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Review Article

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Role of Digital Technologies During COVID-19: A Rapid Review

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Abstract

Many countries across the globe are suffering from global health crises due to COVID-19. COVID-19 infected millions of peoples across the globe. Almost every nation in the globe is extremely concerned about the effects of the COVID-19 epidemic. In order to help the global public health response to COVID-19, digital technologies are being used. This paper systematically analysis the applications of Digital technologies to battle the pandemic. Role of digital technologies like Internet of Things (IoT), Internet of Medical Things (IoMT), drones, and robotics used in health care sector is broadly discussed. This paper helps the doctors and medical researchers to fight the pandemic with the help of digital technologies.

Keywords

COVID-19, Internet of things, Internet of medical things, Robots, Drones

Introduction

Infectious acute respiratory syndrome coronavirus-2 is a member of the single-stranded, positive sense RNA virus family coronaviridae (SARS-CoV-2). COVID-19, known as "Coronavirus-2019," is a respiratory disease caused by this virus. It affects the respiratory system and causes symptoms including coughing, fever, tiredness, and dyspnea, much like the influenza virus. Coronaviruses are positive-sense RNA viruses with spherical, 600 - 1400 Å diameter [1-3]. When seen under an electron microscope, coronaviruses have the appearance of a crown because of the spike-like proteins that cover their surfaces.

The virus's precise origin is experts have mapped its genomic sequence despite being unknown and found that it belongs to the CoV genre of the coronavirus, that normally get their genetic material from rats and bats [1]. In China's Wuhan City Hubei region, the COVID-19 was first noted to have an impact on human life in December 2019. The COVID-19 has now been detected in 213 nations and autonomous territories, spreading like wildfire over the remainder of the world [2]. The necessity for fast actions to stop the COVID-19 outbreak's disastrous impacts has been spurred by the sharp increase in COVID-19 events throughout the world. the potential for various technologies to lessen the negative impacts of the pandemic and hasten the healing process. With digital technology, nanotechnology also used with various fields.

Diagnostic instruments

The creation of quick and accurate diagnostic instruments is aided by nanotechnology. Testing can be completed more quickly and accurately if viral components can be identified using nanoparticle engineering.

Development of vaccinations

By acting as carriers, nanoparticles can improve the stability and efficacy of vaccinations. For example, certain COVID-19 vaccines use lipid nanoparticles to securely transfer genetic information into cells.

Antiviral materials

To lower the danger of viral transmission, a variety of settings can benefit from the application of nanomaterials with antiviral characteristics. These substances might consist of nanoparticles coated on their surfaces to prevent viruses from proliferating and spreading.

Medication delivery

Targeted medication delivery is made possible by nanotechnology, and this is very useful when treating COVID-19. Antiviral medications can be directly delivered using nanoparticle design.

Pandemic diseases

The bulk of these outbreaks were caused by corona viruses like SARS-CoV and MERS-CoV, but the four recent pandemics were all caused by distinct influenza viruses including H1N1, H2N2, and H3N2. Two more pandemics like Spanish Flu in the year 1918 and the Swine Flu in the year 2009, were brought on by the H1N1. While the Asian Flu in the year 1957 and the Hong Kong Flu in the year 1968 respectively, caused by the H2N2 and H3N2 viruses (Table 1) [4].

Digital Technologies Used to Handle Pandemic Diseases

As a first line of defence, the government has chosen to employ a variety of technologies. Like application of IoT, IoMT, drones, robots, etc. IoT is a technology that consists of networked computer device that transfer data across the network automatically. Recently, the healthcare sector has shown a lot of interest in IoMT. It consists of combination of hardware and a software program linked to healthcare IT systems. The creation of the vaccine is the first problem in present pandemic and also to find an effective method of reaching the patients is another problem. The IoT idea is the most effective way to accomplish this.

Drones and robots are examples of audio-video technology that can help to access to COVID-19 patients which minimizes human engagement. Wearables, such as Bluetooth and GPS technology, are another useful way to monitor health and level of stress.

Table 1: Data related to the statistics of past pandemics.

Disease	Year	Deaths (in millions)
Spanish Flu	1918	50
Asian Flu	1957	1.1
Hong Kong Flu	1968	1
SARS-CoV	2002	774
Swine Flu H1N1 (new strain)	2009	1.5
MERS	2012	871

IoT and IoMT

For various reasons, IoT is growing in popularity. Widespread use of broadband internet, low cost of technology, and the vast number of individuals who own smartphones, wearable data collection devices, and other "smart" items are the main drivers of this trend.

IoMT uses a variety of networking technologies to connect the healthcare information technology systems by combining medical equipment and applications. With a significant portion of international healthcare institutions currently utilizing it, IoMT is quickly finding its place in society. IoMT is a smart platform that employs intelligent sensors, intelligent gadgets, and cutting-edge communication protocols to analyze biological data and then diagnose patients' illnesses with minimal human participation (Figure 1).

- Remote patient monitoring is one of the IoMT applications.
- Medication order monitoring.
- Sending the concerned healthcare specialists, the medical data tracked by the wearables [5].

Disease monitoring

An effective monitoring and surveillance system is required for tracking patients in the present pandemic as the number of COVID-19 patients is rising at an alarming rate. In terms of contact tracking, cluster detection, and quarantine compliance during this pandemic, IoT can be quite useful. It is crucial to spot sick people in crowded areas, and infrared thermometers are typically used to achieve this. However, it does not appear to be very effective because, first, the thermometer might not reach everyone in the throng and, second, it might cause the virus to spread since a health official must check many individuals who are waiting in line, and any one of them could be sick. As a result, a substitute technology is needed, and IoT appears potential [6]. IoT technologies adapted for effectively identifying the patients.

Smart thermometers

By connecting to a smartphone application, these thermometers may send their readings right away to the business. The data is processed by Kinsa to generate regular maps that

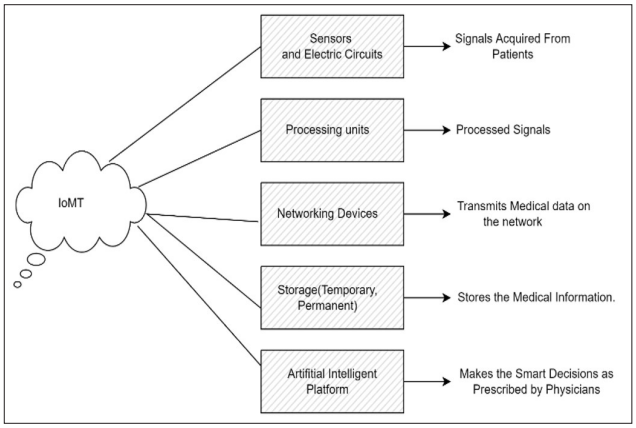


Figure 1: Architecture of IoMT.

reveal which United States (US) regions are experiencing a upsurge in high fevers, enabling the US authorities to pinpoint possible hotspots. In recent years, Kinsa's maps has demonstrated a high level of accuracy in the quick forecast for spread of virus throughout the US, surpassing even the CDC's official app [4].

IoT buttons

Hospitals themselves may be a major source of infection risks for staff as well as patients. Many hospitals in Vancouver have kept battery-operated IoT buttons to reduce this hospital acquired infections and to maintain excellent hygiene [4]. Any size facility may quickly implement these battery-operated buttons. They serve to quickly inform the supervisors so that they may be made aware of cleaning and maintenance concerns which can pose a risk for public safety [7].

Disease management

Due to the fast spread of COVID-19, tight lockdown measures have been put in place worldwide to stop the transmission of illness. An estimated Ten billion individuals have quarantined themselves at their home, according to the estimate. On the other side, there has been a large demand for crucial medical equipment and supplies. The inhabitants, some of whom may be prospective patients, must leave their houses in order to seek medical attention, which runs counter to the efforts being made for isolation and quarantine.

The medical professionals are advising anyone with minor or suspected symptoms to be at home due to the shortage of isolation units and appropriate medical equipment. In such a dire case, IoMT may be utilized as a medical podium to construct a comprehensive illness management database for governments and healthcare organizations as well as to assist the afflicted persons in getting the appropriate healthcare facilities at home. The measures for COVID management are as follows:

- Patients with minor symptoms do not need to be admitted to the hospital. Instead, consumers may purchase the medical equipment they need, including POC kits, masks, gloves, sanitizers, and thermometers, to detect and monitor COVID-19 to give prescriptions at home.
- Patients are using the internet to upload information about their routine health condition to the IoMT platform, where it will be disseminated to nearby hospitals, the CDC, and regional health organizations.
- Depending on each patient's health situation, doctors could provide online consultation. If necessary, CDC and other health organizations might then allocate tools and sites for quarantine.

Drone technology

Unmanned aerial vehicles (UAVs) include any aircraft with no human pilot present (UAV). It has a ground controller and a channel of communication between the two. Most of the drone use is for military purposes, commercial purposes, scientific research, the agricultural industry, medical applications, and other uses [8] like crowd-policing and surveillance, drone racing as a hobby, aerial photography, etc.

Drones used for surveillance and screening at COVID-19

To effectively survey locations and watch crowds, Micro Multi Copter, a top industrial drone manufacturer located in Shenzhen, China, has placed over 100 drones in numerous Chinese cities [9]. The drones' sky speakers may be used to provide instructions to anyone who are not following the rules set out by the Chinese government.

Unmanned aerial spectrum monitoring technology has been given to the Telangana police in India by the international technology solutions company Cyient to assist in managing the COVID-19 lockdown. The police can respond quickly to any unwanted situation because to the surveillance cameras on the drones that have been deployed, which can efficiently monitor critical metropolitan regions [10].

To halt the COVID-19 virus's proliferation in India, New Delhi government has used a multifunctional drone. The "corona combat" drone contains a tank with 10 liter of disinfectant for cleaning public places, night vision and thermal cameras, a medical box for medical supplies, and other features [11]. Unlike infrared thermometers, which can only detect the temperature of one person at a time, this drone can be used to monitor the temperatures of many people at simultaneously [12].

Drones for public announcements

Drones may be incredibly helpful for transmitting crucial information in addition to monitoring crowds, especially in places with limited access to open channels of communication. Officials have employed drones in California, Florida, and New Jersey to deliver messages to homeless populations or to inform and caution citizens about social exclusion. To educate the public of the rules established for the declared state of emergency, the police at Madrid in Spain, utilized a drones fitted to a loudspeaker [13]. European governments are also deriving advantage through drones; numerous countries used drones for public announcements to make awareness during pandemic to limit spread of illnesses [14].

Drones used for medical supply

In addition to the needs for personal protective clothing, technology to allow the remote monitoring the patients with mild symptoms, the virus increased the demand for laboratory testing. Delivery by drones has shown to be a practical answer in this situation as they are used to transfer samples from the hospitals to laboratories, supply necessary safety gear like masks and gloves, and deliver medical gadgets to patients home for monitoring remotely.

As it eliminates the need for people to access affected areas and run the danger of getting the virus, disinfection by drones has shown an efficient method for reducing transmission of coronavirus. With Spain being the first European nation to do so, these cleaning drones have effectively deployed in nations including China, Indonesia, Chile, and UAE.

Food delivery by drones

Demand for meal delivery services has never been stronger because the majority of eateries were closed, and the public is advised to be indoors so as to halt spread of the coronavirus. As COVID-19 is so infectious, more delivery firms have chosen contactless delivery methods to reduce the danger of infecting consumers as well as delivery personnel. Drones are the perfect tool for contactless food delivery, and the Chinese e-commerce business JD has employed them to carry food packages to outlying regions of the country with great success. Figure 2 shows how drones perform different tasks at COVID-19 [15-17].

Robots

Robots are intelligent devices that were used at COVID-19 pandemic. Due to the lower danger of infectious disease transmission from patients, robots may readily be employed as frontline soldiers in medical units. Additionally, the ultraviolet (UV) disinfection technique is simple to use robots to protect dangerous disease-prone locations using standardized practices, minimizing the spread of the illness through surfaces in hospitals or isolation facilities that are polluted. It is advised to use disinfecting robots with little to no human touch, which entails cleaning, and their lives are at jeopardy [18].

Disinfecting/spraying robots

Around the world, the usage of portable robots for item cleaning and disinfection is expanding quickly. In the case of communicable illnesses like COVID-19, cleaning and cleanliness are unavoidably crucial for ensuring safe indoor and outdoor circumstances [19].

One such robot for disinfection is UVD-bot. It is an autonomous germ-killing robot that works with UV radiation (UVC-254 nm). The coronavirus is effectively neutralized by the UVC light employed in this robot because it causes problems with DNA base pairing. The result is completely autonomous and quite effective in disinfection, and it can clean a room in less than ten minutes. The robot's main function is to sanitize hospital facilities, preventing people from polluted areas from coming into close touch with patients [20].

Our robot, Mila grow iMap9, uses a traditional technique for cleaning. In accordance with the ICMR's recommendation, the iMap9 uses sodium hypochlorite for cleaning surfaces of COVID-19 carrying spores. The working period according to the performance specifications is between 60 and 130 minutes after a full charge. A mobile application may be used to control its functioning [21]. It can disinfect the floor entirely automatically. The robot's internal HEPA filter is exceptionally efficient and removes 99.97 percent of everything which is less than 0.3 m. This bot's use of very accurate sensors ensures live mapping, ensuring that no area is missed out on cleaning, which is a benefited to control infections.

Hospitality robot

Due to the pandemic, which has increased the mortality rates among healthcare personnel, the job of receptionist and nursing robots has been quickly expanding [22]. Three distinct sorts of robots—a nurse robot, a medical server robot, and a receptionist robot—perform the responsibilities [23].

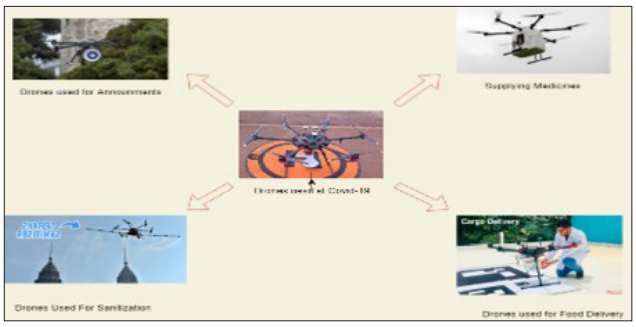


Figure 2: Drones performing different tasks during COVID-19.

An illustration of a hospitality robot is Sona 2.5. It was created with the use of intelligent obstacle avoidance technology, has a vision camera for facial recognition, and can transport up to 15 kg, making contactless delivery feasible.

Rail Bot's (R-Bot) infrared capabilities plus the presence of a nightlight with a roughly 6-hour battery life make it possible to performs the necessary functions while also having the advantage of being able to work in the darkness. R-Bot is controlled by a smartphone app through Wi-Fi and provides two-way audio and video communication, making it easy for doctors to keep an eye on their patients [24]. Figure 3 show robots helping individuals during COVID-19 [25].

Teleoperation and telepresence systems

A dual-arm robot (YuMi, IRB 14000) and sensing device are used in teleoperation systems so that information about the operator's upper limb movement may be collected and utilized to remotely direct the robot's motion. The finger actions are seen when wearing gloves [26, 27].

Healthcare professionals can watch patients using two-way audio-visual communication using telepresence system, which are same as teleoperation systems containing feature of voice over internet protocol. Typically, these robots have capacitive touch screen attached in front (Table 2). And the audio/video conferencing system that is based on Web-Real-Time Communication is used to facilitate communication between the patient and the medical staff [28, 29]. Figure 4 shows how robots worked essentially at hospitals to serve patients [30].

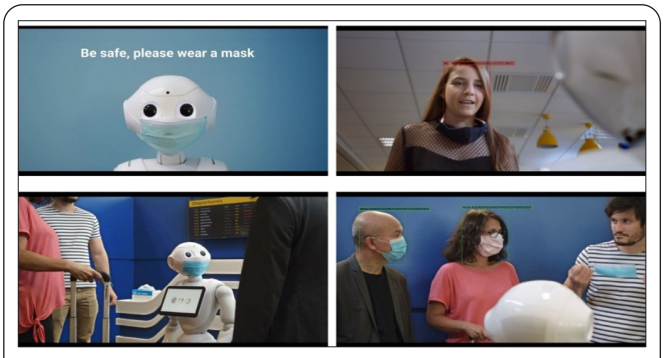


Figure 3: Robots interacting with peoples to reduce spread of virus.

Table 2: Telepresence robots used during post-pandemic.

S. No.	Telepresence robot	Description
1	Niga-Bot	A mobile telepresence robot named Niga-Bot is used to conduct real-time audio and video conferences between patients and medical professionals.
2	Maitri	The robot has an LCD screen that allows medical professionals to communicate with patients remotely. Its height is 3.5 feet. It has Wi-Fi capabilities and can be controlled with a smartphone. After being charged, the battery gives power to robot up to eight hours. Because of its versatility, Maitri may also be used to provide patients with food and drink.
3	Zorabot	With the aid of its attached camera and image processing abilities, the robot is able to converse in 53 different languages, determine whether someone is appropriately donning mask and gives a count of people present in a space. The robot can monitor visitors' body temperatures using thermal cameras and respond appropriately.



Figure 4: Robots became essential workers in the COVID-19 response.

Surgical robots

Since autonomy promises several benefits, including mechanical accuracy, stability, and the capacity to operate in dangerous conditions, engineers and medical researchers have been working continuously to apply it to surgery [31].

Wearables used during pandemic

The phrase "Wearables" refers to a group of electronic and wearable devices that can be implanted within the body, incorporated into clothing and accessories, tattooed on the skin, or worn hands-free. Motion or sensors on wearable technology provide real-time data tracking and wireless transmission.

Smartwatches offer data on activity patterns, heart rate, and sleep duration. This may be supplemented in the future with new wearable technology that track things like cortisol levels for stress tracing, biomarkers of inflammation and blood oxygen levels, skin temperature and many more [32-34]. The gadgets can be utilized to remotely track the healing of patients by receiving treatments or isolating themselves at homes. Table 3 shows the different digital wearables used to detect the patients' health [35, 36].

Wearables help to be aware of the symptoms, signs, and biomarkers present in patients who have already contracted COVID-19 in order to quickly assess, identify, and stop the disease's long progression, reduce the risk of chronic effects, and help patients return to their pre-COVID-19 health.

Table 3: Various wearable devices used to detect the human body at pandemic.

S. No.	Wearable devices	Uses
1	Smart textiles	Skin temperature, Metabolites
2	Electronic epidermal tattoos	Stress biomarkers
3	Face masks	Breathing pattern, Airborne pathogens
4	Smartwatches	Activity, Heart rate, Blood O_2 levels
5	Smart lenses	Intraocular pressure
6	On teeth sensors	Drugs (Ex: antivirals and antibodies)
7	Smart patches	Electrocardiogram
8	Microneedle patches	Checks metabolites (like glucose and lactate)
9	Wristbands	Electrolytes, Skin temperature
10	Smart rings	Blood pressure

Conclusion

This review investigates the applications of digital technologies in fighting global pandemic disease. This paper aims to explore potential spplications of IoT, IoMT, drones, robotics in health care sector. IoMT has been used for remote patient monitoring for the people who got effected. Drones used for supplying medicines, spraying disinfectants, etc., and robotics used for building a communication between patients and doctors. This review will be helpful for medical practitioners and researchers who planned to apply and use digital technologies for COVID-19. Researchers can easily understand the potential applications of digital technologies to fight various pandemic diseases.

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None.

Conflict of Interest

None.

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