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# A Review of Internet of Things (IoT) and Blockchain In Healthcare: Chronic Disease Detection and Data Security

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**ABSTRACT**

The role of Internet of Things (IoT) technology continues to increase in various fields, especially health. IoT can connect doctors with their patients via the Internet. Portable IoT-based health monitoring devices can significantly reduce the distance between patients and doctors. The important influence of IoT technology in the health sector can be seen from its efficiency and important role in developing and improving the quality of health services. IoT is the last Internet revolution that allows integrity between machines and objects. Developers and users still have to pay attention to data security, considering that medical history is a matter of privacy for some people. Blockchain technology has been predicted by the industry and research community as a secure, fast, reliable and transparent solution for IoT-based systems. Most blockchain technology is used for data management operations in the IoT-based health sector, which improves data security, including data integrity, access control, and maintenance of privacy.



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## 1. INTRODUCTION

The role of technology continues to increase in various fields. The use of information technology has increased significantly due to the increasing use of IoT (Internet of Things) devices [1][2]. IoT implementation can be implemented in the health service sector. IoT can connect doctors with their patients via the Internet. Portable IoT-based health monitoring devices can significantly reduce the distance between patients and doctors. IoT allows doctors to approach each patient individually, analyze health status, and calculate treatment methods individually. In addition, patient health can be checked remotely, with low investment costs, low power consumption, high performance, and response in real-time [3] [4] [5].

The important influence of IoT technology in the health sector can be seen from its efficiency and important role in developing and improving the quality of health services. The development of various applications or systems can be used to address challenges in the health sector. IoT is the last revolution of the Internet that allows integrity between machines and objects [6]. This technology is used in the health sector to carry out various actions, including detection, treatment, and monitoring. IoT devices can help patients get the right treatment [7]. The system or research that has been developed needs to be reviewed again to find out how big its role is in overcoming health problems. With this evaluation, it is hoped that developing IoT technology, especially in the health sector, can improve its functionality.

This paper presents various research reviews related to IoT in the health sector that researchers have previously carried out. This research study is divided into two types: research related to developing IoT systems for several diseases and data security in the IoT platform.

## 2. RELATED RESEARCH

IoT-based systems are emerging technologies that integrate software, hardware, physical objects and computing devices to communicate, collect and exchange data. IoT provides a seamless platform to facilitate interactions between humans and various physical and virtual things, including healthcare processed by the domain [8].

The development of systems for several types of chronic diseases has been developed, such as epilepsy. Research conducted by Souleyman Hassan et al. [9] has created an IoT-based monitoring system for epilepsy patients. This disease's seizures are unpredictable, and most epilepsy patients experience dangerous physical symptoms during an attack that make the patient uncomfortable while performing daily tasks. This is the background for the creation of the system. The system focuses on a common type of epilepsy, namely "Grand mal epilepsy Tonic-Clonic (GTC)" seizures. The prototype of this epilepsy monitoring system was tested and obtained average accuracy results of 98.90%, 95.49%, 83.0%, and 87.21% for body temperature, heart rate monitoring, muscle spasms, and fall detection.

Many practitioners have carried out research related to the diagnosis of heart disease. Heart disease is one of the main causes of morbidity and death worldwide [10] [11]. This disease can cause complications such as infection of the coronary arteries and decreased function of the blood vessels, which can cause incidents such as heart attacks and strokes [12]. Even the heart rate can also be used as an indicator to diagnose the presence or absence of heart problems [13] [14] [15].

Research written by M Restu Ilhami [16] has the theme of designing an IoT-based coronary heart early detection device. The tool uses a pulse sensor with other IoT circuits as a blood flow detector. The data recorded by the sensor is sent via a smartphone as output that the user can access. The output received is a signal that can be classified whether it is a type of coronary heart or not. The results of this study can be concluded that the tool created can detect weak and high heart signals with BPM rates. Then with this tool, early coronary heart disease can be classified through applications with additional information in the form of several detected symptoms.

Besides being detected as early as possible through IoT devices, heart disease can also be monitored and classified according to more specific health conditions [14]. Chao Li et al. have researched the theme of monitoring heart disease as a comprehensive health service by creating an IoT-based system. The patient's physical signs, such as blood pressure, EKG, and relevant environmental indicators, can be continuously monitored through the system. In addition, four data transmission modes are provided that balance healthcare needs and demands for communication and computing resources. System testing uses a smartphone application for data communication. The system is responsible for receiving and storing the monitored data from the monitoring device via BlueTooth and transmitting it according to the mode. Meanwhile, on the server side, which is a web-based application, it is intended for doctors to ask for monitored data [17].

Apart from the IoT devices for the two diseases already mentioned, there are also IoT-based systems for detecting blood pressure and body temperature. The system created by Ganjar Suwasono Adi et al. created automation of blood pressure and body temperature detection, thus facilitating health data collection. This system uses an air pump and solenoid valve to fill and empty air in the cuff using the MPX5700 sensor. As for body temperature detection, the AMG8833 camera infrared sensor is used. The sensor reading results are sent via the Message Queue Telemetry Transport (MQTT) protocol connected to the NodeMCU ESP8266. The results of monitoring sensor nodes displayed via smartphone obtained an average error of 6.41% for systolic readings and 7.45% for diastolic readings based on the MPX5700 sensor, and 2.39% for temperature readings based on the AMG8833 sensor [18].

## 3. IOT APPLICATION IN HEALTHCARE

### 3.1. Remote Patient Monitoring

Remote patient monitoring is the most common application of IoT devices for healthcare [19]. IoT devices can automatically collect health metrics such as heart rate, blood pressure, temperature and more from patients who are not physically present in the healthcare facility, eliminating the need for patients to go to a provider or collect them themselves [20]. When an IoT device collects patient data, it is passed to a software application where healthcare professionals and patients can view it. Algorithms can be used to analyze data to recommend

treatments or generate alerts. For example, an IoT sensor that detects a patient's very low heart rate can generate an alert so healthcare workers can intervene. The main challenge with remote patient monitoring devices is ensuring that the highly private data collected by these IoT devices are secure and private.

### 3.2. Glucose Monitoring

For the more than 30 million Americans with diabetes, glucose monitoring has traditionally been difficult. Not only is it inconvenient to check glucose levels and manually record results, but doing so reports a patient's glucose levels only at the exact time the test is provided [20]. If levels fluctuate widely, periodic testing may not be sufficient to detect a problem. IoT devices can help address these challenges by providing continuous, automatic monitoring of glucose levels in patients. Glucose monitoring devices eliminate the need to keep records manually, and they can alert patients when glucose levels are problematic [21].

### 3.3. Heart-Rate Monitoring

Like glucose, monitoring heart rates can be challenging, even for patients in healthcare facilities. Periodic heart rate checks don't guard against rapid fluctuations in heart rates, and conventional devices for continuous cardiac monitoring used in hospitals require patients to be attached to wired machines constantly, impairing their mobility [22]. Today, a variety of small IoT devices are available for heart rate monitoring, freeing patients to move around as they like while ensuring that their hearts are monitored continuously. Guaranteeing ultra-accurate results remains a challenge, but most modern devices can deliver accuracy rates of about 90 per cent or better [20].

### 3.4. Connected Inhalers

Conditions such as asthma or COPD often involve attacks that come on suddenly, with little warning. IoT-connected inhalers can help patients by monitoring the frequency of attacks and collecting data from the environment to help healthcare providers understand what triggered an attack [20]. In addition, connected inhalers can alert patients when they leave inhalers at home, placing them at risk of suffering an attack without their inhaler present or when they use the inhaler improperly [23].

### 3.5. Depression and Mood Monitoring

Information about depression symptoms and patients' general mood is another data that has traditionally been difficult to collect continuously [24]. Healthcare providers might periodically ask patients how they are feeling but could not anticipate sudden mood swings. And, often, patients don't accurately report their feelings. "Mood-aware" IoT devices can address these challenges. By collecting and analyzing heart rate and blood pressure data, devices can infer information about a patient's mental state. Advanced IoT devices for mood monitoring can even track data such as the movement of a patient's eyes. The key challenge here is that metrics like these can't predict depression symptoms or other causes for concern with complete accuracy. But neither can a traditional in-person mental assessment.

### 3.6. Robotic Surgery

By deploying small Internet-connected robots inside the human body, surgeons can perform complex procedures that would be difficult to manage using human hands. At the same time, robotic surgeries are performed by small IoT devices [25].

## 4. SECURITY IN IOT

In addition to systems that have been widely developed both for the detection and monitoring of chronic diseases, it is also necessary to pay attention to the security section in the data communication process, where the health industry has adapted to cloud technology and has used it for more effective health treatments [26]. Some modern hospitals are found to be conducting experiments using IoT, which records not only the patient's illness but also the patient's vital parameters collected from monitoring devices connected to the hospital's core network. Compromising patient records can result in a breach of confidentiality between doctor and patient, which is one of the most fundamental pillars of medical practice. Processes in the network include exchanging big data among connected devices and sending it via the Internet to a central server for data analysis. The exchange of sensitive information is quite common in IoT networks, and leakage or loss of important data becomes dangerous for the network as well as the owner of the information. Therefore, communication over the IoT network must follow security standards [27].

Blockchain technology has been predicted by the industry and research community as a safe, fast, reliable and transparent solution for IoT-based systems [28]. In addition, this technology has been identified as the most effective method for maintaining the confidentiality and security of real-time control systems [29]. Most of the blockchain technology is used for data management operations in the IoT-based health sector, which improves data security, including data integrity, access control, and maintenance of privacy [30]. Several studies on blockchain for IoT-based systems have been carried out, including research conducted by Prabhat Kumar et al., themed deep learning using blockchain for data transmission in IoT-based health systems. In this research, the "Blockchain-orchestrated Deep learning approach for Secure Data Transmission in IoT-enabled healthcare system, hereafter referred to as" (BDSDT) architecture, is designed. In particular, BDSDT provides a two-level architecture to guarantee security. At the first level, all IoT devices are registered, verified (using zero proof of knowledge), and then added to the blockchain network using smart contract-based ePoW consensus. At the same time, the second level incorporates a deep learning architecture. In this feature, the original data is extracted using an autoencoder technique rarely used by bi-directional short-term memory to identify intrusions in the network. In addition, this study uses IPFS-based off-chain storage to make BDSDT more scalable. The results indicated that the proposed framework outperformed competing strategies in blockchain and non-blockchain settings and obtained an accuracy close to 99% [31].

Kebira Azbeg et al. researched BlockMedCare: Health care systems based on IoT, Blockchain, and IPFS for data management security. Specifically, the designed system is made to support remote patient monitoring, especially regarding chronic diseases that require routine treatment. This system considers three main parameters: security, scalability, and processing time. In terms of security, this can be ensured using a re-encryption proxy combined with blockchain to store hash data for access control using intelligent connectivity. In contrast, an IPFS-based off-chain database stores data to ensure blockchain scalability. The results found in experiments for diabetes management found that the system has shown a good improvement in terms of safety [32].

## 5. CONCLUSION

Based on the reviews conducted, it can be concluded that IoT technology in the health sector has been widely implemented. So it is clear that benefits can be drawn from developing IoT technology. But in this case, developers and users still have to pay attention to data security, considering that medical history is a matter of privacy for some people. Research related to data security in IoT-based health systems has been carried out a lot, as mentioned above, for that hopefully with this discussion, the development of IoT for the health sector can be further optimized both in terms of benefits and security guarantees.

## REFERENCES

[1] R. Komalasari, “MANFAAT APLIKASI TEKNOLOGI IOT DI MASA PANDEMI COVID-19 - STUDI,” no. January 2020, 2021, doi: 10.38204/tematik.v7i2.469.
[2] A. J. Perez, F. Siddiqui, S. Zeadally, and D. Lane, "A review of IoT systems to enable independence for the elderly and disabled individuals," *Internet of Things*, vol. 21, p. 100653, 2023, doi: https://doi.org/10.1016/j.iot.2022.100653.
[3] R. A. Rayan, C. Tsagkaris, and R. B. Iryna, *The Internet of Things for Healthcare : Applications , Selected Cases and The Internet of Things for Healthcare : Applications , Selected Cases*, no. January. Springer Singapore, 2021.
[4] N. Singh, S. P. Sasirekha, A. Dhakne, B. V. S. Thrinath, D. Ramya, and R. Thiagarajan, "Measurement : Sensors IOT enabled hybrid model with learning ability for E-health care systems," *Meas. Sensors*, vol. 24, no. November, p. 100567, 2022, doi: 10.1016/j.measen.2022.100567.
[5] S. Ratna, “SISTEM MONITORING KESEHATAN BERBASIS INTERNET OF THINGS ( IoT ),” pp. 83–87.
[6] F. Z. Fagroud *et al.*, "ScienceDirect ScienceDirect Impact Impact of of IoT IoT devices devices in in E-Health : E-Health : A A Review Review on on IoT IoT in in the the context context of of COVID-19 COVID-19 and and its its variants variants," *Procedia Comput. Sci.*, vol. 191, pp. 343–348, 2021, doi: 10.1016/j.procs.2021.07.046.
[7] D. Verma *et al.*, "Biosensors and Bioelectronics : X Internet of things ( IoT ) in nano-integrated wearable biosensor devices for healthcare applications," *Biosens. Bioelectron. X*, vol. 11, no. March, p. 100153, 2022, doi: 10.1016/j.biosx.2022.100153.
[8] M. Haghi, M. Madanipour, M. Nikravan, P. Asghari, and E. Mahdipour, "Journal of Network and Computer Applications A systematic review of IoT in healthcare : Applications , techniques , and trends," *J. Netw. Comput. Appl.*, vol. 192, no. January, p. 103164, 2021, doi: 10.1016/j.jnca.2021.103164.
[9] S. Hassan, E. Mwangi, and P. Kamita, "Heliyon IoT based monitoring system for epileptic patients," *Heliyon*, vol. 8, no. November 2021, p. e09618, 2022, doi: 10.1016/j.heliyon.2022.e09618.
[10] M. Abdel-basset, A. Gamal, and G. Manogaran, "A novel group decision making model based on neutrosophic sets for heart disease diagnosis," 2019.

[11] S. S. Sarmah, "An Efficient IoT-Based Patient Monitoring and Heart Disease Prediction System Using Deep Learning Modified Neural Network," vol. 8, 2020, doi: 10.1109/ACCESS.2020.3007561.
[12] Z. Al-makhadmeh and A. Tolba, "Utilizing IoT wearable medical device for heart disease prediction using higher order Boltzmann model : A classification approach," *Measurement*, vol. 147, p. 106815, 2019, doi: 10.1016/j.measurement.2019.07.043.
[13] V. No, I. Salamah, S. N. Afifa, and E. Hesti, "Edumatic : Jurnal Pendidikan Informatika Rancang Bangun Pendeteksi Penyakit Jantung menggunakan Teknik Algoritma Fuzzy Logic berbasis IoT," vol. 6, no. 2, pp. 176–185, 2022, doi: 10.29408/edumatic.v6i2.6164.
[14] P. Studi *et al.*, "RANCANG BANGUN MONITORING DETAK JANTUNG ( HEART RATE ) SEBAGAI INDIKATOR KESEHATAN BERBASIS INTERNET OF THINGS ( IOT ) Design and Build Monitoring Heart Rate As An Indicator Of Health Based."
[15] M. Aldi, A. Mochamad, R. Widiarto, and R. S. Kusumadiarti, "Health Monitoring System Dengan Indikator Suhu Tubuh , Detak Jantung Dan Saturasi Oksigen Berbasis Internet of Things ( IoT )," vol. 7, no. 2, pp. 108–118, 2021.
[16] M. R. Ilhami and A. T. Hanuranto, "RANCANG BANGUN ALAT PENDETEKSI DINI PENYAKIT JANTUNG KORONER BERBASIS INTERNET OF THINGS ( IOT ) ( EARLY DETECTION TOOL ARCHITECTURE CORONARY HEART DISEASE BASED INTERNET OF THINGS ( IOT ))," vol. 6, no. 2, pp. 4736–4747, 2019.
[17] C. Li, X. Hu, and L. Zhang, "ScienceDirect ScienceDirect The IoT-based heart disease monitoring system for pervasive The IoT-based heart disease monitoring system for pervasive healthcare service healthcare service," *Procedia Comput. Sci.*, vol. 112, pp. 2328–2334, 2017, doi: 10.1016/j.procs.2017.08.265.
[18] G. S. Adi, F. Satria, and K. Gumilar, "Sistem Pendeteksi Tekanan Darah dan Suhu Tubuh Portabel Menggunakan Protokol MQTT," no. July, 2021, doi: 10.31544/jtera.v6.i1.2021.77-84.
[19] N. Sharma *et al.*, "A smart ontology-based IoT framework for remote patient monitoring," *Biomed. Signal Process. Control*, vol. 68, p. 102717, 2021, doi: https://doi.org/10.1016/j.bspc.2021.102717.
[20] ordr, "10 Internet of Things (Iot) Healthcare Examples, and Why Their Security Matters," 2022.
[21] T. N. Gia *et al.*, "IoT-based continuous glucose monitoring system: A feasibility study," *Procedia Comput. Sci.*, vol. 109, pp. 327–334, 2017, doi: https://doi.org/10.1016/j.procs.2017.05.359.
[22] K. V. S. S. Ganesh, S. P. S. Jeyanth, and A. R. Bevi, "IOT based portable heart rate and SpO2 pulse oximeter," *HardwareX*, vol. 11, p. e00309, 2022, doi: https://doi.org/10.1016/j.ohx.2022.e00309.
[23] FINDAIR, "IoT with the use of smart inhalers," *FINDAIR*, 2021. http://findair.eu/resources/blog/iot-with-the-use-of-smart-inhalers/.
[24] C. R. van Genugten, J. Schuurmans, W. van Ballegooijen, A. W. Hoogendoorn, J. H. Smit, and H. Riper, "Discovering different profiles in the dynamics of depression based on real–time monitoring of mood: a first exploration," *Internet Interv.*, vol. 26, p. 100437, 2021, doi: https://doi.org/10.1016/j.invent.2021.100437.
[25] Y. Tameze and Y. H. Low, "Outpatient Robotic surgery: Considerations for the Anesthesiologist," *Adv. Anesth.*, vol. 40, no. 1, pp. 15–32, 2022, doi: https://doi.org/10.1016/j.aan.2022.06.001.
[26] K. Kasat, D. L. Rani, B. Khan, J. Ashok, M. K. Kirubakaran, and P. Malathi, "Measurement : Sensors A novel security framework for healthcare data through IOT sensors," *Meas. Sensors*, vol. 24, no. August, p. 100535, 2022, doi: 10.1016/j.measen.2022.100535.
[27] A. Yeole, D. R. Kalbande, and A. Sharma, "ScienceDirect ScienceDirect Security of 6LoWPAN IoT Networks in Hospitals for Medical Data Security of 6LoWPAN IoT Networks in Hospitals for Medical Data Exchange Exchange," *Procedia Comput. Sci.*, vol. 152, pp. 212–221, 2019, doi: 10.1016/j.procs.2019.05.045.
[28] A. Alfrhan, T. Moulahi, and A. Alabdulatif, "Blockchain : Research and Applications Comparative study on hash functions for lightweight blockchain in Internet of Things ( IoT )," *Blockchain Res. Appl.*, vol. 2, no. 4, p. 100036, 2021, doi: 10.1016/j.bcra.2021.100036.
[29] A. I. Taloba *et al.*, "ORIGINAL ARTICLE A blockchain-based hybrid platform for multimedia data processing in IoT-Healthcare," *Alexandria Eng. J.*, vol. 65, pp. 263–274, 2023, doi: 10.1016/j.aej.2022.09.031.
[30] E. M. Adere, "Blockchain in healthcare and IoT: A systematic literature review," *Array*, p. 100139, Mar. 2022, doi: 10.1016/J.ARRAY.2022.100139.
[31] P. Kumar, R. Kumar, G. P. Gupta, R. Tripathi, A. Jolfaei, and A. K. M. N. Islam, "Journal of Parallel and Distributed Computing A blockchain-orchestrated deep learning approach for secure data transmission in IoT-enabled healthcare system," *J. Parallel Distrib. Comput.*, vol. 172, pp. 69–83, 2023, doi: 10.1016/j.jpdc.2022.10.002.
[32] K. Azbeg, O. Ouchetto, and S. J. Andaloussi, "BlockMedCare : A healthcare system based on IoT , Blockchain and IPFS for data management security," *Egypt. Informatics J.*, vol. 23, no. 2, pp. 329–343, 2022, doi: 10.1016/j.eij.2022.02.004.