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Digital Transformation and Emerging Technologies for Fighting COVID-19 Pandemic: Innovative Approaches

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Digital Transformation and Emerging Technologies for Fighting COVID-19 Pandemic: Innovative Approaches

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This book is dedicated to all members of the scientific research group in Egypt (SRGE)

Preface

In the age of digital transformation, artificial intelligence (AI) and big data are playing a key role in processing the data to be converted into knowledge and decisions. With the rapid growth in the number of newly confirmed and suspected COVID-19 cases in 2020, COVID-19 extremely threatens public health, countries' economic, social life and the international relations around the world. In the fight against COVID-19, AI techniques and big data analytics have played a significant role in many aspects. Moreover, AI, big data, Internet of things and Blockchain-driven technologies present visualization for COVID-19 outbreak information that helps in detecting risk allocation and regional transmissions. Thus, many researchers have been developing specialized tools using AI techniques and big data analytic tools for early prediction and diagnosis of COVID-19 cases to contribute to its containment before spreading.

These models had been a great help to clinicians and decision-makers for making the appropriate recommendations for treatments. The value of integrating AI and big data tools strongly will provide clinicians and decision-makers with helpful information on COVID-19 disease, which will reduce their efforts. Thanks to its high ability to isolate and pick features, AI techniques have today been used in the medical imaging domain. Machine and deep learning technology is primarily applied to identify and distinguish pediatric viral pneumonia and bacteria.

Some recent technologies such as unmanned aerial vehicle (UAV) or drones are used to detect the infected people in different areas in the same country. In addition, robots are used in fighting the COVID-19 by protecting the workers and staff people who are dealing with infected people. On the other hand, other technology such as robotics plays an important role in saving the life of medical staff during COVID-19 pandemic and to assist patients during the treatment process.

Blockchain technology will play an important role with COVID-19 in securing many transactions and dealing in strict confidentiality, as patient's image transmission, digital and statistical data related to the patients. In addition, the adoption of Bitcoin as an official currency alternative to banknotes currencies in order to avoid the transmission and spread of infection is a great challenge for governments.

The book aims to present the AI and big data analytics solutions to help healthcare sectors and the medical staff to protect them and limit the spread of the COVID-19. Also this book presents the problems and challenges and presents to the researchers

and academics some future research points from the AI point of view that can help healthcare sectors and limit the spread of COVID-19.

The content of this book is divided into three parts.

- The first part presents the effective role, importance and practical applications which include new models, systems and results of AI technology in fighting against COVID-19.
- The second part analyzes and describes the role of digital transformation and different emerging technologies for monitoring and controlling COVID-19. Some recent technologies such as big data, drones, 3D printing, robotics and the Fourth Industrial Revolution to tackle COVID-19 have been presented.
- The third part introduces the smart networks for tracking COVID-19 and Blockchain technology for securing and management of COVID-19 patient's data.

Finally, editors would like to encourage the readers and researchers to expand and explore the knowledge in the main topic of this book in order to create their implementations and obtain new results to tackle COVID-19 as a global pandemic. We acknowledge the members of the Scientific Research Group in Egypt (SRGE), for their effort and handling this book.

Cairo, Egypt
August 2020

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Artificial Intelligence Technology Against COVID-19

Digital Transformation and Emerging Technologies for Tackling COVID-19 Pandemic

Mohamed Elsersy, Ahmed Sherif, Ashraf Darwsih, and Aboul Ella Hassanien

Abstract Several emerging technologies were introduced to tackle the unprecedented crisis of the new COVID-19. Remarkable emerging technologies are outlined, such as machine and deep learning, Internet of things, cloud and fog computing, and blockchain technology. Those emerging technologies have been explored to support the solution proposed to ensure the integration of these technologies to fight the pandemic. Also, numerous emerging technologies used for the COVID-19 fight have been highlighted. Finally, the impact of COVID-19 is discussed, and applications showing how to mitigate this impact using the emerging technologies are outlined.

Keywords Digital transformation · Emerging technologies · Artificial intelligence · Internet of things · Big data · Blockchain · Cloud computing · The fourth industrial revolution · COVID-19 · Coronavirus

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1 Introduction

Since the first warning issued on January 12, 2020, by the World Health Organization (WHO), a new Coronavirus outbreak, many technologies, and solutions have been used to combat the pandemic. The concern was raised because of the emergence of new breathing diseases that appeared in Wuhan city, China. The evidence was highly suggestive, according to the WHO, that the outbreak was associated with crowds and transfer of droplets for infected persons. Later, there was a high rate of infection among healthcare employees and a high possibility of transmission from humans to humans [1]. The COVID-19 pandemic has brought more than eleven million cases reported globally by the date of July 5, 2020, and has taken more than half a million lives worldwide [2]. At the moment, Egypt is one of the most affected nations in the vicinity, with as much as 74,500 total instances of infection and a widespread causing 3324 deaths, the highest rate within all the Arabic countries [3]. Because of the reported active cases of COVID-19, all affected nations face a situation of partial or complete lockdown wherein the range of infected cases may even surpass the capacities of all healthcare systems, including those with the most resources in the USA and Europe [4, 5]. State programs focused on interaction monitoring, isolation, and social distancing, in the absence of particular vaccines or medical drugs. On condition that the pandemic wave strength increases, the proposed solutions will adapt. Besides, the following dynamics of SARS-COV-2 transmission all around the world [6]. The effectiveness, length, and urgency of the response are all always needed in all cases.

Emerging technologies keep disrupting the manner commercial enterprise is carried out everywhere in all countries. Companies seeking to succeed in today's marketplace are rapidly recognizing the need for a complete digital transformation roadmap that incorporates numerous technology platforms through the entire framework of the organization. Researchers are seeking to implement resilient, lengthy-term, cloud-based digital infrastructures that drive their healthcare solutions' future-of-work, future-of-connection, data management, related digital experiences, and digital innovation techniques for healthcare solutions [7]. The cloud-based digital infrastructure that propels many groups into a thrilling deep dive into the different moving components and challenges of imposing a resilient, relatively aggressive future business landscape. This work is introducing the digital transformation pioneering solutions and emerging technologies across the world, along with complete analysis that will explore the latest cases of use of emerging digital technologies against COVID-19. Digital technologies have captured the imagination during the global pandemic for their potential to support people in their fight against COVID-19. Earlier than the new COVID-19, health, education, social and economic crisis, the most noticeable uses of emerging technologies, such as artificial intelligence (AI), were their various entertainment applications in growing productivity [8]. Nevertheless, now new digital technology's ability to reach beyond this has been exposed to the public at large. Emerging technologies, which include AI and IoT,

assist in speeding up the vaccine's production, forecast the public health interventions will be more successful and maintaining the public up to date with accurate information [9].

A variety of technological solutions to tackle the impacts of the COVID-19 pandemic are emerging. Digital technologies including IoT, AI, blockchain technology, and big data analytics, were among those at the forefront [10]. Digital technologies will play an essential role in strengthening public health responses to the COVID-19 pandemic, according to the WHO and the Center for Disease Control and Prevention (CDC) [11]. The newly proposed technologies have also helped researchers to transfer plenty of their lives online, sustaining economic and educational structures. At the same time, the majority of people stay home, and assisting the target in the workforce remains connected. But not all regions and social communities are similarly capable of harnessing emerging technology's ability to combat the virus. According to the status of the 2019 broadband survey, while the internet usage penetration rate is 51.2%, it is still 45% in developing countries and 20% in the least developed countries [12]. Digital and information gaps have always persisted, however in a situation, wherein many human beings must stay at home, it transforms from a drawback to a debilitating weakness. A long-term study is necessary to improve exposure to emerging technology, and short-term research is needed to ensure that lack of access does not turn into an inability to maintain everyday life.

Several measures were launched against COVID-19 by UNESCO and its allies to unlock the potential of applications of new emerging technologies. Emerging technologies mentioned in the sections below clarify how these innovations are used to address the COVID-19 catastrophe. COVID-19 crisis tells us that we should promote the socially beneficial applications of emerging technology, and work on enhancing connectivity and usage in areas where they are missing. This chapter concludes that most of the patients who could not get better had a fever, cough, general exhaustion, and most possibly malaise, as depicted in Fig. 1, the symptoms and prevention measures for COVID-19 as recommended by WHO [13, 14].

The remainder of this chapter is organized as follows. Several solutions primarily based on the AI is mentioned in Sect. 2 to mitigate the impact of the COVID-19. Section 3 introduces the IoT as a promising and significant solution for the control and mitigation of the epidemic. Section 4 depicts big data analytics for the same reason. On the other hand, cloud and fog computing is an obtainable solution, as described in Sect. 5. Blockchain is a novel technology demonstrated in Sect. 6. The fourth industrial revolution is combining many technologies, as presented in Sect. 7. Section 8 sums up the contents of the chapter and discusses future challenges.

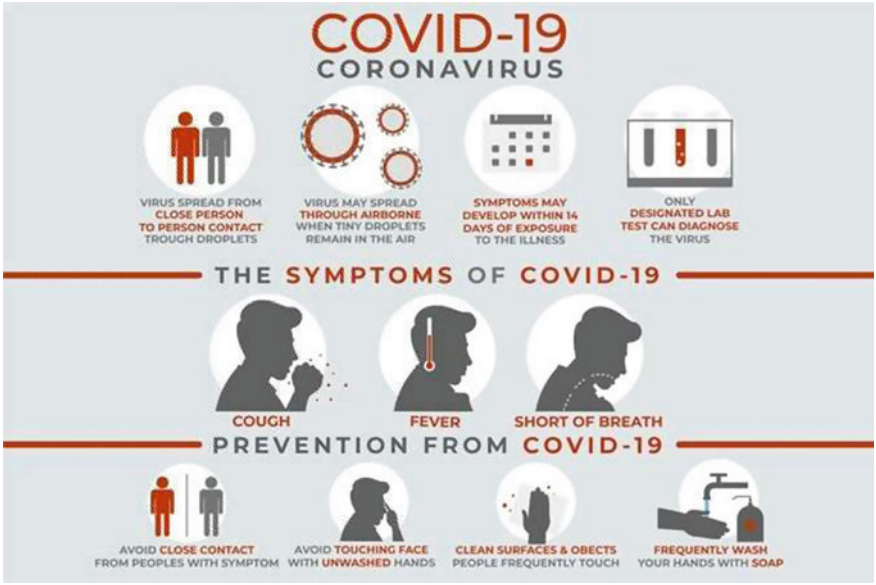

Fig. 1 Symptoms and the prevention measures from the COVID-19 pandemic

2 Artificial Intelligence

2.1 Solutions Based on Artificial Intelligence

With AI playing a leading role in solving necessary and tedious activities for enterprises, the human worker will spend more on complex jobs, which effectively provides workers with a higher degree of professional fulfillment and more effective utilization of critical thinking capacity. COVID-19 is the brand-new pandemic that is hitting worldwide. Patients across the globe face unique symptoms. The maximum number of patients with excessive signs and symptoms die, mostly the elderly and those at risk from health problems. AI has proved to be a groundbreaking technical advance and continues to be a highly successful weapon against COVID-19 when used appropriately [15].

AI can help authorities to combat COVID-19 in several ways. It used to predict risk, to develop drugs, and to bust the fake news. One of the potential ways in which AI is used against COVID-19 is the risk prediction of infection. The risk of becoming infected typically is a function of a multitude of factors. May include age, hygiene practices, the present state of health, personal medical records, pre-existing conditions, or some records of travel. Direct mathematical models do not produce fruitful results for these factors. A comprehensive analysis of these factors, however, integrated with AI techniques, can offer a more accurate and reliable forecast of individual risk profiles [16, 17].

One of the main issues with the COVID-19 is the virus' complexity, and lack of proven viral testing and treatment protocols. In this respect, Machine Learning (ML), a subset of AI, may prove to be a compelling technology to accelerate drug development [18, 19]. In past epidemics, ML has also demonstrated its efficacy in the phase of drug production. For example, Bayesian ML models were used in the course of the Ebola epidemic to speed up the process of designing molecular inhibitors against the virus [20]. With COVID-19, ML can be used in two significant ways [21]. Firstly, it can be used to quickly build and traverse existing knowledge graphs so that potential vaccines can be rapidly identified. Second, it can be used to accurately forecast the results of interactions between drug targets [16].

Furthermore, the unpredictable periods that preceded the COVID-19 epidemic have created many misconceptions and conspiracy theories. There was a lot of misinformation on social media platforms doing the rounds. To curtail the dissemination of such fake news and provide confirmed facts, technology companies such as Google, Youtube, and Facebook have used AI techniques. All these platforms endeavored to screen content for even the slightest bit of misinformation. YouTube has put in place stringent measures to take down any video that propagates false news [22]. The deep learning techniques are another subset of AI, which will be explained in the next section.

2.2 Solutions Based on Deep Learning

Deep learning (DL) as the new branch of machine learning emerged because of the vast computing power and big data sets available. DL enables multiple actors to build a standard, robust machine learning model without sharing data, thus addressing critical issues such as privacy, security, access rights for the data. Meanwhile, access to different data types in the same data sets should also be considered. DL applications range over numerous industries, counting military, telecommunications, IoT, or drug discovery. DL can be used in multiple forms of healthcare, as shown in Table 1.

Table 1 Applications of deep learning in healthcare

Basic biomedical research	Translational research	Clinical Practice
Automated experiments	Biomarker discovery	Disease diagnosis
Automated data collection	Drug-target prioritization	Interpretation of patient genomes
Gene function annotation	Drug discovery	Treatment selection
Prediction of transcription factor binding sites	Drug re-purposing	Automated surgery
Simulation of molecular	Prediction of chemical	Patient monitoring
Literature mining	Genetic variant annotation	Patient risk satisfaction of primary prevention

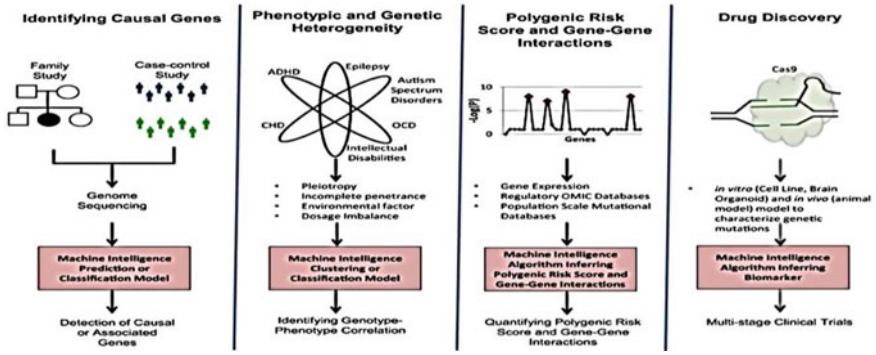

Fig. 2 Genetic interpretation as an example of AI solutions in healthcare

Several machine learning techniques are discussed to show expecting the affected person's recuperation. The support vector machine (SVM) turned into a test at the given facts with average absolute mistakes. The epidemiological information set becomes organized with the aid of researchers from many fitness reviews of actual-time instances to symbolize one of a kind attributes that make contributions as the main elements for drug discovery and re-purposing. In-intensity evaluation with other gadgets getting to know algorithms, inclusive of artificial neural networks and a regression model, changed into examined and as compared with the SVM results [23, 24].

Different classification models discussed to make the best use of the clinical data provided online to be able to predict the severity of the corona cases and classifying those into (acute, mild, and smooth) cases. SVM on many attributes of symptoms and other relevant information of patients achieved minimal classification error, which proves the feasibility of the proposed approach. Authors in [25] also demonstrated that symptoms alone could not help in deciding the severity of the cases. Moreover, data and statistics about COVID-19 are changing, and new data is added every minute. As a result, more records can be usable by the given model. As seen in Fig. 2, the genetic interpretation is an example of the use of AI in healthcare.

3 Internet of Things

3.1 Solution Based on the Internet of Things

The IoT is the new era of communication. Utilizing the IoT, physical objects such as sensors can be engaged in creating, getting, and exchanging the health data seamlessly and consistently without the intervention of the human. Existing and new IoT applications aim to increase the level of comfort, efficiency, and automation for the users [26]. With the technological advancement of the IoT, it is easy to connect various

objects (or things) through the Internet. In such a provision, these objects collaboratively collect a massive amount of data from different sources and then originate a meaningful insight (or information) from the collected data. In the IoT environment, these objects are broadly classified into two distinct categories: (i) physical objects such as drones, surveillance cameras, smartphones, vehicles and smart homes, and (ii) virtual objects such as e-ticket and e-wallet [27].

The Internet of Medical Things (IoMT), also known as the healthcare IoT, is the integration between the software applications and the medical devices through the connection of the healthcare system. Nowadays, IoMT has witnessed an enormous number of its applications according to the increased demand in using mobile devices that use near field communication (NFC) readers. These readers facilitate the interaction between the tools and the healthcare system [28]. Several applications of the IoMT have been proposed, such as monitoring the patients' conditions remotely by using some wearable/implanted devices to transmit the patients' data to the connected professionals, tracking the medication records, and update the required medication according to the patient status. Due to its ability to collect, analyze, and transmit/receive health data efficiently, the healthcare providers realized the urgent need of the IoMT technologies to reduce the burden on the healthcare system [29, 30]. An example of such IoMT techniques that are used to mitigate the COVID-19 is the smart thermometer. A US health technology company called Kinsa had launched Internet-connected thermometers eight years ago to test people for severe fevers. While initially designed to monitor the flu, these thermometers nevertheless prove to be highly useful in identifying possible COVID-19 clusters across the USA. These thermometers are connected to a mobile application, which enables them to transmit their readings to the business immediately. Once received, Kinsa assimilates this data to generate daily maps showing which of the US regions are witnessing an increase in high fevers, thus enabling the US authorities to identify potential hotspots [31]. Furthermore, telemedicine/telehealth is called the method of using IoMT technology to allow remote monitoring of patients. This approach helps physicians to assess, diagnose, and treat patients without having to engage directly with them [32]. Figure 3 shows the IoT wearable technologies for monitoring healthcare.

3.2 Solution Based on Robots

Robots are another example of IoMT technologies. As governments and medical organizations around the world are struggling to control the COVID-19 outbreak, robots are being deployed to support patient treatment, thus alleviating the stress levels of healthcare workers. Furthermore, robot-controlled non-contact ultraviolet surface disinfection methods are also employed to limit the transmission of the disease via the contaminated surfaces. Compared to the practice of manual decontamination requiring the deployment of cleaning staff and consequently placing them at risk of contracting the virus, autonomous robots for disinfection can lead to rapid

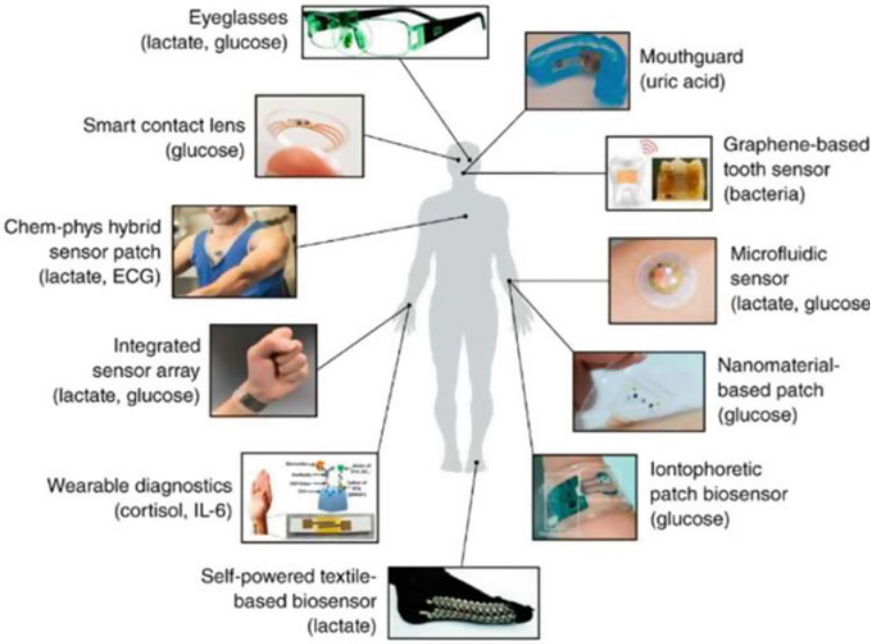

Fig. 3 IoT wearable technologies for monitoring the healthcare

and efficient disinfection [33]. Robots may likely perform activities such as disinfecting buildings, measuring people's temperatures in public spaces or at ports of entry, delivering psychological assistance to quarantined patients, gathering nasal and throat samples for research, and enabling people to attend conferences and exhibits remotely. The use of robots in each case could reduce human exposure to pathogens which will become more and more critical as epidemics escalate [34].

In addition, the use of robotics to keep IoT records could upload every other layer of safety that hackers could want to skip, which will get entry to the network. Robotics gives a robust degree of encryption that makes it, in reality, impossible to overwrite present information facts, especially during the COVID-19 pandemic. Robotics provides transparency by using allowing all of the users who are authorized to get the right of entry to the network. Robotics can offer a steady way to discover a selected source of any records manipulation or leakages and take a brief remedial movement to guide the decision-maker to assign resources according to the patients' needs. Robotics can enable speedy processing of motion and coordination amongst billions of linked gadgets.

Although offering a manner to enable with many of the stakeholders, robotics can permit IoT corporations to reduce their fees by using eliminating the processing overheads associated with IoT gateways (for e. g. traditional protocol, hardware, or communication overhead costs). Intelligent contracts, a settlement between events this is stored inside the blockchain, can, also, allow the execution of contractual

preparations amongst stakeholders primarily based on specific criteria being fulfilled. For example, smart contracts can authorize bills robotically without any need for human intervention, while providing service conditions were met. Some modern blockchain-IoT gamers and their use instance the technology at the back of sensors and smart chips are evolving rapidly, making them more transportable and applicable for real-time interactions with blockchain ledgers. The combination of robotics and IoT has broad potential for the advent of a marketplace of services among devices and allows organizations to create free from gathered facts. The developing number of emerging blockchain protocols, partnerships, and IoT device carriers already indicates that there is a superb match for applications within the IoT sector. The developing number of emerging blockchain protocols, companies, and IoT device carriers already suggest that there is an excellent match for applications within the IoT sector.

3.3 Solutions Based on Unmanned Aerial Vehicles (Drones)

Unmanned Arial Vehicles (UAV) is one of the emerging technologies that can be employed to introduce one of the solutions for the COVID-19 pandemic. UAV helps to deliver the medication for remote patients. With the progress of science and technology, the drone industry is developing rapidly, and the number of drones is also increasing rapidly. This section presents the integration opportunities between UAVs, also known as drones, and solutions suggested to mitigate the impact of COVID-19. With the aid of the recently emerging technologies, UAV can control, monitor, and communicate with other drones over the Internet to overcome their limited wireless communication ranges with the ground stations, finite computation, and energy resources. Therefore, this integration of drones in providing service for healthcare will allow seamless interaction with the drones over the Internet. Besides, drones enable their control anywhere and anytime without restriction on distance. In the course of the flight, drones usually need a wireless network to control their system. The information collected during the trip from the drone needs to be transmitted back to the ground station to guide the actions taken regarding the current situation. Not only the pictures and paths observed by UAV in the area of interest can help, but also those data can decide the impact of the COVID-19.

As shown in Fig. 4, the drones can be used in the surveillance during the lockdown, carrying the medical needs to remote areas, spraying the disinfectants to protect people in the surrounding, and carrying the food supplies to the hit regions [35]. Because the quantity of interconnected robotics grows, the post-pandemic era gives a feasible technique to assist the usage of an excess of robotics in the healthcare area.

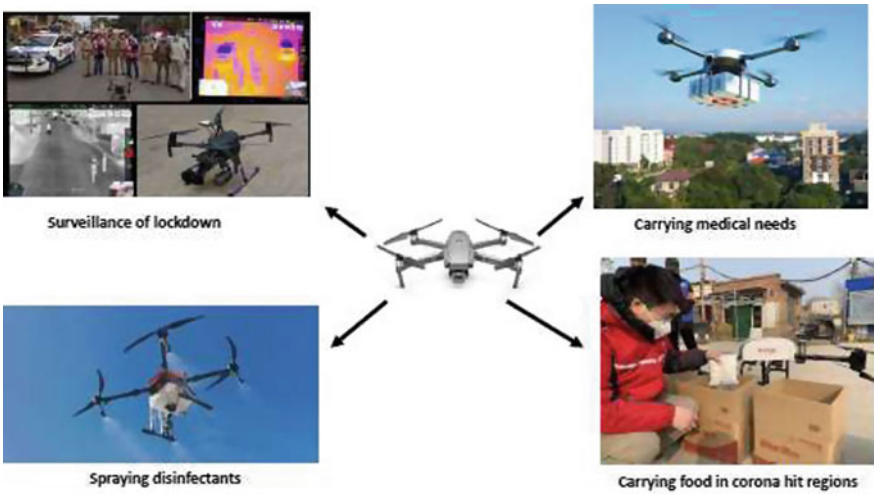

Fig. 4 Drones use for the COVID-19 pandemic

4 Big Data Analytics

The latest years have visible clinical imaging strategies like picture archiving and verbal exchange systems (percent), which emerge as a crucial part of diagnosis and treatment, in tandem with the subsequent-technology cell networks and technologies like big information analytics. It can offer more reliable data evaluation and management while requiring minimal human effort. In a consultant discipline hospital in Wuhan, Internet-enabled medical imaging platforms allowed for actual-time analysis of COVID-19 patients, and in doing so, relieved some of the burden on the medical institution's medical personnel [36].

Big data Analytics Healthcare organizations in many countries have proposed various models of healthcare information systems in order to get the best services and care for the patients. Big data in healthcare and medicine refers to these specific broad and complex data which are difficult to analyze and handle using conventional software or hardware [37, 38]. Big data analytics include heterogeneous batch processing, data quality control, analysis, modeling, interpretation, and validation [39]. Big data analytics framework offers detailed information to discover from the considerable amount of data available. Big data analytics in medicine and healthcare, in particular, allow the analysis of the large data sets of thousands of patients, the identification of clusters and the correlation between datasets, and the development of predictive models using data mining techniques [40]. Big data analytics in medicine and healthcare incorporates analysis techniques in many research fields such as bioinformatics, medical imaging, sensor analytics, medical informatics, and

health informatics. The new knowledge discovered through big data analytics techniques should give patients, healthcare professionals, and health decision-makers significant advantages [41].

Data mining techniques used on electronic health records (EHRs), web and social media data enable the identification of optimal practical guidelines in hospitals, the identification of association rules in the EHRs [42], and the disclosure of disease monitoring and trends in health. Besides, data integration and analysis with different characteristics, such as social and scientific, will lead to new information and intelligence, explore new theories, and identify hidden patterns [43]. An example of how big data analytics can be used during the ongoing COVID-19 outbreak when people use social media to acquire and exchange historically and unprecedently different types of information. To respond to the epidemic, only situational information is valuable to the public and authorities. It is, therefore, important to recognize such situational details and understand how it is being propagated on social media so that effective strategies for publishing information for the COVID-19 epidemic can be aware [44]. Another example of using big data analytics to mitigate COVID-19 is using wireless cellular data to classify areas with high human density and mobility that are at risk of COVID-19 spread. Crowded regions with actively moving people are susceptible to disease spread, mainly if they include asymptomatically infected people along with healthy people [45].

5 Blockchain Technology

In this section, blockchain technology is discussed and the possible extension for this technology to mitigate the effect of COVID-19. The following applications for the IoT, starting with LoRa, industrial, heterogeneous, supply chain, and finally, the military applications. More challenges in the use of the blockchain are discussed, emphasizing the use of blockchain to secure the patients' records. People, during and after the pandemic, need more connections with each other. On top of the products and even places, people visit to track the infected and active cases. The new technology of the blockchain offered more opportunities in providing better healthcare services.

Blockchain is gaining an increasing number of prominence each day, thanks to its full programs in numerous walks of lifestyles [46]. To the uninitiated, a blockchain is a continuously enlarging document of transactions between parties [47]. Such files may be used to verify the claims of a celebration that a deal has undoubtedly happened. Seeing its software, numerous groups and governments throughout the globe have started the usage of blockchain to build apps that may assist in countering the COVID-19. Those apps aim to cope with a significant problem; that's the shortage of integration of proven information assets. In keeping with specialists, one of the foremost advantages of the use of blockchain-enabled apps is blockchain's capability of validating continuously changing records. Blockchain and IoT are each emerging technologies with outstanding capacity, but lacking extensive adoption because of technical and security worries. Numerous corporations within the marketplace are

already running on use cases combining the two techniques, as collectively, they provide a manner to limit the safety and accompanying business dangers. They can gain hands-on revel in IoT and blockchain generation, provoke discussions, and share thoughts on solutions. This innovation space is designed to help corporations define their method around IoT and blockchain and encourage them to pursue it.

6 Cloud and Fog Computing

During the last months, several nations the world over have skilled numerous types of wide-ranging work and distance learning as governments had been coming to controls with COVID-19. Quarantine, lockdown, shelter in location, countries gave this isolation unique names, but this time turned into characterized through the identical want to transform many groups from retail to education. The era has been very vocal approximately the amount of digital transformation they have got supported their customers with this technology. COVID-19 changed their attitude on the way to adapt to the digital transformation and prioritized their execution. The extra trade people see, the tighter it is far to consider groups will move again to how matters have been earlier before this crisis. The mindset of no going back is not merely coming from the truth that COVID-19 will impact many in-character sports and areas from open offices, to travel and activities.

The preference to exchange is also the result of seeing the superb impact digital transformation has on an enterprise. People were transforming too throughout this time of the lockdown due to COVID-19. Humans were examined every day at the same time as they are trying to work, train, and live from home. Plenty of harder tests come from dropping jobs and a steady income. As social norms alternate, a number of the customers might spend a number of the more time customers need to learn to bake, cook, speak a new language. Others would possibly want to examine new talents to re-input the place of work after the disaster.

Very distinctive attitudes to studying: one is supporting humans with mental health, and one is helping to construct a more considerable marketable skillset. The good news is there are masses of content that has been made to be had via different agencies: webinars, digital university guides, or even online training. Consistent with the LinkedIn professional blog, human beings watched 1.7 million hours of learning content material on LinkedIn learning, accessed through the cloud and fog computing, versus. Half a million hours on common before the unfolding of the Corona. The growth in getting entry to the cloud answers equals a threefold leap in time spent getting to know. They want to accumulate new digital talents that better prepare the hard work pressure for the incoming duties of the destiny that would possibly have accelerated throughout COVID-19. Still, there are clear signs that a situation is going to become difficult or unpleasant with the expected second wave of the pandemic, or that no existence of the vaccine or medication is going to make

the impact mitigation fail. Any company wants to train and retrain the generations even in college, the contemporary team of workers through cloud and fog computing solutions.

7 The Fourth Industrial Revolution

After the general data protection regulation (GDPR) is introduced in May 2019, the United States and Europe have strict medical-privacy rules. The new technology approaches should focus on the secure encryption of data, especially during its transmission between computers. By adapting the fourth industrial revolution principles, there is a possibility to cover the lack of regulation surrounding the corporate use of personal data. Breaches of healthcare systems have exposed more than 100 million people data in the USA. The fourth industrial revolution approaches for speech recognition also threaten people's privacy. Privacy groups have concerns about the deal between NHS and Amazon. It is considered a data protection breach that is going to happen soon. Google health data scandal gives the researchers a vision to start to fear the controversy over the night in gate project that will, under the scheme, undermine trust in research. National health systems give Amazon free use of health data under the Alexa advice deal. UK health service will not gain commercial benefit from future Amazon products using its data.

To sum up, the fourth industrial revolution is one of the emerging technologies with great potential, but still lacking widespread adoption due to technical and economic concerns. Several companies in the information technology market are already working on use cases combining this technology, as together they offer a way to minimize the safety and accompanying business risks. Companies should start considering the implementation of the fourth industrial revolution to address their COVID-19 pandemic issues, starting small by learning from current use cases and projects in the industry. These innovative solutions were designed to help organizations define their strategy around the fourth industrial revolution and to inspire them to pursue the new emerging technology. Table 2 introduces the primary industries hit by the COVID-19 and how these industries are managing the risk factors in these cases. These industries start from the tourism industry, which was paralyzed hard by the pandemic to the telecommunication, which was fully loaded by the pattern of employees changing to work from home style.

More advancements in chips and sensor technology provide users with the sense of affecting their surrounding environment through actuators embed into the physical elements in the real world, which gives users the path to the cyber-physical systems (CPS). In these systems, users can control physical phenomena through a cyber-interface that affects the device in the physical world—using these CPS, more additional capabilities aids in converting the insight into actions.

The IoT connects people, locations, and products, and in so doing, it gives possibilities for price creation and capture. Sophisticated chips, sensors, and actuators are embedded into bodily items, every transmitting statistic to the IoT network. The

Table 2 Industries hit by the COVID-19, their risk factors and suggested mitigation technology

Industry	Risk factors			Mitigation
Automotive	A sudden drop in sales	Automobile plants shut	A sharp drop in stock prices	Bailout plans, robotics
Aviation	High cancellations	Decreased revenues	Increased debts	Big data, travel bubbles
Tourism	A decrease in the numbers of international tourists	A drop in consumer confidence	High cancellation rates	Drones, big data
Oil and gas	A collapse in oil prices	Imbalance in real estate demand	Travel restriction	Big data
Construction	Unavailability of labor	A decline in real estate demand	Financial difficulties	Robotics, blockchain
Food	Government guidelines	Instability in food demand and supply	Potential supply chain disruption	Robotics
Telecommunication	Traffic congestion	Workforce reduction	Network reliability	AI, Drones
Healthcare	Unpredicted load	Workers at high risk of infection	Lack of resources	AI, IoT, Drones

analytics abilities of the IoT use this statistic to convert insights into movement, impacting enterprise tactics, and primary to new operating ways. However, there are still some technical and protection issues that continue to be unaddressed. Security is a fundamental problem with IoT that has hindered its big-scale deployment.

The significant scale implications of the COVID-19 pandemic on the global financial system are attributed to the response gadget followed its initial outbreak. Even though the response to the COVID-19 pandemic has been more organized than the reaction to preceding epidemics and pandemics, more problems within the contemporary pandemic reaction remain unsolved. All the underlying troubles with the contemporary response and key getting to know the factors for future public health emergency management. The lack of transparency that happened at the beginning of the pandemic is a significant fault, and solutions should establish stringent guidelines to ensure the immediate release of the information concerning any potential health emergency. Proactive monitoring for the impact of the diseases should be forced by technology to recognize the threat promptly. A higher degree of pandemic readiness is required through the use of the fourth industrial revolution. Isolation of the high-risk regions should be done immediately after the identification of the pandemic threat. Following the outbreak of the pandemic health screening measures and travel, restrictions should be introduced sooner to stop the spread of the pandemic.

8 Conclusion and Future Aspects

As a result of the COVID-19 pandemic, shortly, everything will be transformed with the digital transformation and the emerging technology into a digital entity. In this chapter, the conceptual foundation of the highlighted technologies, for fighting the crisis of the COVID-19 pandemic, is outlined. The newly faced crisis of the COVID-19 pandemic needs a complex solution that not just a fusion of several technologies such as cloud computing, big data, and IoT but also includes robotics, AI, and deep learning. These kinds of techniques aid in bringing a recent fourth industrial revolution to the current infrastructures and the used emerging technologies may transform different sectors of our daily life activities. Following the trends of the COVID-19, those emerging technologies have gained many advanced capabilities that managed it to improve the performance of the most sophisticated missions such as pandemic control and mitigation as well as applications where a rapid response is a necessity to resume action in such applications. However, COVID-19 is still considered a hot topic that all the emerging technologies should operate in a cooperative and coordinated manner to give optimized, safe, and reliable besides secure results. In this chapter, the emerging technologies associated with COVID-19 pandemic, technologies empowering the proposed solutions, real-time applications for control the pandemic, comparison with such high threats acting as a significant research area have been addressed for researchers to make secure for their implementations shortly.

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The Role of Emerging Technologies for Combating COVID-19 Pandemic

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Abstract The outbreak of the new coronavirus disease (COVID-19) in 2019 resulted in more than 100,000 infections and thousands of deaths. The number of deaths and infections continues to rise rapidly since the virus date of appearance. COVID-19 threatens not only human health but also many aspects of life such as manufacturing, social performance, and international relations. Emerging technologies can help in the fight against COVID-19. Emerging technologies include blockchain, Internet of Things (IoT), artificial intelligence (AI), and big data technologies, and they proved its efficiency in practical fields. These fields include the fast aggregation of multi-source big data, fast visualization of epidemic information, diagnosing, remote treatment, and spatial tracking of confirmed cases. Every country in the world is still seeking realistic and cost-effective solutions to stand against COVID-19 under current epidemiological conditions. This chapter discusses the concepts of emerging technologies, applications, and contributions to combating COVID-19. Moreover, the challenges and future research directions are reviewed in detail. Also, a list of publicly available open-source COVID-19 datasets will be presented. Finally, this chapter concludes that cooperation among government, medical institutions, and the scientific community is significant and critical. Also, there is an urgent demand for improvement in the analytical algorithms and electronic devices to combat the COVID-19 pandemic.

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Keywords COVID-19 · Artificial intelligent · Big data · Blockchain · Internet of things

1 Introduction

In December 2019, the World Health Organization (WHO) has declared a new coronavirus disease-19 called COVID-19 as a pandemic. COVID-19 was primarily appeared in the city of Wuhan in China and has grown rapidly worldwide as shown in Fig. 1. The COVID-19 pandemic has generated an unusual economic and health crisis that required a rapid response from medical professionals, government organizations, and scientists. Due to limited resources and the urgent demand for medical supplies, this crisis has required quick and innovative solutions. The innovative use of emerging technologies has been introduced to meet growing demands. The scientific response to combat COVID-19 has been much faster and more widespread. At the end of 2019, the number of published academic research including the word "coronavirus" reached 755 articles [1, 2].

Scientific researchers have brainstormed ideas that can narrow the crisis and improve the prevention of future pandemics. Not only medical specialists but also scientists assisted with digital technologies have tackled the pandemic with novel approaches. The main digital effort was obtained from the Artificial Intelligence community in the automated detection of COVID-19 using "CT" computed tomography and X-ray scans. Many efforts have been made to analyze the emotional and social behaviors using social networks, such as the detection of COVID-19 from cough samples, obtaining academic articles for semantic analysis, and automated follow-up of contacts [3].

The main objective of this chapter is to show the effectiveness of emerging technological developments that are being executed to combat the COVID-19 pandemic. This chapter surveyed cutting-edge solutions using these emerging technologies. In

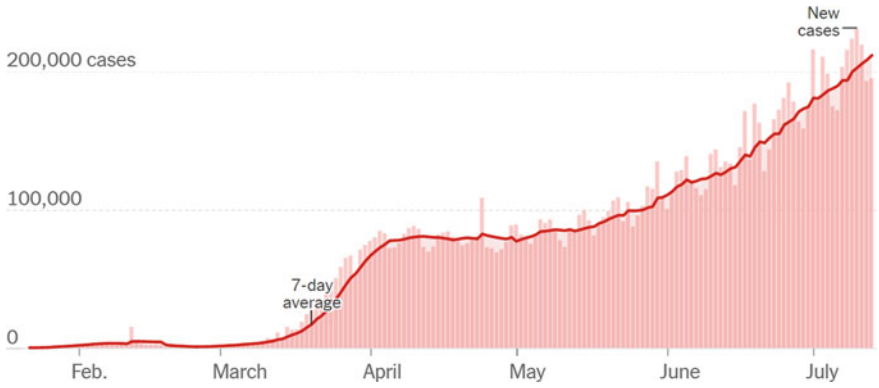

Fig. 1 Global COVID-19 trend for 11 July 2020 (*source* **NYTimes**)