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Internet of things (IoT) applications to fight against COVID-19 pandemic

Ravi Pratap Singh a, Mohd Javaid b,*, Abid Haleem b, Rajiv Suman c

a Department of Industrial and Production Engineering, Dr B R Ambedkar National Institute of Technology, Jalandhar, Punjab, India
b Department of Mechanical Engineering, Jamia Millia Islamia, New Delhi, India
c Department of Industrial & Production Engineering, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India

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Abstract
Background and aim: The current global challenge of COVID-19 pandemic has surpassed the provincial, radical, conceptual, spiritual, social, and pedagogical boundaries. Internet of Things (IoT) enabled healthcare system is useful for proper monitoring of COVID-19 patients, by employing an interconnected network. This technology helps to increase patient satisfaction and reduces readmission rate in the hospital.

Methods: Searched the databases of Google Scholar, PubMed, SCOPUS and ResearchGate using the keywords “Internet of things” or “IoT” and “COVID-19”. Further inputs are also taken from blogs and relevant reports.

Results: IoT implementation impacts on reducing healthcare cost and improve treatment outcome of the infected patient. Therefore, this present study based research is attempted to explore, discuss, and highlight the overall applications of the well-proven IoT philosophy by offering a perspective roadmap to tackle the COVID-19 pandemic. Finally, twelve significant applications of IoT are identified and discussed.

Conclusions: IoT is helpful for an infected patient of COVID-19 to identify symptoms and provides better treatment rapidly. It is useful for patient, physician, surgeon and hospital management system.

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1. Introduction

The Internet of Things (IoT) is a well-defined scheme of interconnected computing tactics, digital, and mechanical devices possessing the capability of transmission of data over the defined network without having any human involvement at any level. All these discussed devices are associated with their particular unique identification numbers or codes. IoT is now well established and proven technology which acts as a junction to the umpteen tactics, instantaneous analytics, philosophy of machine learning, sensory products, etc. Moreover, IoT in typical daily functioning is recognised as the utility of the products or the appliances serve the real-life requirements of human beings in various means such as; security system of the home, smart lighting arrangements, and many more others which is easily controllable through our daily using smart speakers, smartphones, etc. [1,2].

In the present pandemic situation, all the countries, including India, are fighting with COVID-19 and still looking for a practical and cost-effective solution to face the problems arising in several ways. Researchers in physical sciences and engineering are attempting to take such challenges, to grow new theories, to describe new study problems, to generate user-centred explanations, and to edify ourselves and the overall civilian. This brief review has aimed to provide awareness of this innovative technology and its significant applications for COVID-19 pandemic.

2. IoT and its background for COVID-19 pandemic

In straightforward words, the Internet of Things (IoT) is the system of interconnected devices/operations complied with all the network elements such as; hardware, software, connectivity of the network, and any other required electronic/computer means that
ultimately makes them responsive by supporting in data alteration and collection. If we talk a bit more about IoT, it is beyond to a concept that develops the overall architectural background which ultimately allows the integration and the effective exchange of the data between the person in need and the service providers. In the present situation, most of the problems are arising because the non-effective reachability to the patients, which is the second most considerable issue after the concern of vaccine development. The use of the IoT concept makes the reachability to the patients quite useful, which ultimately help to provide them with significant care so that they can get out of this disease.

3. Need for the study

In the problematic current pandemic situation, the number of infected persons is increasing day by day globally, and there is a vast need to utilise the well adequate and organised facilities offered with the Internet of Things methodology. Furthermore, IoT has already been employed to serve the asked purposes in different domains in which the Internet of Healthcare Things (IoHT) or Internet of Medical Things (IoMT) are associated with the present issues. By following up the guidelines and the facilities of IoHT/IoMT, the number of resolved cases can be enhanced and improved too.

4. Key merits of IoT for COVID-19 pandemic

IoT is an innovative technology which ensures that all infected persons due to this virus are quarantine. During quarantine, it is helpful for a proper monitoring system. All high-risk patients are tracked easily using the internet-based network. This technology is used for the biometric measurements like blood pressure, heart-beat and glucose level. Fig. 1 shows the critical merits of IoT for COVID-19 Pandemic.

With the successful implementation of this technology, we can see an improvement in the efficiency of medical staff with a reduction in their workload. The same can be applicable in the case of COVID-19 pandemic with lesser expenses and mistakes.

5. Processes involved in IoT for COVID-19

IoT is an innovative technological platform to fight with COVID-19 pandemic and can fulfill significant challenges during the lockdown situation. This technology is helpful to capture the real-time data and other necessary information of the infected patient. Fig. 2 shows the significant processes used by IoT for COVID-19.

In the first step, IoT is used to capture health data from various locations of the infected patient and manage all the data using the virtual management system. This technology helps control the data and follow up on the report attained.

6. The overall impact of IoT in context to COVID-19 concerns (i.e. contact tracing, cluster identification and compliance of quarantine)

As discussed, the internet of things concept utilises the interconnected network for the effective flow and exchange of data. It also enables the social workers, patients, civilians, etc. to be in connection with the service beneficiaries for discussing any issue and cooperation. Therefore, by employing the proposed IoT tactic in COVID-19 pandemic, the effective tracing of the patients, as well as the suspicious cases, can be completely assured. The symptoms related to the coronavirus are now known to most of them, civilians. By developing a well-informed group of a connected network, the identification of the cluster can be made out significantly. Some particular smartphone-based application can also be developed so that the needy ones can get be benefitted out of it. The proper reporting of the symptoms and the recovery must be up-to-dated to the controller, i.e. doctors, physicians, caretakers, etc. so that the impressive move can be opted out to optimise the overall quarantine period.

7. Global technological advancements to resolve COVID-19 cases rapidly

Thus, to overcome and make the civilians more aware about the COVID-19 pandemic, the government of India has launched a smartphone application named as — ArogyaSetu, which is aimed to develop a connection between the important possible healthcare services and the people of India. Similarly, in China, the mobile application called as — Close Contact (English translation) is launched for its civilians. This application tells the app holder about the closeness to the corona-positive person. So that the extra care can be taken while moving outside. USA government is soon going to launch a similar kind of mobile application for its civilians at the end of April 2020.

After China, Taiwan was the most predictable to have more number of cases of COVID-19. However, Taiwan quickly militarised and instituted specific methodologies for any possible coronavirus case identification, suppression, and resource provision to guard the health of the community. Taiwan provided and integrated its national health insurance database with its immigration department and took catalogue to instigate the creation of big data for analytics; it generated real-time warnings during a clinical visit based on travel antiquity and medical symptoms to aid case identification. They have also made use of this latest technology, which includes scanning of QR code, connected reporting of transport history, etc. for the possible identification of the infected ones.

8. Significant applications of IoT for COVID-19 pandemic

IoT uses a large number of interconnected devices to create a smart network for the proper health management system. It alerts and tracks any types of diseases to improve the safety of the patient. It digitally captures the data and information of the patient without any human interaction. This data is also helpful for appropriate decision-making process. Table 1 discusses the major applications of IoT for COVID-19 pandemic.
IoT is used for various applications to fulfill the important requirement of alleviating effects of COVID-19 pandemic. It has the capability to predict the upcoming situation with the help of appropriate captured data. Its applications are applied for proper management of this pandemic. The patient can use IoT services for proper monitoring of heart rate, blood pressure, glucometer and other activities for personalized attention. It helps to track the health conditions of older people. The significant applications of this technology in healthcare are to track the real-time location of medical equipment and devices for smooth treatment process without any delay. Healthcare insurance companies can use this technology to detect fraud claim and provide transparency in the overall system. This improves treatment workflow of the patient with efficient performance and also helpful for decision-making process during complex cases.

9. Various issues and future scope of the study

The primary point of concern while employing the Internet of Things in the present pandemic situation COVID-19 is about the security and privacy of the data received, which is unique and imperative from patient health point-of-view. The second thing is about the care to be taken while integrating the data network among the devices involved and protocols. Fig. 3 depicts the summarized view of issues and challenges in implementing IoT for COVID-19 pandemic.

Moreover, future work should be targeted over data storage and management. The process of making cost-effective adoption applications will also to be considered in further studies.

10. Conclusion

IoT provides an extensive integrated network for healthcare to fight with COVID-19 pandemic. All medical devices are connected to the internet, and during any critical situation, it automatically
conveys a message to the medical staff. Infected cases can be handled appropriately in a remote location with well-connected tele-devices. It handles all cases smartly to provide ultimately strengthened service to the patient and healthcare. IoT seems to be an excellent way to screen the infected patient. In healthcare, this technology is helpful to maintain quality supervision with real-time information. By using a statistical-based method, IoT gets helpful to predict an upcoming situation of this disease. With proper implementation of this technology, researcher, doctors, government, academicians can create a better environment to fight with this disease.

**Declaration of competing interest**

None.

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