Application of IoT in Current Pandemic of COVID-19

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Abstract As we know that Internet, a rebellion innovation has transformed everything, Internet of Things has made a hope for excellent future of Internet with Machine-Machine (M2M) type of communication. This review paper has also shown that it is possible and affordable to construct these smart systems based on Internet of Things (IoT). IoT delivers exceptional advancement in the healthcare domain. This paper explores the roles of IoT that revolutionize the healthcare domain by providing enormous healthcare benefits to the mankind by offering affordable and practical healthcare solutions. The main focus of this paper is to discuss the role of IoT in smart hospitals and its significance to deal with pandemics is also highlighted. For serving the community-specific needs during spread of pandemic, various smart devices can be utilized that can provide varied functionalities including proper monitoring of high-risk patients, tracking their bio-metric measurements and capturing real-time data. We have also studied various blueprints which can sense unforeseen happenings using numerous sensors and reveal the facts accumulated on LED display. Observational outcomes have shown good agreement with the hypothetical statements.

Keywords: Internet of Things, Sensors, Smart Hospitals, Smart Cities, Wireless Sensor Network

1. Introduction

With the advancement in smart technologies, their applications are ever-expanding in the domain of healthcare. “Smart Hospital” refers to the smart healthcare infrastructure, making use of IoT technologies and enabling all healthcare stakeholders to connect via IoT devices. With help of this coordination, the quality and congruity of health services can be enhanced, thereby leading to enhanced care of patients. With help of wearable devices, sensors, smart computing, capability of remote monitoring, IoT can be beneficial in emergency situations too. Continual monitoring of patients’ health can assist medical professionals to take suitable actions at the apt time. IoT based systems are also beneficial to provide health-care facilities during the time of pandemics. Due to lack of clinical infrastructure, dealing with health crisis can be a cause of concern for many countries. As the number of patients increase during a pandemic, in many countries, the clinics and hospitals are straightforwardly overwhelmed leading to insufficient availability of resources. To tackle the situation, there is a need of efficient vaccine deployment systems that are capable of managing and distributing vaccines for pandemic during emergency [1]. With the advent in technology such as IoT at a rapid pace, health care industries are playing a major role in the holistic development of a country.
This is because it depends on the quality of medical care treatments provided to patients. The involvement of various new technologies helps in performing functions such as automatic patient care i.e. measuring blood pressure, heart beat rate, surgeries and operations. According to the survey conducted by Aruba Networks [1], IoT implemented by healthcare organizations mainly for patient monitoring and maintenance is around 73% and remote operation and control is near to 50%. One of the major advantages of involving IoT in health care systems is that it helps in reducing infections due to assessments by doctor, heart attack due to clot of air embolism in IF (intravenous)fluid, medication errors in surgery. Additionally, with the use of intelligent devices to smart hospitals enhance medical experiences of patients and reduce the labor intensity of medical staff.

2. Literature Review

Here, we sketch little applicability that may facilitate by urban IoT standard that are of reasonable concern in the city context. Because that can visualize win-win situation of flourishing quality and booming the applications bided to civilians while fetching an efficient improvement for city administration to decrement in operative expense. Some areas that have been considered in this paper where IOT can be availed very often are Smart hospitals, Smart environment and Smart education service.

Figure 1: IoT’s connectivity concept and application areas

**IoT in Current Pandemic of Corona Virus Disease COVID-19:**
The existing challenge of COVID-19 has affected all countries worldwide. This section explores the applications of IoT that can serve as a roadmap to tackle this pandemic by providing a practical approach to confront the pandemic.

Raju Vaishya et. al. reviewed the role of Artificial Intelligence (AI) as unequivocal innovation for analysing and prevention from Covid-19 and various other pandemics. AI is an imminent and valuable tool for early identification of infections and to monitor the condition of infected patients, thereby augmenting the treatment consistency and the process of decision making. AI can be valuable in
treatment of COVID-19 and also for appropriate health monitoring. AI can also assist in formulation of treatment regimens, strategy of prevention and for the development of various drugs and vaccines [2]. Ravi Pratap Singh et. al. reviewed vital applications of IoT for the COVID-19 pandemic that include the need of a fully-integrated network in the hospitals that enables the staff and patients to quickly respond in case of emergency, thereby enabling transparent and automated treatment of patients. Other IoT applications include the tele-health consultation (for patients in remote areas), impactful patient tracing, rapid screening through smart devices that enable the transmission of real-time treatment information and to predict the future situations that would assist to achieve a superior working environment [3]. Jichao Leng et. al. developed an IoT system to be established in hospitals that has numerous applications including various data collection methods, uploading data to cloud platforms, enabling secure connection and providing real-time feedback [5]. For healthcare industries, IoT devices are capable of providing sensor data that can be potentially processed as well as analyzed in the real-time. As there is centralized storage of data, thus the collected data can be efficiently processed [6]. Shahidul Islam, Mohammad, et al highlighted need of continuous presence of healthcare workers and necessary amenities, especially in remote areas if some emergency situation arises. Thus, there is a need for development of flexible health care systems that are based on IoT [7]. Oshtiany, Hitoshi et. al. highlighted the major challenge faced by healthcare industry that is the production of superior-quality vaccines that are adequate and available in the desired time-span, allowing hasty immunization of entire community throughout the globe. They highlighted another challenge faced during pandemics that involves the prompt delivery of pharmaceutical commodities all over the country, which may require maintaining efficient balance between non-pharmaceutical and pharmaceutical intervention [8]. Fong, Ignatius W et. al. highlighted the pattern of infectious diseases is expected to change and this may be a tedious task to be analyzed and managed [9]. Bedford, Juliet, et. al. is highlighted the need of accurate estimation of tracking history of the infection that can help in estimation of asymptomatic infection and pattern of outbreak [10]. Abid Haleem et. al. demonstrated the role of IoT in the field of “orthopedics”.

The vital IoT applications in orthopedics can include tracking of orthopedic devices, bone-motion information, knee-replacement, providing information about any deformations or fractured bones, thereby helping in bringing considerable changes in the field of orthopedics by providing well-informed decisions [4].

**IoT in Building Smart Hospitals:** To avoid the spread of pandemics and to get real-time suggestions for the purpose of decision-making, the healthcare organizations require apt technologies that can be beneficial for tracking as well as controlling the spread of various diseases. However, many countries face issues in dealing with pandemics. B. G. Ahn, Y. H. Noh et al. had proposed a system for determining the ECG signals in sitting positions by means of a smart chair which senses signals and can be examined using a monitoring system [12]. H. Almotiri, M. A. Khan et al. proposed a system to gather real-time data from patients using mobile devices and store it on network servers that are connected to internet. This data can be used for the medical diagnosis of patients [13]. T. S. Barger, D. E. Brown et al. developed system to observe as well as to track the movements of patients in in-house facility in order to the check the behavioural patterns [14]. I. Chiuchisan, H. N. Costin et al. proposed a framework to avert from any danger in case of sick people who are admitted in smart ICUs. This system informs the relatives and doctors about any discrepancy in their health conditions by monitoring body movements [15]. M. S. D. Gupta, V. Patchava et al. developed a framework using Raspberry Pi which measures and account ECG values in addition to other health parameter of the patient which can be helpful for further examinations of patients [16].

P. Gupta, D. Aggarwal et al. used Intel Galeleoo development board which can gather different data and hence upload it to the database from where it can be used by the doctors as a result help in reducing the discomfort of patients to visit hospitals for regular checkups [17]. K. Sahoo, S. K. Mohapatra, et al. studied and analyzed cloud-based health database in order to determine the probability of a diseases in patient using the threshold values [18]. S. Tyagi, A. Aggarwal, et al. helped in overcoming the shortages of doctors in the healthcare sectors where with the permission of patient’s family and relatives their data
is shared on the cloud with peer patients, labs and hospitals so that clinical aid can be provided at the earliest [19]. B. Xu, L. D. Xu, H. Cai et al. presented a data model to gather and publish IoT data globally, so that it can be accessed anytime and anywhere in case of emergency [20].

3. Technological framework of the IoT:

The technological IoT framework is reviewed in for providing clinical care to patients. With help of numerous biomedical sensors, the physiological parameters can be collected. Gateways and cloud can analyse and store this information and are capable of further sending the data to care-givers for their analysis and review. Even in case of life-threatening.

| S. N | Component Used                          | Description of the Components used                                                                 |
|------|----------------------------------------|-------------------------------------------------------------------------------------------------------|
| 1    | Peripheral Interface Controller (PIC)  | PIC is an advanced microcontroller developed by “Microchip technologies” widely used for modern electronics applications. PIC controller integrates numerous types of advanced interfacing ports as well as memory modules. |
| 2    | Radio Frequency Identification (RFID)  | RFID and aids machines to record meta-data, identify objects as well as to control the individual targets with help of radio waves. It is used for identification, monitoring as well as tracking various objects attached with tags (globally as well as automatically) and in real-time. |
| 3    | Wireless Body Area Network             | WBAN’s involve extensive range of tasks e.g. including data collection from body sensors, convey the data to remote databases and managing the various medical equipment’s. WBAN’s are also capable of monitoring remote patients with help of e-health and tele-health applications, thereby providing “flexibility” to healthcare organizations and “mobility” to patients [11]. |
| 4    | Gravity Sensor                         | Gravity Sensors compute the acceleration effect of Earth’s gravity on device encompassing the sensor. Basically, it is derived from accelerometer, wherein other sensors help in removing linear acceleration from data. |
| 5    | Wireless Sensor Network (WSN)          | WSN’s refer to the interconnected sensor nodes which communicate wirelessly to gather the surrounding data. Generally, nodes are of low power and are distributed in an ad-hoc and decentralized manner. |
| 6    | Electronic Product Code                | It refers to a universal identifier which provides s a unique identity to a particular physical object. The identity is unique among the physical objects. |
| 7    | Temperature Sensor                     | “LM35” is an inexpensive and small IC useful for measuring temperature ranging from -55°C to 150°C and can be interfaced with any microcontroller. |
| 8    | Pulse Rate Sensor                      | It is a heart-rate sensor for Arduino, which can incorporate live heart-rate data. The sensor can clip on a fingertip or earlobe and can be plugged into Arduino. It also comprises of an open-source monitoring app that can graph the pulse in real time. |
| 9    | Ultrasonic Sensor                      | It is an electronic device that can measure the distance of a target object by producing ultrasonic sound waves. Then it converts reflected sound into electrical signals. |
Sweat Sensor technology can be optimized for sports performance as well as for medical monitoring and can have a role beyond physical health too.

LCD is a type of flat panel display that utilizes liquid crystals for its primary form of operation.

GPRS module is a circuit or chip that may be used for establishing communication between a computing machine and GSM or GPRS system.

LDR is a component having a variable resistance which changes with the light intensity falling upon it.

IR Sensor is used to sense characteristics of its surroundings by emitting or detecting “Infrared radiation” and are also able to compute heat emitted by an object.

4. Application areas of IoT in handling COVID-19 pandemic:

In case of pandemic situations, IoT can prove to be a cost-effective and efficient solution by providing timely help and significant care to critical patients as well. The healthcare workers can screen, monitor and assess the physiological parameters of infected patients even without coming in direct contact with them. Through the real-time monitoring of patients, many lives can be saved in case of extreme medical emergency situations. By reducing unnecessary visits during pandemic, IoT enables patients to get proper medical assistance and prescriptions from health experts.

| S.N | Application Area                          | Description                                                                 |
|-----|-------------------------------------------|-----------------------------------------------------------------------------|
| 1   | Track Live location of Home-Quarantine persons | IoT is beneficial for contact tracing as well as for tracking home-quarantine persons. |
| 2   | Identification of Hotspot using IoT        | IoT is beneficial for cluster-identification and hotspot identification.     |
| 3   | Capture Real Time Data                     | For real-time health analysis, health monitoring and collection of patient’s data, in order to have real-time interaction |
| 4   | Monitoring and Tracking high risk patients  | For high-risk patients, continuous monitoring is required for efficient preventive actions. |
| 5   | Monitoring and Storing COVID19 patient’s data on cloud | With help of connected medical devices, patients’ data can be stored and can also be used later for future health prediction or detection of any abnormalities. |
| 6   | Tracking Clinical infrastructure related to COVID19 treatments | For tracking location of medical equipment and medical record when needed. |
| 7   | Checking Availability of ambulance dedicated to COVID19 patients | For real-time monitoring of ambulance location and for accurate on-time information sharing. |
5. Application areas of IoT in Building Smart Hospitals:

The goal of IoT is to efficiently manage access and control numerous facilities, uniquely identifiable devices and assets thus can be efficiently utilized in smart hospitals. The various applications of IoT in smart hospitals are summarized in Table 3.

| S.No. | Application Area                  | Description                                                                 |
|-------|-----------------------------------|------------------------------------------------------------------------------|
| 1     | Secure Patients Data              | By adopting strong security solutions, patients’ data can be protected from unauthorized access. |
| 2     | Tracking Tools and Instruments    | To manage inventories and track location of equipment’s.                      |
| 3     | Augmented Reality                 | Using augmented reality surgeons can study the patients’ anatomy prior to actual surgery. |
| 4     | 3D Scanning of Bones              | IoT can provide Anatomical visualization of bones in the 3-Dimensional space   |
| 5     | Remote health monitoring          | For supporting patients’ medical conditions even outside clinic.              |
| 6     | Personalized treatment            | For ensuring treatment adapted to patients, thus leading to more precise treatment. |
| 7     | Facility Management               | For security and safety of patients and staff, there is a need to maintain numerous parameters including air regulation, humidity and temperature. |

6. Conclusion and Future Scope:

In this paper, we have reviewed the role of IoT in healthcare and to cope with chronic diseases as well as during pandemic illness or any natural disaster. From the above-mentioned frameworks and study, we extract the consequences that IoT can offer numerous benefits for smart hospitals such as low price, good reliability even in case of pandemics, wherein healthcare workers can avail most of these benefits even without coming in direct contact with infected people. With the new appearing facts day by day, they sustain noticing the demand for affordable management. We are moving closer to the end point of the partition between realistic, practical, digital worlds. IoT is step by step serving a sea of modification applications in our everyday existence, which makes our life much easier. Fieldworks, case studies are conducted for acceptance of IoT at broad extent, without disclosing its formulation challenges and provide secrecy and protection to the end users. The implementation of IoT requires energetic and hard attempts to handle. It assumingly conveys even a minor alter in user's superiority of life. With a broadly shared, localized sophisticated scheme of intelligent devices, IoT has enabled improvements to significant facilities in utilities, hospitals, education and other areas, which gives a modern scheme to technology advancement.

References

[1] Hessel, Luc, 2009 European Vaccine Manufacturers (EVM) Influenza Working Group. "Pandemic influenza vaccines: meeting the supply, distribution and deployment challenges." Influenza and other respiratory viruses 3.4: 165-170.
[2] Vaishya, Raju, et al. 2020 Artificial Intelligence (AI) applications for COVID-19 pandemic." Diabetes & Metabolic Syndrome: Clinical Research & Reviews.
[3] Singh, Ravi Pratap, et al. 2020 Internet of things (IoT) applications to fight against COVID-19 pandemic." *Diabetes & Metabolic Syndrome: Clinical Research & Reviews.*

[4] Haleem, Abid, Mohd Javaid, and Ibrahim Haleem Khan. 2019 Internet of things (IoT) applications in orthopaedics." *Journal of Clinical Orthopaedics & Trauma.*

[5] Leng, Jichao, Zihuai Lin, and Peng Wang. 2020 An Implementation of an Internet of Things System for Smart Hospitals." *2020 IEEE/ACM Fifth International Conference on Internet-of-Things Design and Implementation (IoTDI).* IEEE.

[6] Ray, Partha Pratim, et al. 2020 Blockchain for IoT-Based Healthcare: Background, Consensus, Platforms, and Use Cases." *IEEE Systems Journal.*

[7] Shahidul Islam, Mohammad, et al. 2019 Monitoring of the human body signal through the Internet of Things (IoT) based LoRa wireless network system." *Applied Sciences* 9.9.

[8] Oshitani, Hitoshi, Taro Kamigaki, and Akira Suzuki. 2008 "Major issues and challenges of influenza pandemic preparedness in developing countries." *Emerging infectious diseases* 14.6: 875.

[9] Fong, Ignatius W. 2012 Challenges *in infectious diseases*. Springer Science & Business Media.

[10] Bedford, Juliet, et al. 2020 COVID-19: towards controlling of a pandemic." *The Lancet* 395.10229: 1015-1018.

[11] Khan, Jamil Yusuf, et al. 2013 Wireless body area network (WBAN) design techniques and performance evaluation. Journal of medical systems 36.3: 1441-1457.

[12] B. G. Ahn, Y. H. Noh, and D. U. Jeong. 2015 Smart chair based on multi heart rate detection system. In 2015 IEEE SENSORS, pages 1–4.

[13] S. H. Almotiri, M. A. Khan, and M. A. Alghamdi. 2016 Mobile health (m-health) system in the context of iot. In 2016 IEEE 4th International Conference on Future Internet of Things and Cloud Workshops (FiCloudW), pages 39–42.

[14] T. S. Barger, D. E. Brown, and M. Alwan. 2005 Healthstatus monitoring through analysis of behavioral patterns. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 5(1):22–27. ISSN 1083-4427.

[15] I. Chiuchisan, H. N. Costin, and O. Geman. 2014 Adopting the internet of things technologies in health care systems. In 2014 International Conference and Exposition on Electrical and Power Engineering (EPE), pages 532–535.

[16] M. S. D. Gupta, V. Patchava, and V. Menezes. 2015 Healthcare based on IoT using raspberry pi. In 2015 International Conference on Green Computing and Internet of Things (ICGCIoT), pages 796–799.

[17] P. Gupta, D. Agrawal, J. Chhabra, and P. K. Dhir. 2016 Iot based smart healthcare kit. In 2016 International Conference on Computational Techniques in Information and Communication Technologies (ICCCTICT), pages 237–242.

[18] P. K. Sahoo, S. K. Mohapatra, and S. L. Wu. 2016 Analyzing healthcare big data with prediction for future health condition. IEEE Access, 4:9786–9799. ISSN 2169-3536.

[19] S. Tyagi, A. Agarwal, and P. Maheshwari. 2016 A conceptual framework for iot-based healthcare system using cloud computing. In 2016 6th International Conference - Cloud System and Big Data Engineering (Confluence), pages 503–507.

[20] B. Xu, L. D. Xu, H. Cai, C. Xie, J. Hu, and F. Bu. 2014 Ubiquitous data accessing method in iot-based information system for emergency medical services. IEEE Transactions on Industrial Informatics, 10(2):1578–1586. ISSN 1551-3203.

[21] J P Bentley, "Temperature sensor characteristics and measurement system design", Journal of Physics E: Scientific Instruments, Volume 17, Number 6.

[22] F.-G. Chen, J.-Y. Wang, S. Chen, S.-C. Tu and K.-Y. Chen, 2015 "A hang-and-play intravenous infusion monitoring system", Proc. IEEE Comput. Soc. Int. Conf. Appl. Comput. Inf. Technol. Int. Conf. Comput. Sci. Intell., pp. 278-281.