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Internet of Things in the Healthcare System: A Study

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Abstract

Today's health care is increasingly focused on technology. Unexpected deaths among humans are a problem that arises from delayed medical attention. The development of a body health monitoring system is therefore necessary. The Internet of Things (IoT) enables the integration of numerous devices capable of connecting to the internet, providing information on the state of a patient's health and providing information in real time to doctors who can help. The term "Internet of Things" (IoT) refers to a system or methodology that enables physical objects to connect and communicate with one another through networking technology. The in-depth analysis of developments in IoT-based healthcare methods is presented in this paper. It also categorises a prevailing IoT-based healthcare net and provides a summary of all prospective systems. In this context, study of IoT health care protocols offers a thorough overview of the topic. A thorough survey of IoT healthcare services and applications is also launched. IoT device data can assist medical professionals in choosing the most effective course of therapy for patients and achieving desired results. For achieving requirements like Data and device security, encompassing the confidentiality and integrity of data as well as the authentication of devices, IoT has been established in healthcare system.

Keywords: Internet of things, Healthcare network, health monitoring system

1. Introduction

Internet technology has steadily gotten more prevalent and is permeating every part of our lives. The phrase "Internet of Things" (IoT), coined by Kevin Ashton, refers to internet based data with newly evolving comprehensive facilities architecture [1][2]**.** IoT healthcare apps have the ability to precisely track individuals, items, samples, and provisions. They can also handle a variety of stakeholders, such as hospitals, doctors' offices,

nursing homes, and the local community, and evaluate the data collected. Utilizing biometric data or collecting crucial factors from sensors to improve quality and maximise resource use[2]. By generating valuable insights, productivity, and cost-effectiveness, the Internet of Things (IoT) integration has had a variety of effects on living quality. IoT in healthcare is used to increase patient monitoring [2], lower costs, and promote innovation in patient care. This has made it possible to develop unique approaches to remote monitoring, autonomous assistive solutions, pharmaceutical administration, initial caution and active treatment programmes, quality management, and maintenance of health equipment.

The Internet of Things (IoT) has emerged over the past ten years as a major movement in 4th generation revolution technologies that may provide each smart product and gadget with excellent interconnection to the internet infrastructure [2][3]. IoT is an extremely potent distributed network made up of a huge quantity of items. New methods of working, communicating, engaging, amusing oneself, and living will be made possible by the Internet of Things (IoT), which will serve as the foundation for worldwide policy to connect physical items, substances, and people[3]. The IoT enables physical things to perform, obtain information, and synchronize their conclusions by commissioning its basic technologies, including pervasive and persistent computing, fixed devices, intellect technologies, sensor networks, internet conventions, and domain-oriented applications [4].

A system built on the Internet of Things (IoT) can sense the world and use a variety of IoT-based applications to analyse artificial intelligence data. The Internet of Things (IoT) has a growing number of exciting application areas in the healthcare sector, enabling prompt, outstanding telemedicine and healthcare amenities to be provided to patients via distant help. Utilizing a variety of potential applications, many medical services are offered, including home drug delivery, exercise programmes, remote health monitoring, and treatment for numerous chronic conditions [4][5]. The primary goals of medical devices, services, actuators, sensors, and diagnostic tools are therefore to improve end-user experiences through IoT-based healthcare. Additionally, IoT devices are capable of accurately identifying the best times for repeated and regular tasks. By guaranteeing the best applications and services, the IoT also offers dynamic scheduling for more patients using limited resources [5].

The majority of IoT devices are made to be energy-efficient, with minimal dispensation and storing abilities. The absence of user friendly boundaries increases complication and causes engineers to disregard IoT security. Using modern technology and protecting privacy, especially in the healthcare industry, requires production safety the

facilitator of secure and secured data movement, and usage. So the writers of this study are looking into the IoT security resolutions, privacy agendas, and procedures that are now available [5][6]. The problems faced by the healthcare system are: Unavailability of real time data, Lack of smart care devices, In accurate standard analytics. So by implementing the internet of things in this field we can provide real time data as well as accurate standard analytics and can make things better to the healthcare industry [7].

2.   Functionalities of IoT in healthcare

2.1 Remote Health Monitoring

It will assist medical professionals in remotely monitoring the patient's health. Medical professionals can analyse patient healthiness, administer context based, tailored medicine, and update providers on patient requirements with the data gathered from remote monitoring equipment. Heart rate monitors, breathing and asthma monitors, and insulin monitoring are a few examples [8].

2.2 Self-assistance and monitoring body wearables

Here IOT Helps patients and the medical club understand the patient's health situation at all times, monitor health from a distance, encourage people to take measures based on the readings from wearable technology, and respond to emergencies with the medical team and care providers. Ones that come to mind are health monitoring tools like heart rate monitors and fitness trackers [8].

2.3 Infusing personalised patient care

In this case patient-focused medications enable the automation of drug demand and supply. Utilizing wearable IoT devices, this is implemented. Infusers for insulin and asthma inhalers powered by the Internet of Things are two examples. equipment upkeep for medical devices Both money and lives are saved by the effective maintenance of medical equipment [8].

2.4 Maintenance of medical equipment

Medical equipment maintenance done properly saves lives and money. The maintenance crew can successfully provide support in advance thanks to the data aquireed, issues stated, and usage tracking [8].

2.5 Management of medical assets

To answer to dangers, save quality supervision costs, and improve the quality of medical treatment for patients, couches, medical kits, and other resources must be easily trackable.
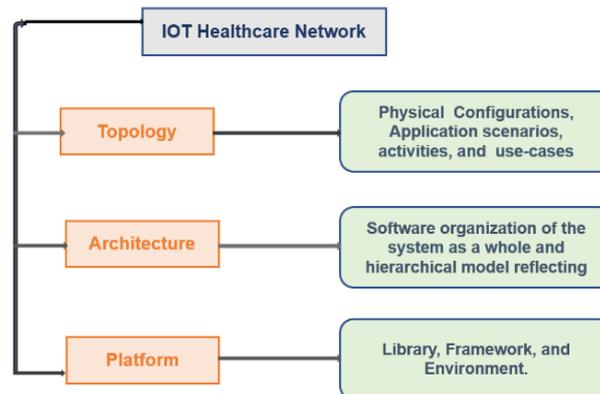
3. IoT Healthcare Networks

Figure 1. Block diagram of healthcare network

3.1 IoT Healthcare Network Topology

The IoThNet topology demonstrates typical healthcare scenarios where a composite computing network manages a high number of significant signs and instrument data over distant monitoring. It applies to the composition of different components. According to the aforementioned manner, it can react so that caretakers can monitor the patient's condition from anywhere. The health-IoT cloud is connected to the IoT healthcare infrastructure, which combines clinical equipment with multiple IoT devices, to conduct research and store the obtained data [5][6].

3.2 IoT Healthcare Network Architecture

The IoT healthcare system planning's guiding concept outlined the technical and functional organisation of the healthcare network's physical components. Healthcare network architecture still has several challenges with caretakers, wireless local area networks (WLAN), program running, secure infrastructures, and IoT gateway-capable computer systems. The composition, signalization, and data transfer of the architecture are three sophisticated e-Health delivery services [5][6]. The excellence of service technique and

resource provision are accepted by methods in the IoT healthcare network while supporting heterogeneous service configuration and signalization protocols.

3.3 IoT Healthcare Network Platforms

The platform for services in the IoT system that is centred on resident health data is called the IoT healthcare system platform model. The platform has four layers like accessing layer, support layer, business layer and data persistent layer respectively. According to the support layer, it is helpful to categorise the many healthcare models that describe how caregivers can access various databases. Similar concepts include data platforms as the business layer's and smart objects' middleware. Here, the model protects the platform for automated design technique and accompanying interoperability that are set up for the IoT network [5]. It equips several users with a variety of sensors for the collection of health data, allowing the Internet of Things gateway to share the support control devices.

4. IoT Healthcare Security

Healthcare providers, IoT device managers, and developers must take appropriate security precautions with the data that these devices collect. As a result, if IoT devices are not properly protected, they could be utilised as gateways for stealing critical data. In fact, 82 percent of healthcare firms claim to have been the target of attacks on their IoT equipment.One way to solve this problem is by creating secure IoT hardware and software. To prevent data from unmonitored devices getting into the wrong hands, it's equally crucial to make sure that IoT devices in healthcare are controlled appropriately[3]. For instance, a patient monitoring device with outdated firmware or a device that is not suitably neutralized once it is no longer required may present a chance for attackers to breach a network or steal protected health information.

4.1 IoT Healthcare Security requirements and challenges

Table 1. IoTh security requirements and challenges

IoT Healthcare Security	Features
Security Requirements	• Denial of Services. • Unauthorised usage. • Privacy of data. • Creation of reliable platforms. • Legitimacy. • Data communication controller

Security Challenges	• Maintenance of standardisation. • Interaction with internet. • Restriction on computation. • Control secure protocol. • Embedded plans with software. • Assimilate with analysed fitness data. • Memory limitations and uncertainty.
Attack Taxonomy	• Attacks based on info disruption. • Based on host properties. • Based on network properties. • New technical paradigm.

4.2 Healthcare Services using IoT

Table 2. IOT Healthcare Services

Services	Merits	Limits
Ambient supported living	• Permit interoperability form several heterogeneous devices • Monitor health and GPS limitations	• Costly • Require daily monitoring or treatment
Advanced drug reaction	• Drug identification • Examine the consequences of pharmacological excipients.	• Knowledge about the technologies availability
Wearables	• Biometric measurement of heart rate, oxygen level • Alter the health information.	• Offers plenty of distractions • Lack of privacy
Semantic medical access	• Usage of different ontologies • Helps in processing the data	• Incorrect information about SMA framework • IOT of security issue
m-Health	• Monitor 24*7 health situations based on physical and simulated existences	• Lack of data security • Lack of accuracy
Children health information	• Organize the child's behaviour • Detect child health condition	• Data accuracy • Avail ability of knowledge

4.3 IoT Sensors used in Healthcare

In healthcare system iot sensors are made to respond to particular situations in the physical environment and then produce a signal (often electrical) that can reflect the severity of the condition being observed [8]. A more particular scenario, like light, heat, sound, distance, pressure, and other elements. So the sensors being used are listed in table 3.

Table 3. IoT Sensors with examples used in healthcare

Sensors	Description with examples
Temperature Sensors	Convert the temperature of the air or a physical object into an electrical signal by using the information. TSYS01, BMP180, Tmp102, TSD series

Humidity Sensor	Detects the humidity of air/mixture of pure gas HTU3500, HTU2X
Photo optic Sensor	Detects changes in light and transforms them into electrical signals. ELM4000, EPM4001, SPO2 ,Finger clips.
Pressure Sensor	Detects the blood pressure or pressure on the object 1620, 1630, Flash mount, Bmp180,MS5805,MS5637
Ultrasonic Sensor	Used for bubble detection and fluid differentiation in body- AD101
Force Sensors	Used in medical devices for physical therapy FS19, FS20, FC22

4.4 IoT Modules and Applications

The term "Internet of Things" (IoT) modules or chips refers to electronic components that are integrated in vehicles, furniture, and other items and are capable of linking to wireless systems and switching data. These gadgets use several protocols like NB-IoT, LTE, and BLE . Revenue from chip modules is taken into account. IoT modules are utilised as SoCs, custom ASICs in the cloud, chips for the systems & servers, and wafer-level packaging for MEMS & sensor clusters [9,10].

IoT apps analyse vast volumes of linked sensor data in the cloud using machine learning algorithms. You may see important performance indicators, statistics for the mean time between failures, and other data using real-time IoT dashboards and alerts. Systems built on machine learning can detect irregularities in equipment, update users, and even start automatic maintenances or preventative steps. Business users may immediately improve current operations for supply chains, customer service, human resources, and financial services with cloud-based IoT apps.

5. Advantages of IoI in Healthcare

- **Cost-cutting:** IoT makes it possible to monitor patients in real-time, thereby reducing the number of pointless doctor visits, hospital stays, and readmissions.
- **Greater Treatment:** It gives complete openness and empowers doctors to make decisions based on the best available data.
- **Disease diagnosis:** Earlier Illness On the basis of symptoms, ongoing patient monitoring and real-time data might assist diagnose diseases at an early stage or even before they emerge

- **Proactive Treatment:** Continuous health monitoring makes it possible to provide proactive medical care.

- **Equipment and Drug Management:** In the healthcare sector, managing medications and medical equipment is a significant concern. Through connected devices, these are effectively monitored and used at lower prices.

- **Error reduction**: Data from IoT devices not only aids in effective decision-making but also guarantees error-free healthcare operations with lower system expenses.

6. Applications of IoT In Healthcare

Table 4. IOT Healthcare applications

Systems for Glucose Monitoring	Diabetes patients may have implants with sensors placed just beneath their skin. When a patient's blood glucose levels drop dangerously low, the sensors in the devices notify them and also store past data for them. Patients will be able to determine when they are most expected to be at danger for low blood sugar both in the present and in the future in this way.
During Cancer Treatment	The best course of action for a cancer patient typically depends on factors other than just age and weight**.** So action trackers track a patient's activities, weakness levels, hungriness, etc.
Medical Alert Systems	People might wear a device like jewelry that can inform friends or relatives in case of an emergency. They would receive a notification on their smartphones the moment assistance was required in an emergency.
Medication Dispensers	There are now implants that deliver medication to a patient throughout the day in consistent amounts. When a prescription has to be renewed, patients will be informed. Missed dosages may also be disclosed to doctors at routine checkups.
Linked Contact Lenses	Sugar patients' blood sugar levels are being delivered through linked contact lenses. However, they will soon be able to assist in regaining the eye's focus and enhancing idea.
Wireless Sensors	In laboratories and hospital refrigerators, wireless sensors are being utilised to guarantee that blood trials, chilled pharmaceuticals, and other biomedical items are always maintained at the right temperatures.

7. Conclusion

The internet has significantly changed the way we live by enabling virtual interactions between people in a variety of circumstances, from work to social relationships. Programming these services lessens the load on people and facilitates the decision-making process because health care facilities are a crucial component of our civilization. The future

of this industry is being changed by the advancement of healthcare schemes through the combination of IoT technology. The thorough examination of the security component of IoT healthcare systems is a significant component of our work as well. This section has covered the general security supplies for an IoT healthcare scheme as well as the typical difficulties in meeting those needs. We discussed about the ways that IoT is dramatically influencing the healthcare industry through its applications and services.

A crucial IoT application that affects loads of devices, peoples survives, and the safety and confidentiality of data and systems is healthcare. It is a multibillion dollar industry that supports the economy while also saving millions of dollars. In order to advance the Healthcare IoT paradigm, it is crucial to explore into the uncharted territory of open research fields as future directions.

References

[1] Shinde, S and Phalle, V "A Survey paper on internet of things based healthcare system" In International Advanced Research Journal in Science, Engineering and Technology, volume 4, 2017

[2] Al-Fuqaha, Ala and Guizani, Mohsen and Mohammadi, Mehdi and Aledhari, Mohammed and Ayyash, Moussa "Internet of things: A survey on enabling technologies, protocols, and applications" In IEEE communications surveys & tutorials, volume 17, pages 2347–2376, 2015

[3] Vermesan, Ovidiu and Friess, Peter and others "Internet of things-from research and innovation to market deployment" In River publishers Aalborg,volume 29, pages 2–4, 2014

[4] Mohan, A.: Cyber security for personal medical devices Internet of Things. In: IEEE International Conference on Distributed Computing in Sensor Systems, Marina Del Rey, CA, pp. 372–374 (2014)

[5] Y. A. Qadri, A. Nauman, Y. Bin Zaria, A. V. Vasilakos, and S. W. Kim, "The Future of Healthcare Internet of Things: A Survey of Emerging Technologies," IEEE Commun. Surv. Tutorials, vol. 22, no. 2, pp. 1121–1167, 2020

[6] M. Burhan, R. A. Rehman, B. Khan, and B. S. Kim, "IoT elements, layered architectures and security issues: A comprehensive survey," Sensors (Switzerland), vol. 18, no. 9, pp. 1–37, 2018.

[7] A. M. Rahmani et al., "Exploiting smart e-Health gateways at the edge of healthcare Internet-of-Things: A fog computing approach," , vol. 78, no. February, pp. 641–658, 2018

[8] Pang, Zhibo "Technologies and architectures of the Internet-of-Things (IoT) for Health and Well-being" In IKTH Royal Institute of Technology, 2013.

[9] https://www.thomasnet.com/articles/instruments-controls/types-of-internet-of-things-iot-sensors

[10] https://www.te.com/content/dam/tecom/documents/sensors/global/SensorSolutionsMedicalApplications.pdf