Chapter 7
Robotics and Drone-Based Solution for the Impact of COVID-19 Worldwide Using AI and IoT

Rachna Jain, Meenu Gupta, Kashish Garg, and Akash Gupta

Abstract  Coronavirus disease 2019 (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. The disease causes a respiratory illness with symptoms like cough and fever and, in more severe cases, causes difficulty while breathing. COVID-19 spreads primarily through contact with an infected person when they sneeze or cough or by touching a surface that has that virus on it and then touching our mouth, nose, or eyes. The disease was first observed in the central Chinese city of Wuhan at the end of 2019. The outbreak has been declared a global pandemic. The novel coronavirus is already reorienting our lives, but the crisis moments also present an opportunity for more sophisticated and flexible use of technology. The epidemic is impacting the global population as the number of cases is increasing rapidly, and there is an urgent need to stop the virus from spreading. The outbreak has triggered massive demand for digital health solutions, and for this, the drones and robots present an excellent method for automation of manual activities. Drones and robots can be used to provide services to the patients and those who are quarantined and are the most desirable and safe way to fight against the outbreak and limit contamination and spread of the virus. The following chapter will discuss the various solutions based on drones and robots in the field of AI and IoT, such as drones being used for social distancing and robots for sanitization. Further, analysis has been made about the total number of cases and deaths around the world and also how it has affected humanity and what measures have been taken to control this deadly disease.

Keywords  COVID-19 · Disease · Drones · Robots · Artificial intelligence (AI) · Internet of Things (IoT) · Technology

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7.1 Introduction

The outbreak of COVID-19 seems to be unstoppable, as the virus has already affected millions of people around the world. The peoples are continuously facing problem due to this deadly virus, which required a cure, but as the number of mortalities is rising, it does not seem to come down. So far, there is no special treatment for coronavirus, and efforts to control its spread have failed. Despite the lockdown in different countries, the number of active cases in the world is only rising. Therefore, there is an urgent need for the surveillance of those who are affected by the virus. The introduction of a digital system may prove beneficial in the coming time in controlling the disease [1].

A wealth of new technologies such as artificial intelligence (AI) and the Internet of Things (IoT) is gaining worldwide attention and becoming very beneficial in these times of crisis. These new technologies possess a great resource in the time of coronavirus. Such techniques are regularly used by doctors and other healthcare staff to communicate with others for manufacturing and making the vaccine for COVID-19 for checkup, surveillance, and deciding the next steps with lesser human contact and involvement [2]. Also, the advanced technologies are used to gather the proper updates and keeping the data well maintained and secured. The machines used under these technologies, such as robots and drones, are supported by wireless connectivity and sensors. The sensors installed inside them help them to visualize and monitor the activities that are happening around them and then correspond to them accordingly [3].

AI is a powerful tool used to develop robots that can help the medical staff and in undertaking sanitization jobs. It is also beneficial to manufacture the healthcare equipment. IoT is proving to be very helpful during COVID-19 with its application of drones, which is continuously being used for monitoring people on the road and ensuring the implementation of quarantine and mask wearing. A drone can also be used by doctors in remote monitoring of in-home patients [3, 4].

7.2 Literature Review

Kamel Boulos et al. discussed the supports of health databases from different technological products. They also talked about the database, which gives a provision for more accurate, efficient, complete, and real-time information on outbreaks and their distribution; this helps to make better decisions about urban fabric risk management. Weber and Podnar Žarko suggest that the IoT devices which support open protocols are much beneficial, and data integrity and safety during communication and transmission should be ensured by the device provider. But this is not at all carried out as explained by Vermesan and Friess, who say that most of the service providers in the city use proprietary solutions that could only be understood by them and often create chaos, and the information is fragmented into pieces. Lawpoolsri
et al. suggest that for continuous monitoring, accurate assessment of data, issues like sharing, access, and quality of data should be supported. People’s movement from one place to another place has been recorded in public places before lockdown was imposed. As stated by Li et al., there were sensors installed in such locations that can receive and deliver data in real time to the network’s digital infrastructure, and their network interconnection makes them extremely successful in providing real-time alerts on various issues [5].

Chun described in the *South China Morning Post* that infrared cameras had been installed at train stations and airports across China. These cameras scan the temperature of the people when gathered in crowds. These cameras also have a special feature of facial recognition, which helps to identify those who are not obeying the self-quarantine orders [6].

Allam and Jones also suggest that for better global understanding and management of urban health, the use of AI data sharing standardization protocols could be used and will be beneficial for the society [7].

The effectiveness of a chatbot based on cognitive behavioral therapy and positive psychological interactions in the nonclinical population has been displayed by Ly et al. The study showed that the people having a “digital relationship” with the chatbot were impacted with good well-being and perceived stress better [8].

Breazeal [9] and Lazzeri et al. (2013) say that robots are now being equipped with “social intelligence” that would help them to react like a normal human being [10]. In [11], authors discuss the problem encountered by charity people in China that relates to crises occurred in tech industry. In this work, authors used Blockchain and Artificial tool for implementation and analysis about handing these crises happened due to COVID-19. Next in [12], author discuss the role of drone in monitoring human emotions. The use of drone is also seen in agriculture for monitoring crops and farming. The main focus of the authors in this paper was to discuss the functionality of drones in social interaction. Drones can also play a vital role in measuring social distancing. Further in [13], the authors focus on mobile-based web survey for identifying COVID-19. They apply machine learning algorithm for further analysis. They propose a method which helps in reducing the spread of viral disease. In [14], the authors propose a novel model using deep Q-learning network that helps in finding drugs to reduce SARS-cov-2-based diseases. Further in [15], they consider the COVID-19 data set of individual patients who died in Hubei, mainland China. The main focus of this study was to analyze the total number of deaths and recovery rate of COVID-19-infected people. Different technologies that have been used in fighting against COVID-19 are discussed in [16]. In this, they discuss the different levels of crises happened due to COVID-19 and medical image processing. The role of AI-based big data in analyzing epidemic outbreaks and the role of smart cities in enhancing the decision by looking policy maker are discussed in [17]. Next in [18], the authors discuss the loss of manpower and economic crisis due to the COVID-19 pandemic. In this work, they discuss the role of wireless communication in COVID-19 and showed how this technology can help in monitoring the spread of viral diseases.
7.3 Critical Event Management

In coping with an unpredicted virus and in the time of such crises, accurate and actionable information is necessary for everyone to take their next step appropriately. There has never been such a pandemic as COVID-19 situation, so researchers around the world are continuously looking for new technologies to fight against this deadly virus. Still, the deployment of such techniques may take a much longer time to impact our lives and save the world from getting diminished. In case of a critical event such as the COVID-19 pandemic, access to information is very important. It has been observed from previous situations that the information in such times is often broken into pieces and cannot provide actionable intelligence. The larger the happening, the more difficult and complicated it is to collect accurate information and assess it to take the necessary next steps.

There are many tools available to solve this complexity and find a more accurate, rapid, and effective response for the pandemic and minimize its impact on society. There are generally four stages of any response management. In the first stage, the data is gathered from various resources about the current situation of COVID-19. This step helps the response team to use the needed analytics tool to use to understand what is happening now and what could happen in the future. A second stage includes the location of required assets, employees, and other vital equipment that could be needed if the situation becomes worse. In the next step, such systems offer large organizations and emergency responders the necessary tools to act for informing people about the actions to be taken and releasing mass scale notifications in severely affected areas and calling up different teams to collaborate if needed. The last stage enables the concerned authorities to review and evaluate all the happenings that occurred during the event so that if something the same happens in the future, the impact may be minimized [19].

7.4 Artificial Intelligence and Internet of Things in Critical Event Management

Internet of Things (IoT) is a well-defined scheme for interconnected computing devices and mechanical devices that possess the capability of transmitting the data over a network without any human or physical involvement at any stage [20]. During lockdown period, it has been observed that IoT systems and devices have been recognized and being used regularly by concerned authorities and responders. These devices help to connect directly those who are affected by an emergency affected by COVID-19. There are several use cases in which IoT can be utilized, such as emergency calling, public warning systems, surveillance systems, and a communication system for situational awareness, proving beneficial in any critical event [19]. It provides a method for all the social workers, patients, doctors, civilians, etc., to get connected and communicate with each when necessary. It is also used to predict the
upcoming situation of COVID-19 with the help of data stored in the database. The COVID-19-affected person can use an IoT device for proper monitoring of his or her heart rate, blood pressure, and other personalized activities. The most significant application of this technology in current time is that it can be used to track the real-time location of medical equipment for a hassle-free process without any delay, and the companies can use this technology to detect fraud claims. This improves treatment flow and is helpful in decision-making [20] (Fig. 7.1).

Artificial intelligence is a very powerful tool that can be used to predict the outbreak and help in minimizing its spread [3]. AI has been applied widely to our different lives in several ways and is also regularly contributing to fighting against the coronavirus. This technology is being used to diagnose, respond, or predict the deadly virus spread [19]. AI can be used along with deep learning to enhance the detection and diagnosis of the COVID-19 virus in a person. It can also be used to alleviate the clinical load of patients by enabling an online medical “chatbot,” which could help patients recognize the early symptoms of the virus and also help in educating them for taking the next steps. A phone-based software could be used for avoiding hospital consultations, as it will store and detect the patient’s data. This data could be developed in AI algorithms for COVID-19 [22]. Further, AI can also contribute to making robots that will assist the doctors and patients in the time of need and could also be used for other purposes such as sanitization (Fig. 7.2).

Fig. 7.1 Role of IoT in COVID-19 [21]
7.5 Artificial Intelligence Meets Internet of Things (IoT)

Persistently the Internet is transforming, and the datasets present are huge, and it is becoming difficult to handle them. This concern raises the need to process this huge data with the computation power. In this domain, AI and IoT can be a breakthrough [24]. This will help the society by reducing human effort and building some smart things.

These technologies could not only be used to make medical tools and in laboratories but can play a crucial role in providing public safety and such similar situations. Smart city professionals could use these technologies to make collaborative strategies and work on rendering the maximum benefit to the people of the country. Cities could provide a huge platform for such technologies to emerge as per their potential. Thermal cameras or Internet of Things (IoT) sensors could be used to detect the outbreak as early as possible to provide minimum loss to people. But these sensors alone will not be beneficial for pandemics like COVID-19, so they have to integrate with artificial intelligence to give significant benefits. It will result in better management of resources and less loss [5].

Fig. 7.2 Role of AI in COVID-19 [23]
7.6 Robots in COVID-19

The outbreak of COVID-19 has now become a pandemic, and therefore global effort is required to fight against it. Robots have the potential to help humans in the current situation. They could be deployed for various purposes and thus serving humanity. These could be used for disinfecting areas, delivering supplies, and many other activities. As seen in the current situation, there is an extensive opportunity and developments available in the field of robotics. This pandemic could prove beneficial for this domain of science to flourish to its full extent. Hence, it develops fully automated robotic systems that could be deployed to serve humanity today and in the upcoming time by providing remote access and avoiding the humans to travel up to the frontlines [25].

7.6.1 Delivery Robots

These community robots ensure the necessary supply of food and medicines and other vital materials, such as masks, face shields, PPE kit, etc., in the community [10]. The robots are used for the delivery of food and medicines to the people who have been quarantined during the COVID-19 period. These robots have been given a special cart-like shape, which brings food to people isolated in a 16-story hotel. Delivery robots are also being used to transport infectious samples to the laboratory for testing so that human interaction can be avoided [26]. Also, these are used to collect transmissible waste from the hospitals and then put it in the dustbins [27]. Robots have become an important part of delivering essential items.

7.6.2 Mobile Robots (Chatbots)

Various healthcare units and hospitals have been regularly updating their digital tools and technologies to provide their best to the patients. AI-based chatbot system has proven very beneficial in the COVID-19 crisis [8]. Chatbots are a computer application that stimulates conversation via chat [28]. These chatbots are natural language processing systems that act as a virtual conversational agent that promotes health and inform and potentially contributes to changes in human behavior. During COVID-19, chatbots could be used to answer the health inquiries, while people look for a specific symptom of the disease such as cough or cold. As many of the countries have been locked down due to the disease, it may have a bad effect on someone’s mental health. Chatbots could also be used under this domain to develop
therapeutic and preventative interventions [8, 29]. Chatbots help people to recognize the early symptoms and simultaneously educate them on hand hygiene [22]. These bots are a great way to consult about some small health issues which may not require consulting to a doctor in physical and hence maintaining social distancing and avoiding the spread and, in return, could also save us some precious time.

7.6.3 Sterilization Robots

Coronavirus not only spread from direct contact with the infected person or via the respiratory droplets but can also spread via contaminated surfaces. If an infected person touches any surface, then the virus stays over the surface for a certain amount of time, depending upon the material of the surface. So, for this purpose, a special type of robot-controlled noncontact ultraviolet (UV) disinfection is being used in many hospitals. UV light devices have been proven effective in reducing the contamination from such surfaces in the hospitals. This is a good method to disinfect such surfaces with the help of a robot, as it reduces the risk for cleaning personnel, and robots could do this work faster than humans and more effectively. Robots could be made in different sizes for sterilization, depending upon the surface to disinfect [25]. Robots are also being equipped with sprays to clean public areas [10] (Fig. 7.3).

Fig. 7.3 A robot using ultraviolet light to disinfect a hospital room [30]
7.6.4 Telemedicine Robots

These are the special robots to help, specifically the patients. These robots have cameras and sensors embedded in them. The video screen helps the doctors to chat with the patients remotely, avoiding the risk of the disease. These robots help healthcare workers to provide treatment to the patients while not being near them. The robots could take the temperatures of the patients and measure the blood pressure [26] (Fig. 7.4).

7.7 Drones in COVID-19

Drones have been playing a very crucial role in the case of this massive pandemic. These are being used for several purposes, such as supplying essential items, monitoring social distancing, or spraying disinfectants around public spaces. Drones allow the fast distribution of essentials in a short time and could also be used by the people post-epidemic event through the use of artificial intelligence, GPS, and large delivery system anywhere and anytime without any need of operator [32] (Fig. 7.5).

**Fig. 7.4** A nurse using the robot to interact with the COVID-19 patient [31]
7.7.1 Traffic and Social Distance Monitoring Through Drones

Artificial intelligence along with IoT is being used to make drones with a special feature of facial recognition, which can identify whether the people on the street are wearing masks or not. These drones are also used to monitor the regular traffic on the roads so that if social distancing is not being maintained or people are roaming unnecessarily, then strict action could be taken against them [6].

7.7.2 Drones for Supplying Essential Items

Drones have been continuously being used to supply essential items such as water, food medicines, lights, etc., to the people who are infected with the COVID-19 virus or are home quarantined and maintaining social distancing. For this purpose, a special infrastructure should be built, which can store all these basic and essential items and can be supplied to the needy in case of an emergency [32]. Drones could also be used to transfer the blood samples of the patients and for providing the medicines to the infected persons. This will reduce the risk of the disease for the doctors and nurses [25].

7.7.3 Drones in Disinfecting Public Areas

Drones are continuously being used to disinfect large public areas. This requires less human interaction and could be done more efficiently while obeying the social distancing norms [26] (Fig. 7.6).
The following section will give an insight into the number of COVID-19 cases around the world and how the different counties are handling this critical situation and coping with the same.

7.8.1 Analysis of the Top Ten Countries with the Highest Number of COVID-19 Cases

The deadly coronavirus has already affected more than 200 countries across the planet. The number of affected cases has been increasing regularly in most of the countries. As of June 2, 2020, 05:55 GMT, there are total 3,089,191 active COVID-19 cases worldwide [33]. Table 7.1 shows the top ten countries which have the highest number of coronavirus cases and are continuously fighting against it (Figs. 7.7 and 7.8).

As the number of cases of COVID-19 is continuously rising, many national and international measures have been taken by different governments of different countries [34]. Most of the governments across the globe placed “lockdown” in their respective countries as “social distancing” plays a very important role in eradicating...
this deadly disease. All the public places and private companies were shut down to prevent the virus from spreading [5]. However, many protocols have been applied for the last few months. The countries with the best medical facility such as the USA, Brazil, the UK, and many others failed in providing facilities to their citizens in the time of crisis. The Indian government has recognized the COVID-19 threat in the earlier stage. After analyzing this threat, they imposed lockdown, which resulted in a slower death rate in India. The people in many countries, such as America, were not following the social distancing and self-quarantine norms, which resulted in a high death rate [35].
The Indian government imposed the lockdown in four different phases keeping in mind the different strategies for each stage to be followed so that the citizens could remain calm and follow the self-quarantine norms and maintain social distancing.

### 7.8.2 Analysis of the Top Five Most Populated Countries Worldwide

Today, the world is suffering from COVID-19, which spread across the globe in a short time. Every country is putting efforts to prepare a vaccine to overcome the impact of this disease, but no one has succeeded. Table 7.2 shows the total infected, recovered, and overall death cases of the top five most populated countries, namely, China, India, the USA, Indonesia, and Pakistan. The impact of COVID-19 on these five most populated countries can be understood by the following analysis.

#### 7.8.2.1 China Case Analysis

China is the most populated country across the globe, with a population of about more than 1.4 billion people. This deadly disease was spread from the Hubei Province of China itself, hence having the highest number of cases initially throughout the world [36]. Approximately 83,017 people were infected from this deadly...
disease in China in which 4634 lost their lives, and 78,307 got recovered from it. Early detection and timely isolation help them to get rid of this deadly disease. China’s government had taken proper actions to fight against this virus [37]. They timely restricted all the international borders and suspended all the flights and train operations. The people of Wuhan district were confined in their houses around 2 months and properly followed all the guidelines provided by the government to get rid of this virus [38]. Finally, the things get back normal in Wuhan, and China’s case proves that with the combined efforts of the local public and the government authorities, it became possible to fight against this virus.

7.8.2.2 India Case Analysis

India is the second most populated country across the globe, with a population of about more than 1.35 billion people. In India, this disease was initially identified in a Kerala student who returned from Wuhan on January 30, 2020, and currently, there are about 197,808 cases of COVID-19 recorded in India, among which 5603 people lost their lives, and 95,415 people got recovered from it. Till now, four phases of lockdown had been employed in India. Lockdown 1.0 and Lockdown 2.0 are somewhat successful, and most of the Indian states showed a positive response by reducing the number of infected cases in these states [39]. But after April 30, when Lockdown 3.0 starts, most of the states in India show exponential growth in the infected cases. Till April 30, there are about 33,000 cases only, and it became around six times higher in just a month. Because of different population density, culture, and diversity of the Indian states, it is difficult to analyze the impact of COVID-19 on the whole of India simultaneously [40].

7.8.2.3 USA Case Analysis

The USA is the third most populated country across the globe, with a population of about 33 million people. The USA has the highest number of COVID-19 cases of around more than 1.8 million and reported the highest number of deaths of about more than 100,000 people. The first case of COVID-19 was published on January 20, 2020, in a 35-year-old man of Washington. The primary reason for having such a high number of cases is the delay showed off in the testing [41]. Also, the US
government initially refused to relax the regulations, which does not allow the health departments and the states to develop their testing kits based on WHO guidelines. All the COVID-19-infected samples were being sent to the headquarters of the CDC (Centers for Disease Control and Prevention) in Atlanta [42]. After that, the delay increases because of the faulty test kit sent by the CDC. These primary factors are responsible for the considerable increase in COVID-19 cases in the USA.

7.8.2.4 Indonesia Case Analysis

Indonesia is the fourth most populated country across the globe, with a population of about 267 million people. Indonesia is having the lowest infected to total population ratio of around 0.000098 in the five most populated countries in the world. Currently, Indonesia has 26,940 active cases of COVID-19, and approximately 1641 people lost their lives due to this deathly disease. The first cases of COVID-19 were observed in a dance instructor and her mother, who was infected by a Japanese person. Then this virus spread among 34 provinces of the country by April 9, 2020. Although the country has a minimum number of cases as compared to other most populated countries mentioned above, it still has the second highest number of cases in Southeast Asia after Singapore and also has the fifth highest number of deaths recorded in Asia [43]. The highest number of recoveries (i.e., more than 500) was observed on May 30, 2020.

7.8.2.5 Pakistan Case Analysis

Pakistan is the fifth most populated country across the globe, with a population of about 212 million people. Currently, as on 1 June 2020, Pakistan has 72,460 active cases of COVID-19, and around 1543 people lost their lives because of this deathly disease, while about 26,000 people got recovered from it in the country. The virus was first observed in a Karachi student who returned from Wuhan on February 26, 2020, and spread among four provinces by March 18, 2020. According to a report [44], 27% of COVID-19-infected cases were increased due to religious gatherings that took place in Lahore. Till now, the maximum number of cases was recorded in Sindh state, and the highest numbers of deaths were observed in Punjab. The Pakistani government employed various phases of lockdown from April 1 to May 9, after which the lockdown was somewhat eased in the different provinces [45]. Not following social distancing rules leads to an increasing number of COVID-19 cases as compared to the earlier number of cases.

Hence, after analyzing the COVID-19 impacts on the five most populated countries, we can conclude that the population factor is not responsible for the increase in the COVID-19 cases in any country. Instead, it depends upon various other factors like population density, rules and regulations, norms, culture, diversity, and the medical facilities of that country. Along with government initiatives, the attitude of
the public toward the government actions also matters. After all, it is the people themselves who can save the country from such type of deadly pandemic.

7.9 Conclusion and Future Scope

Such technologies quite have the potential to change the delivery of healthcare systems around the globe and serve cost-effective health services and narrow the path of well-being gap, but this certainly requires deeper research. Many people may not believe that such technologies could not solve their problems, such as in the case of chatbots, people may hesitate to put in their personal information to get started with the service. They may be uncertain about their quality, or they may think that conversation in this way might lead to some misunderstanding. So there is a need to make the society aware of these upcoming trending technologies, which could help them shortly, so that they can take the maximum benefit out of them for themselves and their families. These technologies could certainly enhance the public health education and communication. The COVID-19 pandemic could prove to be a catalyst for emerging technologies such as artificial intelligence, the Internet of Things, and robotics. The robots and drones have not replaced the human workforce, but these give humanity a chance to operate these technologies by applying their expertise. The world could have any natural calamity at any time, so we should be prepared for any time of situation or pandemic that might hit us. This critical situation of COVID-19 requires unity of people. Every people must follow social distancing and hand sanitization as a solution to fight against this pandemic and work in the concern of every individual on this planet. These analyses help in the future, and people can avoid those things that can harm them. In the future, this analysis can also help a country to take precautions for these critical diseases.

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