lonely and this affects their general health as well [28]. The other problem that faced the medical field is the lack of some medical devices, the most important of which is the ventilator, which has faced a great shortage and is used by the patient when his condition is severe and he is unable to breathe normally alone, so the device is used to make artificial respiration for him, and it is one of the most complex devices in the medical field [29]Figure 2. The great challenge for the medical field was that the number of ventilators supplied to hospitals is very few compared to the number of cases of infection that need to be used [30].

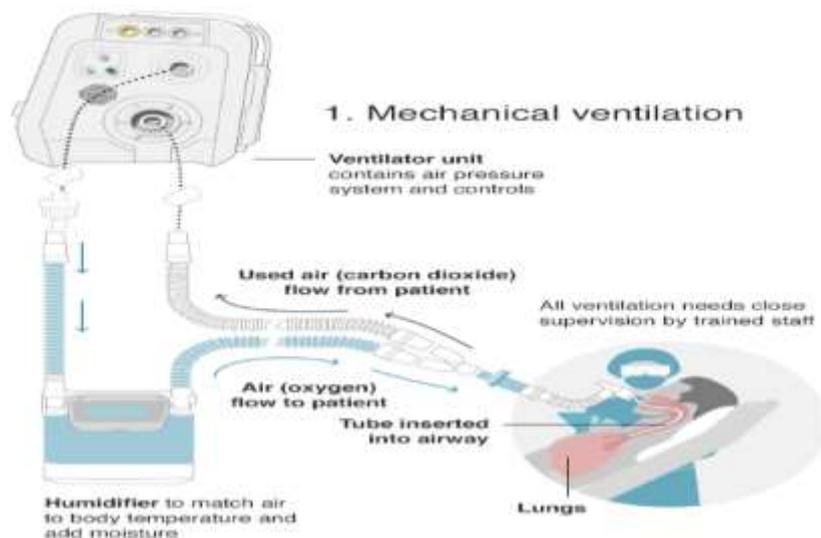


Figure 2: Illustration of a ventilator performing the breathing process of a patient[31]

Due to quarantine and social distancing measures that oblige factories to employ a small number of workers and adherence to preventive measures inside factories, the production of these devices has led to a slow and slow production. In the category of industrial robots, there is the cooperative robot or kobot, which is one of the latest devices in this category [32], which was suggested to be used by some researchers through a published research, where they showed how this type of robot can be used in the production process of ventilators to comfort the human being and produce the largest possible number while adhering to social distancing measures [33].

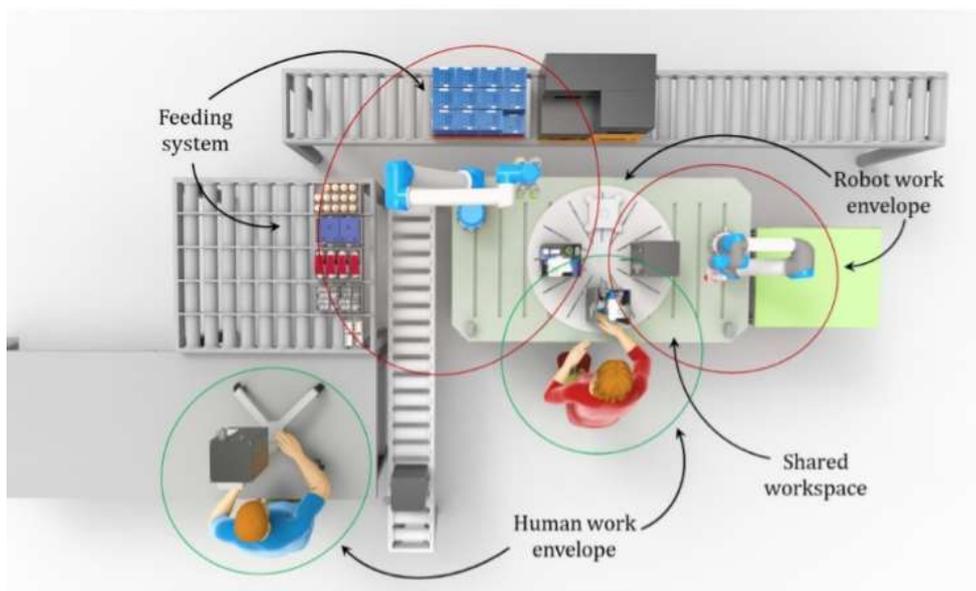


Figure 3: Schematic diagram of a robot assembly system that produces medical ventilators[33].

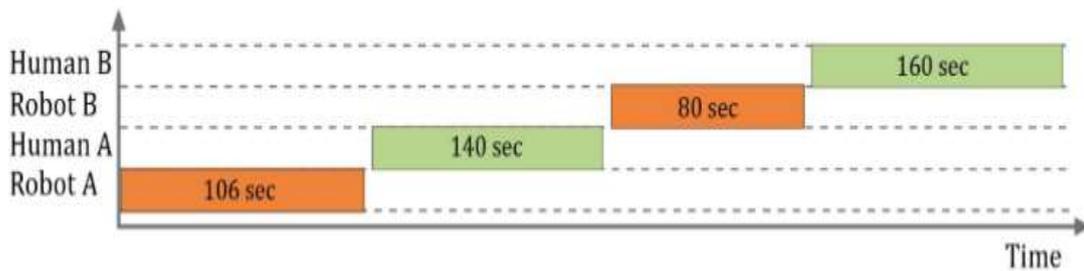


Figure 4: The time it takes to produce one unit of the ventilator[33].

### 3. Social distancing and ways to monitor it

Social distancing is about separating people from each other and in different ways of staying away, this is the main goal of it. Social distancing proves its effectiveness every time it is applied and in different countries and environments, as adherence to it reduces the number of virus infections, and also the other positive aspect of it is the possibility of continuing life, such as continuing to open markets and other public places, but severe distancing must be adhered to inside it, so that governments do not have to shut it down permanently and life becomes paralyzed [34].

Modern technology has been widely used to facilitate monitoring of spacing in various places, to know the extent of compliance with it, and to warn people who do not adhere to this mandatory procedure.

In order for social distancing to be monitored, people must first be detected and know their presence or not so that the distance between them is measured. There are many algorithms in this field that are within the field of computer vision with image processing and deep learning, among these algorithms are R-CNN, SSD and YOLO with their various versions [35].

a. R-CNN : This method was proposed by a group of researchers, who noticed that the results of object discovery had become stable in the years prior to their proposal, so they tried to find a new way to detect objects. Their method is a scalable algorithm, which is why Fast R-CNN and Fast R-CNN have emerged. The method is called R-CNN, i.e. regions with CNN features, because it combines CNN's convolutional neural networks and source proposals [36].

R-CNN is one of the reagents in which the classifier works on the principle of region proposals represented by boxes surrounding the detected object [35].

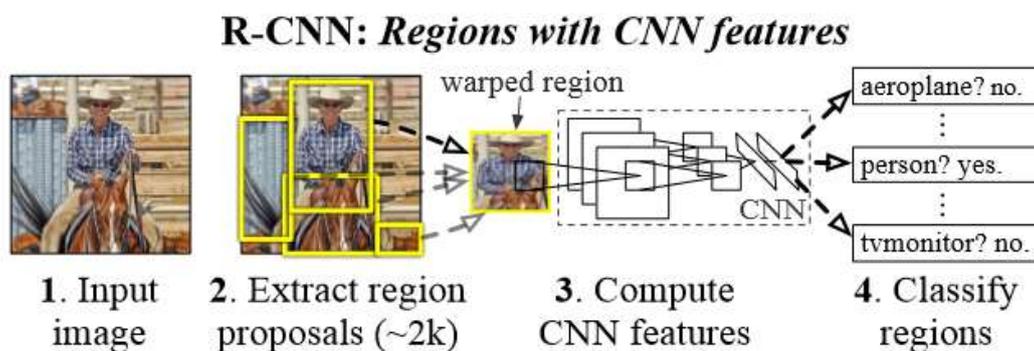


Figure 5: General diagram of the R-CNN object detection[36]

Fast R-CNN : It is the type developed from R-CNN, where the speed of training and testing has been increased, which has led to an increase in detection accuracy, using many innovations. The training speed became 9 times faster, and the test speed was 213 times faster [37].

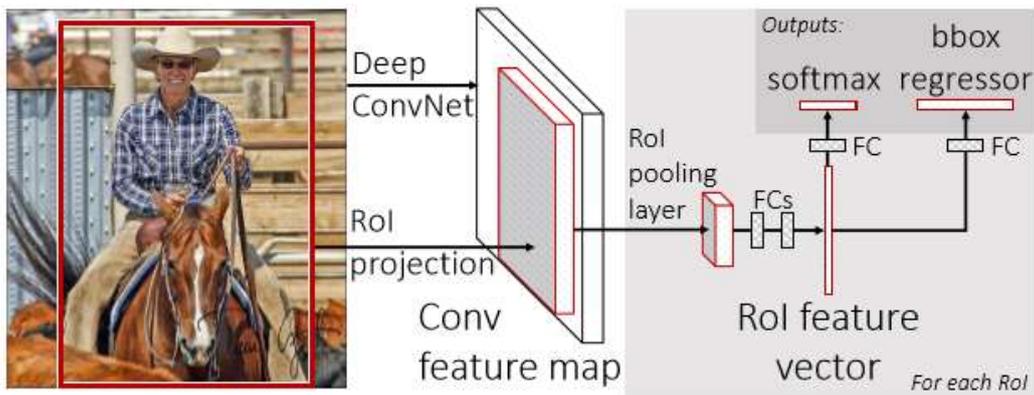


Figure 6: Fast R-CNN architecture[37].

🌟 **Faster R-CNN** : It is an advanced network algorithm for R-CNN that has been proposed by researchers at Microsoft. This type is after a simple optimization of a FAST network with Rpn which is a professional area convolutional network[38]. Due to the results and usefulness of this algorithm, it has been proposed to use it as a method for detecting faces through training [39]. This algorithm represents the fastest method in R-CNN detectors, which is based on the suggestion of the region within the field of deep learning. A system has been proposed to monitor social distancing in which Faster is used by Imran Ahmed and other researchers, and this system consists of two parts: the first is to detect the presence of people, and this is done using the Faster model, which is previously trained for human detection, but here it is also trained on upper vision and a set was used Data for this purpose and then the new data is merged with the existing data. As for the second part, it is monitoring the spacing and using the bounding squares information that was found in the first part of the system, where the Euclidean distance between them is measured. After obtaining the distance, it is compared with the specified distance and by using the pixel-to-physical approach to determine whether or not the social distance has been exceeded, and they have shown that the accuracy may reach 96% [40].

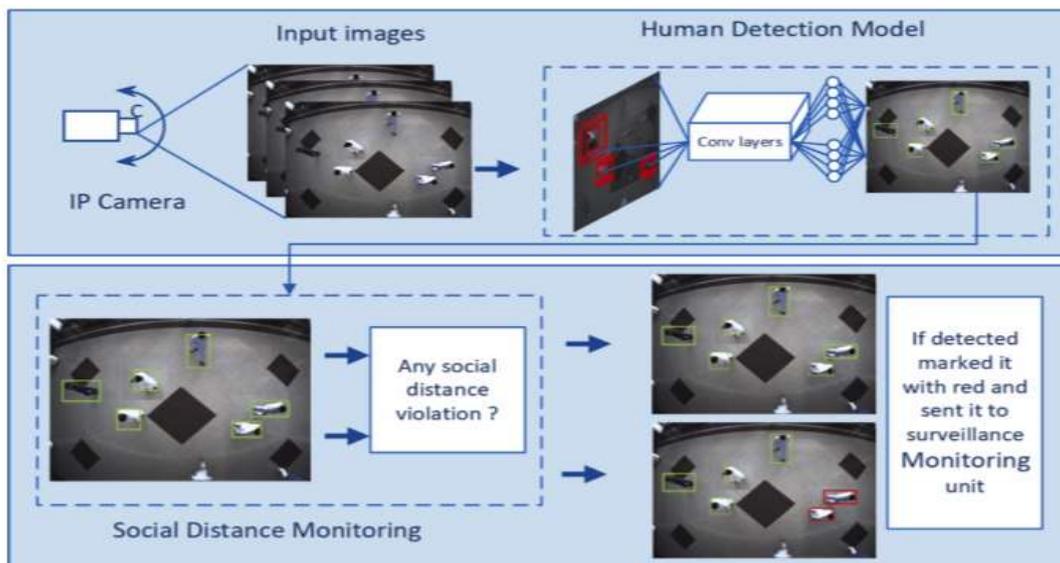


Figure 7: Overview of the framework used to track social distance using a top-down human data collection. Human detection and social distance monitoring are the two components that make up the total system[40].

b. **YOLO (You only look once)** : It was proposed by Joseph Redmond and other researchers in 2016 and is one of the latest algorithms in the field of deep learning that is used to detect objects in real time. Probabilities are directly rated and bounding boxes are placed from whole images by a single neural network and in a single evaluation[41]. After that, it was developed into several versions, including:

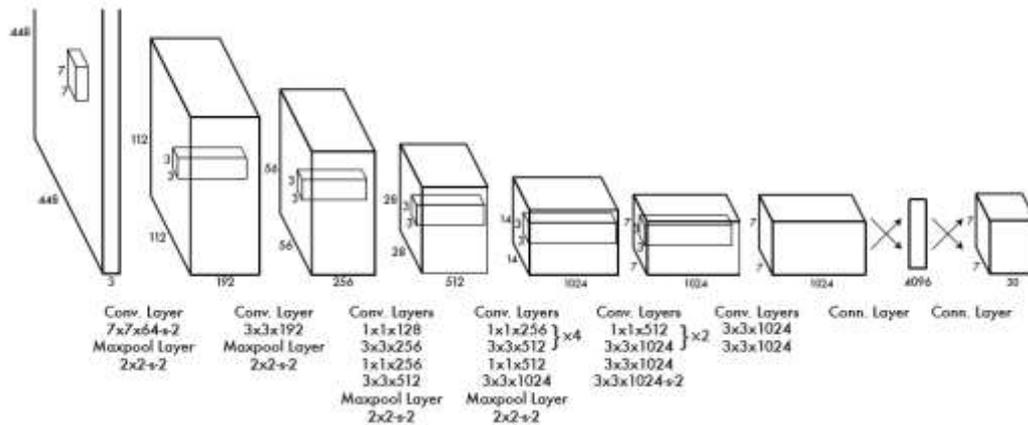


Figure 8: The architecture of YOLO[41].

YOLO v2 : It is the upgraded version of YOLO that detects more than 9,000 classes of objects in real time, so it is sometimes called YOLO9000. YOLO v2 can operate at different sizes using a new multi-scale training method[42]. The first reason for the transmission and spread of the Corona virus is close contact between people, so it is necessary to adhere to social distancing. A system has been proposed to monitor social distancing and detect people using YOLO v2 technology. The proposed system is based on thermal images that are taken by thermal cameras, and people are detected using the deep learning theory YOLO v2, and after detecting people, an algorithm is used to measure this distance to find out whether people are committed or not, and this system can also analyze the temperature of people. The researchers explained that the results of their system give better performance compared to other real-time object detectors [43].

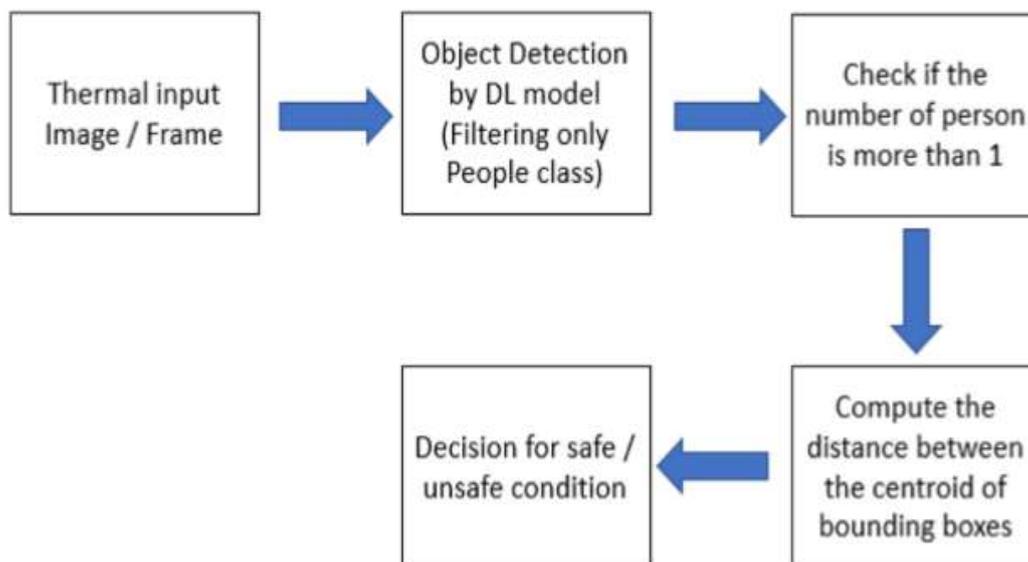


Figure 9: Steps to discover people and classify social distancing on thermal images[43].

YOLO v3 : It is the third upgraded version of YOLO. The two researchers made changes in the design and showed that they were small changes, but they made it better. Compared to its predecessor, YOLO v3 has become larger and more accurate. The accuracy of YOLO v3 is similar to that of SSD, but three times faster, according to the researchers [44]. One of the proposed systems for detecting social distancing in which YOLO v3 was used is a video frame-based system that serves as an input from the camera. The distance is measured through the 2D plane where the video frame is converted into a top-to-bottom view. A recorded video clip of pedestrians walking in the street was used to verify the validity of the proposed method, and through the results it was found that the proposed method is capable of determining social distancing measures between people [45].

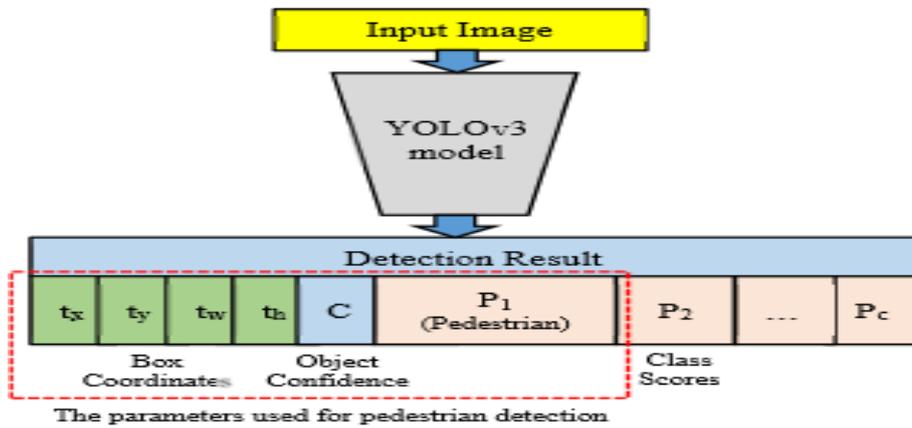


Figure 10: Scheme of the YOLO model that has been implemented[45].

Another proposed system for detecting social distancing in which YOLO v3 has been used is to create an app to monitor people and notify officials when people are not complying with COVID-19 safety measures in public places and workplaces. People are detected in the app by YOLO v3 and the spacing is measured by calculating the Euclidean distance between the squares centers of the detected people. This app is called "Stay Safe" and is developed for the Android operating system [46].

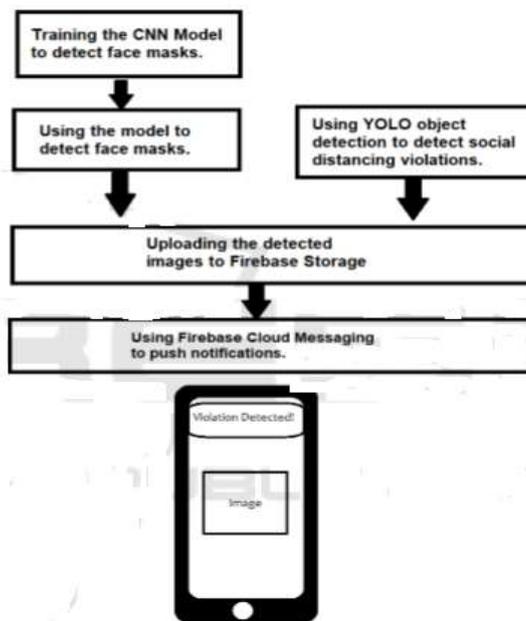


Figure 11: Scheme of the proposed system for the application "StaySafe"[46].

YOLO v3 was used in another proposed system that uses the top view to measure social distance from a distance, and in this proposed system, as far as scientists know, it is the first attempt that used the transfer learning method to strengthen the performance of the model that was previously tested, and a newly trained layer is attached to an overhead data set. . Using the Euclidean distance, the distance between the center coordinates of the squares surrounding the detected persons is measured by approximating the physical distance in pixels and a threshold is determined. The Violation Threshold is then used to check whether the specified social distance has been violated. The accuracy of the model tracking is 95% [47].

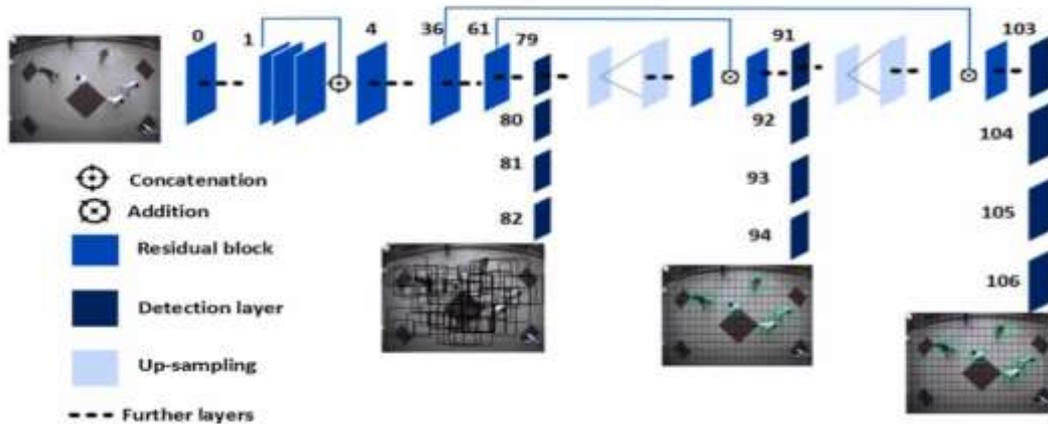


Figure 12: General architecture of YOLOv3 was used to human detection for top-view[47].

YOLO v4 : It is the modern and upgraded version of Yolo. It is an advanced detector and is the fastest in terms of FPS and the most accurate in the detection devices available. It can be used on a large scale because it can be trained and used on a traditional GPU with a RAM capacity of 8-16 GB[48].

A system was proposed to detect social distancing between people, as well as detection for wearing masks, and the YOLO v4 detector was used for real-time detection in video and photo clips, using the principles of optics. The relative distance between individuals is estimated through the coordinates obtained by the detector. This system is lightweight, easy to calibrate, and gives good results, as the researchers explained that the average accuracy of their system was 94.75% with an inference speed of 38 frames per second on the video [49].

YOLO v4 has been used in another system to monitor social distancing. The proposed system here provides a solution to the problem of monitoring the spacing in dark environments, because one of the difficulties encountered in monitoring the implementation of the spacing is at night and dark places. The proposed surveillance system is based on training YOLO v4 on the ExDARK data set with the use of a ToF type camera and it is fixed to monitor people at a distance installed on the camera and the resulting distance is shown in real world units. The researchers suggested using the COCO detection scale to evaluate a solution to the proposed YOLO v4 program for monitoring distance in real time and it shows good performance with an average accuracy (mAP) of 97.84% and the mean error between actual and measured (MAE) for social distance values is 1.01 cm[35].

c. Other algorithms have been used to monitor social distancing

- A spacing monitoring system based on Conv. Neural Network (CNN) detectors [50,51], which is one of the deep learning detectors in a real-time environment, has been proposed. The sliding window method was used by the complex network to detect people. The result of the human presence detector is then used to measure the distance between the people who were discovered and to identify the people who exceed the permissible distance in red. Through experiments, the researchers showed that the results they obtained through CNN detectors are better than others at the time of their work in terms of accuracy with the presence of some false positives when the video sequences in real time [52].

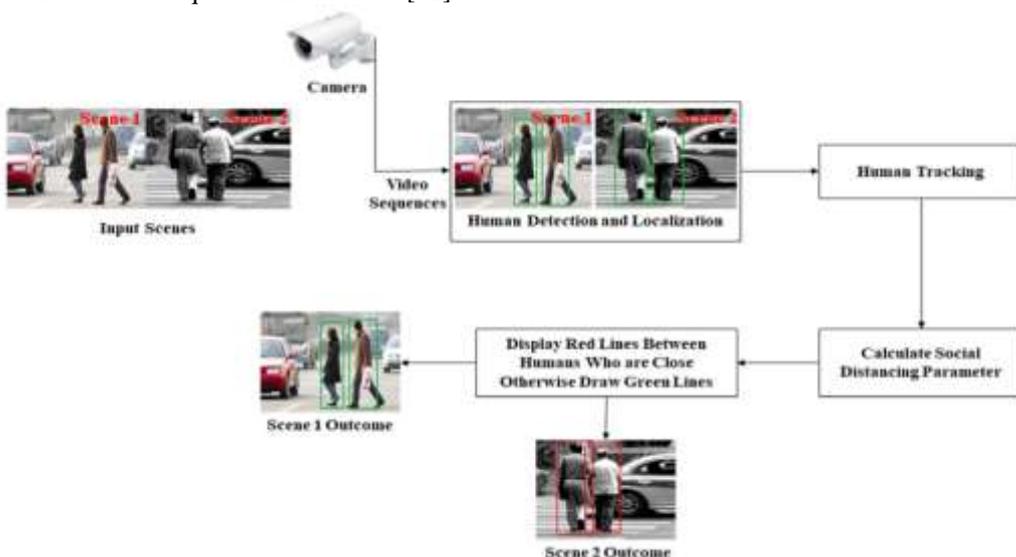


Figure 13: A complete diagram of the proposed system used to detect social distancing[52].

- In another system, Single-Shot Multibox Detector (SSD)[53] algorithm was used to detect people and OpenCV[54] library for image processing. After discovering the people, the distance between the center coordinates of the people who were discovered is calculated and then compared with the fixed pixel values. In the event of an unsafe distance, alerts can be issued to maintain the permitted distance. One of the problems faced by this system, according to the researchers, is the difficulty of correctly detecting people in the external environment and distant scenes [55].

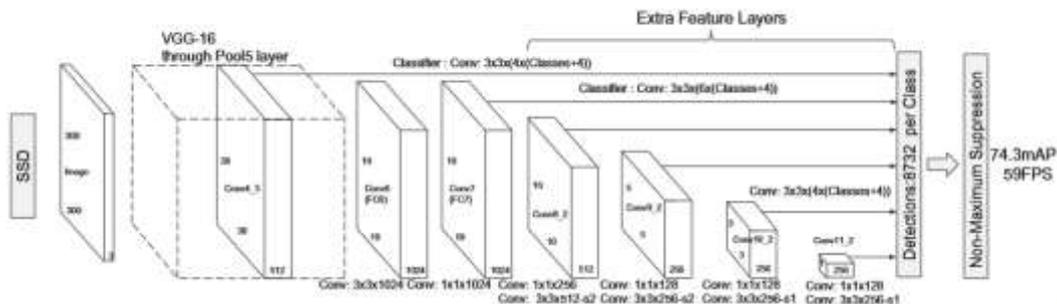


Figure 14: The architecture of SSD[53].

- The proposed system calculates the distance to measure the extent to which social distancing is applied on the campus. A system has been proposed based on the distribution of entry permits to students, which is a mobile nodes within the university campus. BLE packets are used to calculate the social distances between students through the nodes they carry, and the data is collected over a wireless network that is LAN and sent to the monitoring server and the network covers the campus. The program was partially implemented using M5 StickC, and baseline assessments of BLE connections between nodes were conducted[56].

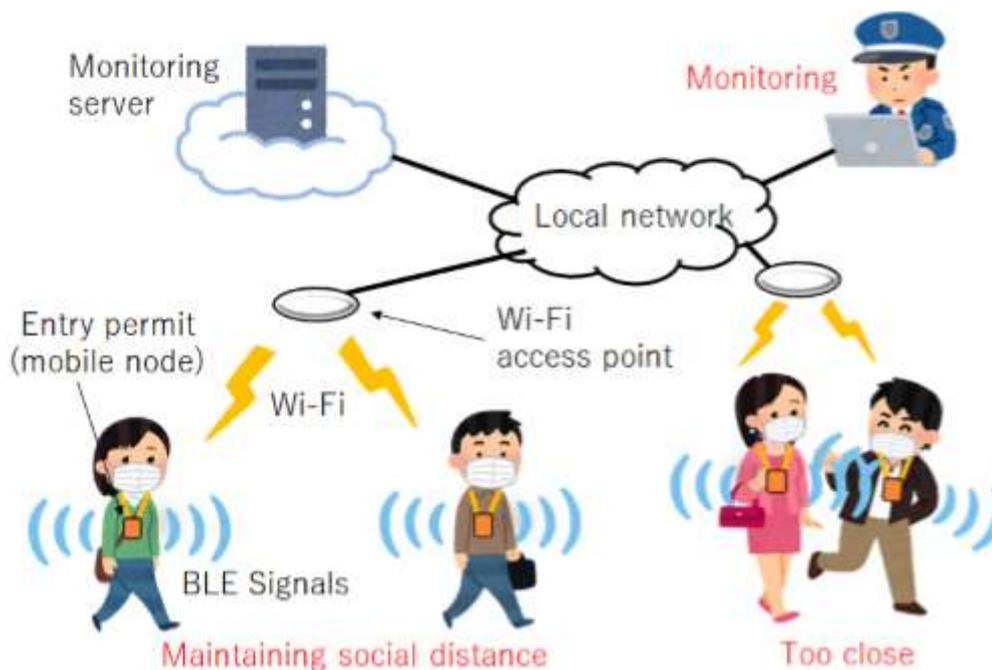


Figure 15: General outline of the proposed system[56].

- In order to create a safe place that contributes to public safety, the researcher suggested building an effective system in which it relied on computer vision and MobileNet V2 architecture to discover the social distancing of people in real time by focusing on automated monitoring in public places. The proposed model has been implemented on the Raspberry pi4 to monitor the activity and detect if there is a distance exceeding through the camera. If there is a violation of the permissible distance, it sends an alert

signal to the control center in this system. Engineering techniques are mixed with the modern deep learning algorithm in order to build a powerful system .It covers three aspects of detection, tracking and verification[57].

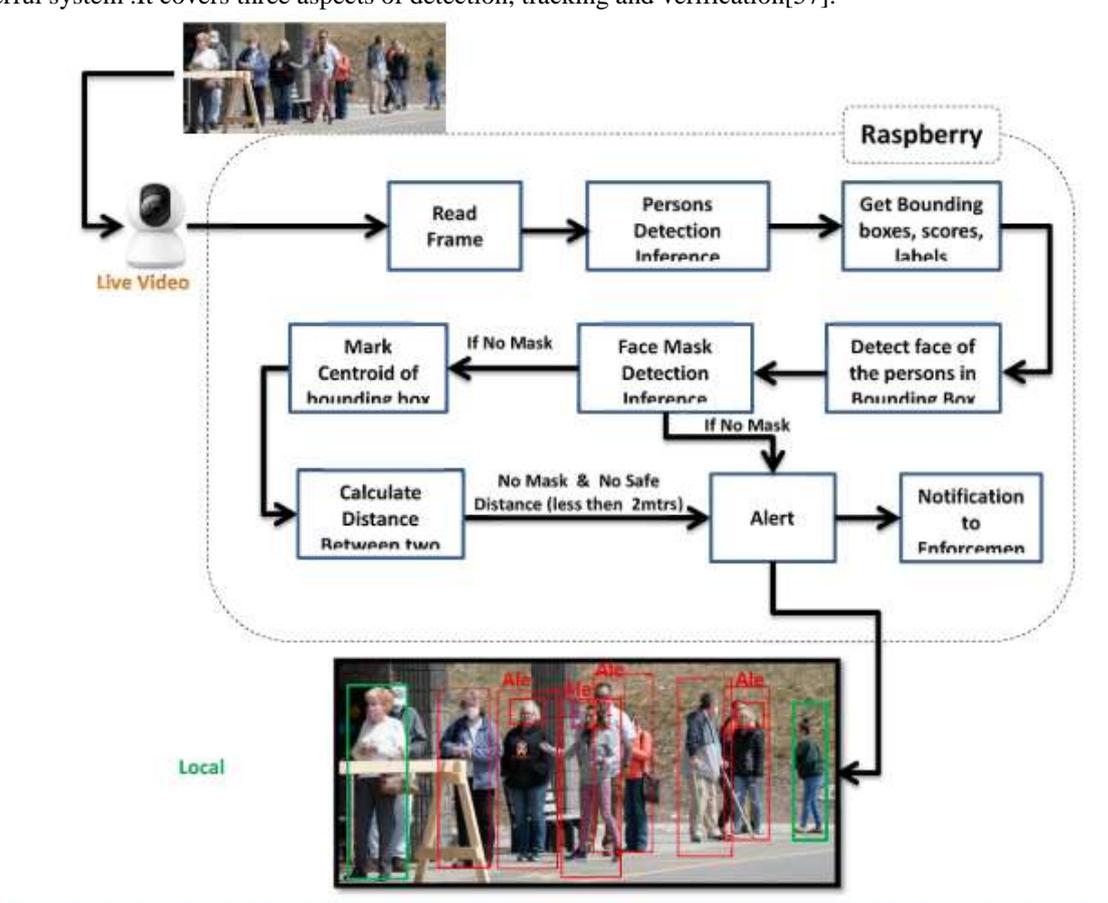


Figure 16: Architecture of the proposed system for social detection[57].

- The researchers proposed a system that uses CCTV cameras with the development of a deep neural network system to calculate the distance between people and automatically detect them in crowded places. The proposed people detector is called Deep Social, and it uses CSP DarkNet53 as a backbone, next to it, SPP/PAN and SAM are used as necks. The activation function is Mish, and the loss function is based on the complete IoU. All this was done to develop a system for detecting people that is able to work in different conditions such as different levels of light, obstruction, shadows and partial vision[58].

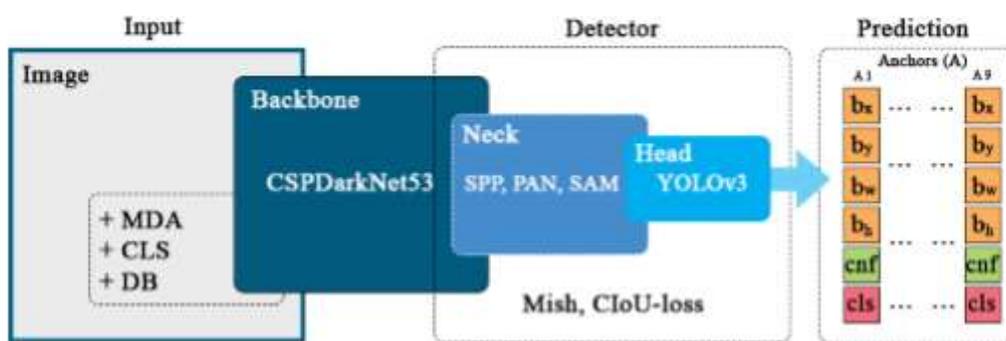


Figure 17: The structure of the proposed 3-level human detection system[58].

**Conclusion:** This paper discussed about the Corona virus and the most important proposed solutions that were used to fight against it, the most important of which is social distancing. We have described the effects of Corona on some important aspects of life, which are the economy, education and the medical aspect, and we have presented some solutions proposed by researchers in various research papers, some papers have provided solutions based on artificial intelligence to help in the medical aspect. We then discussed the importance of social distancing and briefly described various research papers that presented methods based on image processing and computer vision to determine social distancing using images or video feeds. We also introduced monitoring methods and their

integration with artificial intelligence and deep learning model. In the last part, we discussed the R-CNN and YOLO algorithms and some other algorithms used to build systems that can be used to monitor distances and determine whether or not social distancing is adhered to, by first detecting the presence of people, determining their locations, and then calculating the distance between them.

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