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Healthcare Assistance to COVID-19 Patient using Internet of Things (IoT) Enabled Technologies

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ABSTRACT

The IoT can lead to disruptive healthcare innovation. Research articles on IoT in healthcare and COVID-19 pandemics are thus researched in order to discover the potential of this technology. This literature-based research may help professionals to explore solutions to associated issues and battle the COVID-19 epidemic. Using a process diagram, IoT's significant accomplishments were briefly evaluated. Then seven critical IoT technologies that look useful in healthcare during the COVID-19 Pandemic are identified and illustrated. Finally, in the COVID-19 Pandemic, potential fundamental IoT applications were identified for the medical industry with a short explanation. The present predicament has opened up a fresh avenue to creativity in our everyday lives. The Internet of Things is an up-and-coming technology that enhances and gives better solutions in the medical area, such as appropriate medical record-keeping, sample, device integration, and cause of sickness. IoT's sensor-based technology gives a remarkable ability to lower the danger of intervention in challenging circumstances and is helpful for the pandemic type COVID-19. In the sphere of medicine, IoT's emphasis is on helping to treat diverse COVID-19 situations accurately. It facilitates the work of the surgeon by reducing risks and enhancing overall performance. Using this technology, physicians may readily identify changes in the COVID-19′s vital parameters. These information-based services provide new prospects for healthcare as they advance towards the ideal technique for an information system to adapt world-class outcomes by improving hospital treatment systems. Medical students may now be better taught and led in the future for the identification of sickness. Proper use of IoT may assist handle several medical difficulties such as speed, affordability, and complexity appropriately. It may simply be adapted to track patients' calorific intake and therapy with COVID-19 asthma, diabetes, and arthritis. In COVID-19 pandemic days, this digitally managed health management system may enhance the overall healthcare performance.

1. Introduction

The Internet of Things (IoT) transforms the collection, processing and evaluation of information in many business ecosystems nowadays. IoT powered technologies and sensors can be found almost everywhere to gather, monitor and greatly enhance regular healthcare lives and redefine how healthcare facilities and systems enhance their lives. The Internet of things (IoT) enables physical devices to be connected to the Internet, and information may be delivered or received on the Internet. The IoT idea has developed into and from several technologies such as sensors, machine learning, real-time testing, and embedded systems. It deals with the intelligent hospital concept and other fixed- or wireless-based equipment. Intelligent gadgets may collect and exchange data in everyday life to achieve the necessary activity. Smart cities,

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transportation, electronics, entertainment systems, households and linked healthcare reach IoT applications. Different sensors, medical equipment, artificial intelligence, diagnostic and sophisticated imaging equipment are at the heart of medical IoT application. These gadgets enhance production and life quality in both old and new businesses and communities [1]. IoT interconnects all computer, mechanical and digital technologies for data transmission through the Internet without any contact between human beings. During the COVID-19 Pandemic, this technology is blooming in health monitoring. In the current environment, many individuals are dying because of erroneous and premature health information. This technology can instantly detect health problems by the use of sensors [2]. All patient information from COVID-19 is maintained in the cloud, which may further contribute to correct attention. This technology may record a person's regular activities and warn them of health problems. There is an essential prerequisite for the correct equipment to perform a successful medical procedure. IoT is able to do effective procedures and also to analyse progress after surgery. Therefore, the use of IoT helps to improve patient care during the COVID-19 Pandemic. Effective IoT monitoring works well and saves lives from many issues such as diabetes, heart failure, asthma, blood pressure, etc. Intelligent medical equipment is linked through a smartphone in order to communicate the necessary health data to the doctor effortlessly. They also capture information on oxygen, blood pressure, weight, sugar level etc.A trustworthy digital information system is a major medical problem during the COVID-19 pandemic that is tackled promptly by IoT [3]. Unfortunately, there are obstacles to investigating the technology, its advantages, and related critical applications to meet increased efficiency needs. However, due to its expanded capacity, it can answer many problems with new information during COVID-19 pandemics.

2. Integration of IoT in medical field

IoT is able to provide high-quality solutions with the aid of modern technologies. In the field of medicine, it becomes a new reality of an original idea that gives COVID-19 patients the most incredible service and executes exact operations. During the present pandemic, complicated situations are readily managed and digitally controlled [4]. IoT takes on new problems in creating effective support systems for physicians, surgeons, and patients in the realm of medicine. The various process phases are carefully identified for efficient IoT deployment. The IoT process chart in the health establishment is shown in Fig. 1.

3. Role of IoT in healthcare management

The IoT-enabled technologies made remote surveillance feasible in the health sector, unleashed the potential to safely and healthily maintain patients and empowered doctors to provide exceptional treatment. It also boosted patient participation and satisfaction with the facilitation and efficiency of contacts with clinicians. In addition, remote health monitoring helps to reduce hospital stay time and reduces re-admission. IoT also significantly affects cost reduction and improved therapeutic effects in healthcare [5]. IoT transforms the healthcare business, without any question, by altering the scope of devices and people's connection with solutions. IoT offers healthcare applications that benefit patients, families, doctors, hospitals and insurance businesses.

3.1. IoT application in patient

Wearables such as fitness belt and other wirelessly connected devices such as blood pressure and cardiac control, glucometer etc., are accessible to patients. These devices may be used to remember the number of calories, activity restrictions, appointments, blood pressure variations, etc. Through constant health surveillance, IoT has changed the lives of people, particularly older people. This has been a significant impact on people and families. If the regular activities of a person are interrupted, the warning system sends signals to family and health providers to draw immediate attention during crisis hour [6].

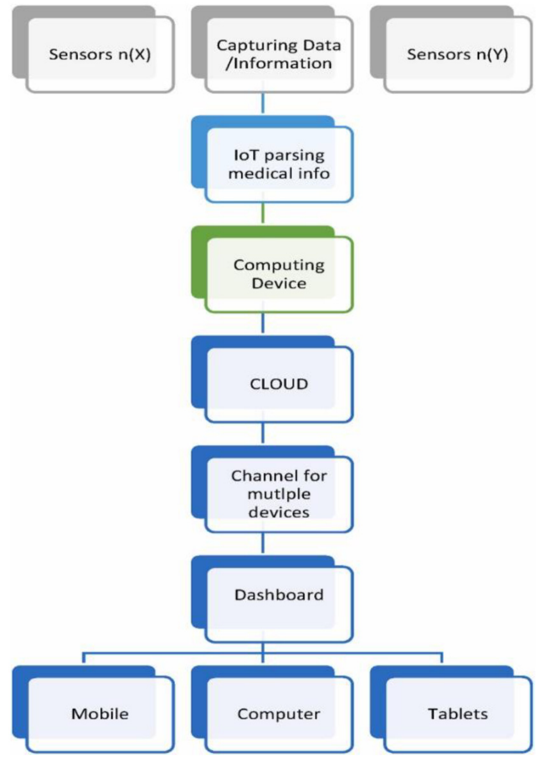

Fig. 1. IoT implementation process chart in the medical area.

3.2. IoT application for physician

The doctor can track patients' health more efficiently by employing wearables and other home-monitoring technology incorporated inside IoT. Any individual can monitor the adherence of patients to treatment regimens or any acute need for medical care. IoT helps healthcare workers to be more attentive and proactively engage with patients. Data gathered from IoT devices may assist doctors in identifying the patient optimal treatment method and achieve the desired results.

3.3. IoT in medical establishment/hospital

There are several more areas in which IoT devices are highly beneficial in hospitals, in addition to health monitoring. IoT sensor-marked devices are used to track medical equipment such as wheelchairs, defibrillators, nebulizers, oxygen pumps and other surveillance equipment in a real-time situation. Medical personnel deployment may also be evaluated in real-time at various sites. For patients in hospitals, infection spreading is a severe worry; in order to avoid the infection of patients, IoT-enabled hygiene monitoring devices aid. IoT devices also support managing assets such as control of pharmaceutical stock inventories and environmental monitoring such as refrigerator temperature and control of humidity and temperature [7].

3.4. IoT for health insurance companies

Health insurers with IoT-related intelligent devices have several prospects. For its underwriting processes and claims operations, insurance firms may exploit data collected through health monitoring systems. These data help them to detect allegations of fraud and to discover possibilities for a subscription. In the process of underwriting, pricing, claims management and risk appraisal, IoT devices provide transparency among insurers and clients. Within all operating processes, in the light of IoT-captured judgments based on data, consumers will have sufficient insight into the underlying thinking behind each choice and process result. Insurers might provide their client's incentives to use and share IoT medical data. For example, customers may incentivize IoT devices to monitor normal activities and comply with treatment and health care programmes. This helps insurers drastically minimize claims. IoT devices may also allow insurance firms to assess claims by the data they collect [8].

4. Existing healthcare monitoring system

Early Predictions system to detect various diseases has been made available. However, they have failed to meet the accuracy level, which occurs due to the wrong selection of Machine Learning models. The Dataset employed were very limited. Even if the models were constructed, they were not available with a user interface and were not user friendly. A normal person felt difficulty in accessing it. Some of the existing systems can show only the symptoms of diseases; they don't have the capability to analyze and generate reports regarding health issues in an individual [9]. Only a limited number of health issues are considered, due to which proper awareness was not created among people. Health-related diagnostics are accessible but quite expensive, making the electronic health system less accessible for rural people, requiring a course of strenuous activities to keep their health monitoring system. Moreover researchers are proposing various protocols in the field of healthcare [13–18] and vehicle communication [19–25] to protect the information exchanged among various devices to devices. Some researchers are providing various techniques for image privacy [26–30] and IoT based application [31–35].

4.1. Integration of IoT in health monitoring during COVID-19

4.1.1. Remote health monitoring

IoT devices are enabled to check heart rate, blood pressure, and blood glucose may keep patients with pacemakers or diabetes at home while their physician is aware of this problem. If data suggest a person facing a crisis, he or she may be transferred swiftly to a hospital, but otherwise, he or she may stay monitored by IoT systems for home safety [10]. As senior health facilities were the vectors for COVID-19, physicians had difficulty finding strategies to treat chronically sick patients and the elderly without posing a danger to others. Healthcare IT News noted that relief money might be used to monitor remote and to do virtual visits to reduce the danger of transmission.

4.2. Telehealth consultations

The infectious characteristic of the virus prompted doctors to use video chat to identify whether or not the patient has been exposed to the virus without having been met. Communication utilizing technology and indoor restricting is an excellent alternative to the mass rush of acute viral versions witnessed at hospitals and elderly homes.

4.3. Digital diagnostics

For monitoring health data following digital diagnosis, many sorts of IoT devices are employed. Compared with conventional thermometers, the advent of intelligent thermometers by Kinsa can gather vital information to exchange with health specialists and follow trends to improve community protection.

4.4. Robot assistance

IoT robots are becoming more common. It is used to disinfect equipment, clean hospitals, and provide medications, which gives health professionals more time to treat their patients. For example, China is the first nation to deploy a Danish company's UVD robots to clean its healthcare facilities during the crisis. These robots employ IoT and aid in the disinfection of treatment zones in nursing homes and clean rooms.

4.5. Tracking

Smart IoT powered tracking thermometers might monitor the disease transmission through fever spikes from their gadgets. This consolidated data helps to monitor where an epidemic might occur among the people in their own areas. The option to build a distinct profile for each user in the homemade collection and distribution of cleansed, anonymous data even better. These thermometers [11].

4.6. Vaccine cold chain monitoring

In poorer nations, delivering necessary immunisation services during COVID-19 has been problematic. Mobile technologies and IoT can optimise the supply chain of the vaccination. Cold chain data loggers deliver correct information from condition records over the mobile data networks to the cloud through IoT sensors put on the vaccine. One example is the IoT-enabled mobile technology, eVIN, created by the UNDP and the Indian government, providing real-time logistical management across the cold chain. The application – coupled to vaccine-positioned IoT sensors – monitors the location, temperature and inventory of vaccine, assuring safe and dependable delivery. The use of eVin in India led to an 80 per cent decrease in vaccination inventory [12].

4.7. Healthcare delivery drones

The IoT-enabled drones have shown to be the lifeline in developing country populations for testing, EPIs, medications and other essential health supplies. Since May 2020, Zipline has allowed drones to deliver crucial medical supplies to Rwandan and Ghana rural health institutions. The drone firm supplies over 160 therapeutic goods, servicing over 2,500 hospitals and health centres across Rwanda and Ghana throughout the epidemic. Other kinds of drones were active in the disinfection or detection of symptoms connected to COVID.

4.8. Disinfection process

In hospitals worldwide, non-chirurgical robots linked to IoI were put to operation, patient rooms were cleaned, COVID 19 was disinfected and sterilised, and special UV light was added, which destroys the virus efficiently. The robot enters the room, and the door is closed since the light might be dangerous to people. After completion, the robot warns personnel about the safety of reopening the entrance outside the chamber. This decreases the danger for primary caregivers in the hospitals and other medical facilities and speeds up the patient cabinets to be changed and ready for the next tenant. IoT was already helping patients before the epidemic spread in healthcare. In addition to managing insulin consumption and exercise or adjusting the pacemaker rates, IoT mainly monitors matters for seniors (currently at most significant risk) based on the patient's condition and demands. Connected wireless devices improve remote monitoring for quicker assistance in a crisis. In addition, IoT can follow marked devices and notify emergency concerns. For example, if an overturning wheelchair or a malfunctioning nebuliser, or a tank of oxygen begins to be running blank, assistance may be sent forthwith. In the face of COVID-19, Medical IoT continues to safeguard patients and health staff equally and will increase even more in a post-pandemic future [7,].

5. Challenges and opportunities

IoT implementation is typically challenged by connection, power, spectrum, bandwidth and costs. Nevertheless, the lowered costs for the use of IoT in healthcare are predicted to drive (including sensors) and greater mobile broadband adoption. The cost-effectiveness of standardized low-energy wireless technologies also contributes to this trend. In addition, large-scale use of technology in the health sector is based on the transfer of health data and records, which raises issues over privacy and security. These concerns have led to the implementation of national IoT regulations in developed markets [6]. However, appropriate laws in poor nations are still needed to boost IoT adoption. Lastly, IoT-applied healthcare is often limited. To achieve a diagnosis, a substantial percentage of health problems need a physical examination. In addition, photos and videos delivered using IoT-powered telemedicine may lack high-quality resolution and need physical treatment.

The involvement of mobile carriers may speed the adoption of IoT in healthcare. One illustration in point is Controller, a company specializing in cold chain monitoring products. The organization cooperates with Vodafone Mobile Operator to monitor Controlling Vaccines data using the Vodafone Managed IoT Connectivity Platform in real-time. As Europe and the Americas have become Controllant's growth area, the company extends its area of operations to Africa with test projects scheduled in Kenya and Nigeria. Such mobile alliances will provide new potential for IoT-enabled healthcare in underdeveloped areas. IoT technology provides emerging economies with a chance to combat COVID-19 effectively and especially in order to drive the digitalization of health systems by bridging significant gaps in price, quality and access. Over and beyond COVID-19, additional IoT development might assist in anticipating future pandemics, employing methodologies based on statistics, and merging with artificial intelligence and big data. In the near future, IoT might therefore be a crucial facilitator for health transition from a reactive to a proactive system [3].

6. Conclusion

IoT makes substantial advances during the COVID-19 pandemic to enhance facilities and the information system in the medical field. It enhances the digitalization and appropriate administration of medical procedures in hospitals. When device/instruments are linked to the Internet, IoT enables new medical applications. For patients, web-based gadgets are introduced in numerous ways to monitor patient health better. It warns people about concerns about public health by monitoring climate change. This technology allows the hospital to be appropriately managed during COVID-19. In monitoring the medicine, it plays an important role by giving confirmed information. This information may also aid the correct distribution of the suitable equipment/device for the appropriate patient. This technique is helpful to reduce waste in the hospital with the correct information system. It decreases the risk of hospital accidents and handles all issues with the aid of well-documented information. This system may help protect costly medical gadgets from being stolen. With a better technical solution, IoT gives superior, relevant and trustworthy data. It permits human testing researchers with the slightest danger. In practice, it provides innovative solutions to a tough challenge in the medical sector during the COVID-19 pandemic. It generates not only the facilities but also saves the lives of each patient. It offers an essential emergency assistance service to minimize the related losses. The most rapid acceptance in the medical profession is owing to its efficiency. IoT is designed to manage better chronic illness, medical crises, improved patient care, fitness, management of blood pressure, health inspections, measurements and control, cardio frequency inspection and audiological aids. It is capable of continuous, reliable monitoring of COVID-19 patients and of improved personalization of the medical sector. IoT-enabled devices may assist digital storage of personal health information for COVID-19 patients and interact with other databases. This technology can aid manual record-keeping to a minimum. It eliminates mistakes and results on time by making a well-informed choice. By adopting this technology, medical devices and networks during COVID-19 become more intelligent and more efficient. These technologies thus provide rapid information and communication to enhance the quality of life of the patient. In the future, this technology will improve the patient's health to better treatment and utilize it for any COVID-19 pandemic.

CRediT authorship contribution statement

Naveen Mukati: Conceptualization, Data curation. **Neha Namdev:** Formal analysis, Funding acquisition. **R. Dilip:** Investigation, Methodology. **N. Hemalatha:** Project administration, Resources. **Viney Dhiman:** Validation, Visualization. **Bharti Sahu:** Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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