

Robotics and Artificial Intelligence Applications in Manage and Control of COVID-19 Pandemic

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Abstract—Robotics and Artificial Intelligence (A.I.), applications have played an essential role in managing and controlling COVID-19 pandemic specifically in hospitals, hotels, restaurants, airports, transportation systems, schools, and others community levels. Artificial intelligence technologies, autonomous vehicles, drones, mobile robots, humanoid robots, manipulator robots and other intelligent robots are used potentially during the outbreak to control the transmission network from person to person. Due to the highly uses, we consider A.I. and robotics in health will likely continue after the COVID-19 pandemic and development of these technologies is needed for fighting against infectious diseases. Furthermore, the uses of these systems in different fields like industry, sports, ergonomics, distribution of goods, and social life will keep going in the coming years. In this article, the artificial intelligent devices and robots helped in fighting, and managing covid19 are explored, including the new trends. These new trends are led by artificial intelligence, autonomous driving, network communication, cooperative work, nanorobotics, friendly human-robot interfaces, safe human-robot interaction, and emotion expression and perception. Furthermore, these news trends are applied to different fields such as medicine, health care, sports, ergonomics, industry, distribution of goods, and service robot. These tendencies will keep going their evolution in the coming years.

Keywords—artificial intelligence (A.I.); autonomous systems; robotics; COVID-19; wearable technologies; drones

I. INTRODUCTION

By the end of October 2020, more than fifty million infections had been reported worldwide, with recently caused over 1,268,000 mortality cases as presented in Figure 1. COVID-19 epidemic has affected millions of people worldwide, including the health of workers and economic aspects among the community. Up to now the only way to stop this outbreak is to keep social distance. The evidence from China and elsewhere shows that Robotics and A.I.' technologies can help fighting against COVID-19 and keep social distance between people and doing some development and needed [1]. The pandemic of COVID-19 lead scientist to create some new technologies and innovative tools to control the outbreak [2].

On other hands, Robotics and A.I., and other technologies have grown up and have been used in different multi-area such

medicine, industry, and social life settings to provide doorkeeper, housekeeping, food, and other service tasks [3]–[6]. The current COVID-19 pandemic has brought forth new application and prospects for robots, including drones, delivery robots, disinfection robots, medical robots, and service robots, for fighting against COVID-19 [7], [8].

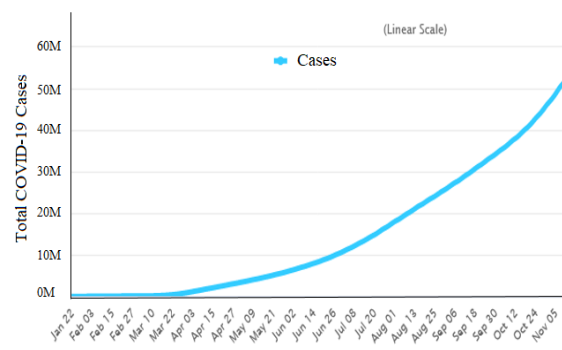


Figure 1. Total confirmed COVID-19 cases in the world (November 10, 2020) [1].

While it is too early to realize what life will look like exactly when it emerges from the COVID-19 lockdowns, It is highly expected that all forms of these technologies used to manage this pandemic will continue to play an important role if developed effectively. These technological innovations may also help achieve the goals of a more sustainable form of social life. Emerging technologies aided in the study of COVID-19, the development of advanced diagnostic equipment, investigating for the cure and vaccine, and responding to medical supply shortages. The advanced use of emerging technologies will continue to have a deep impact on our ability to manage this crisis and should continue to be utilized to help fight this pandemic. This review aims to study the applications and uses of the emerging technologies implemented to manage and control COVID-19 pandemic. The emerging technologies in this review include artificial intelligence (A.I.), robotics, internet of things (IoT), and autonomous vehicles. These technologies raise some questions such as "What roles can robots and other emerging technologies play in health, industry and public life?" How will people's lives be affected after deploying emerging technologies during the COVID-19 pandemic?

II." THE CONTRIBUTION OF ROBOTICS AND ARTIFICIAL INTELLIGENCE (A.I.) IN MANAGING PUBLIC HEALTH AND INFECTIOUS DISEASES

Robots, autonomous vehicles, and A.I. systems have the potential to be deployed to assist in public health and infectious diseases in many ways .for example it can be used for disinfection, measuring symptoms signs, assisting in border monitoring, and delivering medicines, and food. Also it can help stop the spraes of infectious diseases or in large screening and monitoring During the Ebola outbreak 2015, seminars organized by White House Office of Science and Technology Policy and National Science Foundation acknowledged three broad sectors where robots and autonomous vehicles can make a difference: medical care(e.g., decontamination and telemedicine), reconnaissance (e.g., monitoring compliance with voluntary quarantines), and logistics (e.g., contaminated waste handling and delivery) [7]. Most of these applications are being deployed in China and other countries, although many of those tools have shown some scientific limitations. Hereafter we mention some examples for these technologies during COVID-19 pandemic and Table I present some of these technologies that are being used during this pandemic

III." ARTIFICIAL INTELLIGENCE, AUTONOMOUS VEHICLES AND ROBOT'S APPLICATIONS DURING COVID 19

TABLE I. " SOME OF TECHNOLOGIES THAT ARE BEING USED DURING COVID-19 AND THEIR CHARACTERISTICS AND PURPOSES

Applications	Purposes	References
A Headset Like Wearable Device	Track COVID-19 Symptom	Stojanovic, et al. [13]
Fuzzy Based Sliding Mode Control (FBSMC) and Fuzzy Monitored Adaptive Sliding Mode Control (FMASMC)	Control robots in hospitals	Qureshi,et al [14]
The UV-Disinfection Robot	Disinfection robot for hospitals, production lines and pharmaceutical companies	RUBÆK, et al. [11]
Miniature Robot	to Assist the COVID-19 Nasopharyngeal Swab Sampling	Wang, et al. [15]
Repurposing factories with robotics in the face of COVID-19	Ramping-up the production of ventilators by using collaborative robots	Ali, et al. [16]
3D laser scanning	Allows production of personalized masks by measurement of exact facial parameters	Swennen et al. [17]
A contact tracing smartphone application	Wireless and Bluetooth used to identify people who have been in close proximity with COVID-19 patients.	Baharudin,et al. [18]
A.I. system for rapid diagnosis of patients with COVID-19	AI system based on machine learning and deep learning models that combines patient history and information	Mei, et al. [19]

A.I. technologies, Autonomous vehicles (A.V.s) and Robots have made significant progress in fighting against the COVID-19 pandemic. Robotics systems have drastically decreased the risk of infectious disease transmission to frontline healthcare workers by making it possible to monitor, evaluate, and deal with patients from a safe distance. Furthermore, they played significant roles in medical filed, engineering, science and at the community level [8]. As authorities and medical associations struggling to manage the transmission of the COVID-19, new technologies are being used to contribute to the health care systems and accordingly, reducing the stress of the healthcare staffs. Hereafter we mention some examples for these technologies during COVID-19 pandemic and Table I present some of these technologies that are being used during this pandemic.

A. Robots

Robots used in the publics have two primary purposes, one is disinfecting and monitoring spaces, to protect the health of residents and the other is to ensure an adequate supply of foods as it has been used in Wuhan city, China [9] and other cities in the world. Mobile robots perform a vital role in removing individuals from dangerous environments. Also, several different legged wheeled and tracked robot platforms which have been equipped with tanks containing disinfectants liquid have been deployed to fight covid-19. These are modified versions of robots aimed at other applications such as crop spraying. They have been used to sterilize outdoor areas in Wuhan, Shenyang, and Hangzhou, and they are mostly remote-controlled from a phone or tablet. Besides, COVID-19 lead the overall companies to the redevelopment of the old version of their robots to adapt to the new environment [10]. As an example, spot robot is shown in Figure 2 which developed by Boston dynamics company, and it has a universal mounted tablet that facilitates video conferencing with patients in portrait or landscape mode. Also, this robot has attached with monochrome cameras and infrared cameras to check the body temperature and breath rate [10].

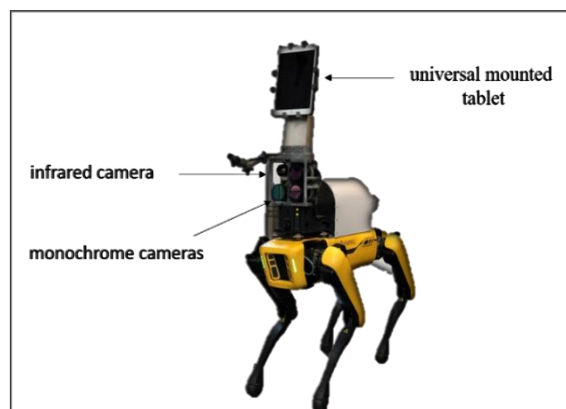


Figure 2." Spot robot used during COVID-19.

Another example is TIAGo robot which is modified to be equipped with a thermal camera to detect patient

temperatures, and now it has a version fitted with a thermal imager that takes remote temperatures from groups of people.

B. Autonomous Vehicles and Drones

Autonomous vehicles and drones are being used during COVID-19 pandemic to assure enough social distancing, thus preventing the spread of COVID-19 virus and protecting lives. These new technologies applications include but are not limited to, delivering foods and essential items, and patrolling for detecting peoples. They check whether the person is wearing a mask or not, the detected person is singular, in couple, trio or a group; whether the individuals are indicating any symptoms of COVID-19, etc. and whether those individuals are abiding with social distancing regulations. Besides drones used for surveillance have emerged, other drones have additional communication features that can listen to sounds and allow enforcer to speak through the drone to the target people remotely. Other features are object recognition, navigation by lidar, human activity recognition, video analytics, obstacle avoidance, autonomous flying abilities, etc. If they had to be carried out by merely flying drones, A.I. is essential to be added to it to breathe life into those machines and make them intelligent enough. Also, Ultraviolet (U.V.) Disinfection Robot, which shows it is effective during COVID-19, is used for many hospitals in China and Europe for hospital sterilization [11].

China is a pioneer in using Autonomous vehicles coupled with thermal cameras to check walker's temperature from the sky. These techniques were showed effectiveness in scanning gatherings to pick out COVID-19 suspected patients. [12]

Using delivery drones in China reported that it reduced delivery time compared with road transportation, and it took individuals out of the process, which helped to decrease the spreading of COVID-19 virus. Drones also helped quickly diagnose and quarantine infected people by using it to bring testing samples to laboratories. More importantly, drones were used to transport medical supplies into hospitals where COVID-19 patients are being treated

C. Artificial Intelligence

Artificial Intelligence technologies is an upcoming and valuable tool to detect early infections to coronavirus and all infectious diseases in general and monitor the patients' conditions. It can significantly improve treatment consistency and decision making by developing some useful algorithms. Scientists have used machine learning and deep learning models to study, diagnose and treat COVID-19. AI also is good for health monitoring. It can track the crisis of COVID-19 at different scales such as medical, molecular, and epidemiological applications. It is also beneficial to accelerate the research on this disease by analyzing the available data. A.I. can help in prevention strategies, developing proper medication regimens, and in drug, and vaccine development. For example, Stefanovic et al. developed a headset that can detect people's temperature and determine any suspected cases for COVID-19. Police and doctors could use these headsets to minimize their infectious rate [14]. When it comes to transferable diseases, surveillance, prevention, and rapid-response efforts can go a long way toward slowing or stalling

outbreaks. However, as artificial intelligence and machine learning become increasingly significant parts of the public health systems, a modern strategy has emerged to help fight against infectious diseases.

Moreover, researchers are developing new ways to use A.I. for predicting infectious diseases spread and effect before it happens. Successful implementation of predictive modelling could represent a significant tool in the prevention and fight to rid the world from some of the most dangerous infectious diseases.

Furthermore, A.I. algorithms are being used to help public health officials enhance their prevention and public awareness efforts. although A.I. still in preliminary stage, public health officers and epidemiologists have already begun to see some of these benefits.

IV." CHALLENGES

Robotics and A.I. technologies have been at the forefront of fighting against COVID-19 pandemic. However, there is a need for the combination of tools like Drones, Robots, and UAVs with telemedicine platforms, A.I., Internet of Things (IoT) technologies and advanced data analytics, to develop an efficient system for monitoring the crowds, detecting suspected individuals, and providing treatment to them, all without the need for any physical human contact. In the future, such an epidemic control system also has the potential to be the basement for developing more dynamic smart city management model. However, at present, the deployment of robots and artificial intelligence in fighting COVID-19 have also reported some limitations such as; 1st Overall new technology is high cost and it is not easy to any person or any developing countries to obtain it; 2nd Robots prove that cannot play an effective role unless with integrated with other new emerging technologies such as A.I., IoT, data analytics and cloud computing; 3rd At present time those new tools have no privacy for patient's and users data which collected by this tools. Although the wide-scale deployment of robots and artificial intelligence systems in the healthcare systems is prospective to take a few more years, an increasing number of hospitals are already contemplating the use of this healthcare systems to enhance the quality of medical service and patient experience, reduce the cost of medical care and minimize the burden on healthcare personnel.

V." CONCLUSION

As cases of COVID-19 continue to increase, and no cure has been shown for this disease up to this moment, so the responsibility for limiting and controlling its impact depends largely on the new emerging technologies such as drones, robotic, IoT, and A.I. Applications. In the context of the rapid spread of the pandemic worldwide, open access to knowledge and technology is essential for a timely response. Standards regarding patient-generated data, including confidentiality, must be adhered to by authorities. Besides, safety standards for the production and distribution of supplies and services must be constantly monitored while new technologies are used. Treatments identified using emerging technologies must also be subject to clinical trial standards. Society needs to strive to uphold all these safety standards to ensure the best

outcomes for patients. Great efforts of various emerging technologies still need to be done to develop more effective and economical tools to help control and manage the impact of COVID-19 pandemic. Integration between engineers and medical researchers is important for developing effective and economical methods to prevent and manage this epidemic. Keeping this as the foundation of this work, we began this comprehensive review with the situation of covid-19 in which we explore its impact and total cases till now. Following that we review the artificial intelligence technologies and robot's applications deployed during COVID 19, in which we present its features, effectiveness, and diagnosis procedures. After that, we discuss the challenges to use these technologies in fighting COVID-19. We also list various research efforts related to these technologies to help manage and control this pandemic.

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