DEVELOPMENT OF IOT IN HEALTHCARE INDUSTRY

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ABSTRACT: The rapid growth of the Internet of Things (IoT) technology over the past few years has made it possible to connect a lot of smart things and sensors together, allowing for seamless data exchange between them. As a result, platforms for data analysis and storage like cloud computing and fog computing are in high demand. One of the IoT application areas that has piqued the interest of business, academia, and the public sector is healthcare. In the medical field, the development of IoT and cloud computing is increasing operational efficiency, staff satisfaction, and patient safety. This survey examines the most recent developments in IoT and cloud computing-based healthcare applications since 2015, as well as the most recent components, applications, and market trends of IoT in healthcare. We also look at how promising technologies like cloud computing, ambient assisted living, big data, and wearables are being used in the healthcare industry. We also look at various global IoT, e-health regulations and policies to see how they help the healthcare industry grow sustainably. In addition, a comprehensive examination of IoT privacy and security issues, including potential threats, attack types, and security configurations from the healthcare perspective, is carried out. Finally, this paper provides trends, highlighted opportunities, and challenges for the future development of IoT-based healthcare by analyzing previously well-known security models for dealing with security risks.

KEYWORDS: IoT, healthcare, cloud computing, security, privacy, fog computing,communication,networking,wearable computing.

I INTRODUCTION

The public sector, industry, and research community all find the Internet of Things (IoT) to be one of their most exciting topics. IoT connects all kinds of connected "Things" into a comprehensive network of interrelated computing intelligence without the intervention of a human, whereas the traditional internet enables communication between a limited number of devices and humans. Patients' health conditions can now be streamed to caregivers in real time thanks to the rise of wireless communication technologies and the Internet of Things [1,2]. Additionally, a number of portable sensors and devices are capable of touching-based measurement of specific human physiological parameters like heart rate (HR), respiration rate (RR), and blood pressure (BP). Even though it is still in its infancy, industries and businesses have quickly integrated IoT's power into their existing systems, resulting in improvements in both production and user experiences [3].

However, data storage, data management, data exchange between devices, security and privacy, unified and ubiquitous access, and the integration of IoT technology into healthcare present a number of obstacles. Cloud computing technology is one option for resolving these issues. Figure 1 depicts a typical healthcare system that combines IoT and cloud computing to enable ubiquitous and transparent access to shared medical data and common infrastructure, perform on-demand services over the network, and meet growing demands [4].
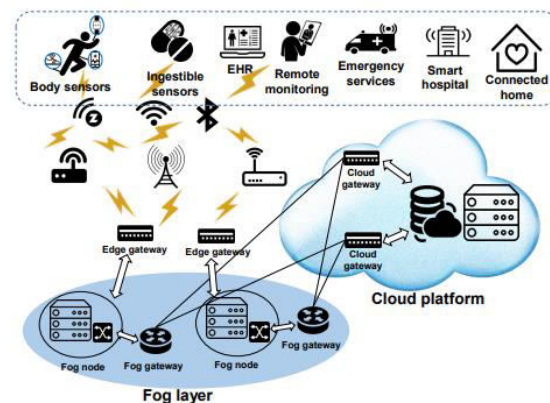

Fig 1 : IOT in healthcare

Through the use of the internet, cloud computing provides servers, databases, networking, software, data analytics, and other computing services for faster deployment, adaptable resources, and economies of scale. In addition, the current shift from the centralized paradigm of cloud computing to the decentralized paradigm of fog computing [5] is getting a lot of attention. Since fog computing performs data analytics on edge devices, real-time processing is made possible, data privacy is enhanced, and costs are reduced. The rise of

portable devices, artificial intelligence (AI), and cloud computing provides a solid foundation for the Internet of Things (IoT) to revolutionize the healthcare industry and all aspects of human life. For more in-depth and comprehensive information about a variety of IoT enabling technologies, their current development progress, and the major challenges that the research community must overcome, interested readers are referred to IoT reviews conducted by [7–11]. In addition, they can consult [4,12] to gain insight into cloud and fog computing technologies, typical application scenarios, various obstacles encountered during system implementation, and potential ongoing research.

Smart cities [13], smart traffic management, waste management, structural health monitoring, security, emergency services, supply chain, retail, industrial management [14–17], and healthcare are just a few of the many applications for which IoT provides appropriate solutions. By 2030, 500 billion devices will be connected, or roughly 58 smart devices per person on the planet, according to a CISCO report [18]. Statista's IoT market research [19] concluded at the end of 2017 that the global IoT market will reach 8.9 trillion USD by 2020, with the healthcare industry

accounting for 7% of the total market value. The Internet of Things (IoT) and cloud computing have made it possible for healthcare professionals to provide faster, more effective, and superior services, resulting in a better patient experience. Consequently, it results in improved healthcare services, enhanced patient experiences, and reduced paperwork for medical professionals. [20] conducted a comprehensive IoT in healthcare survey in 2015, discussing various aspects of IoT in healthcare, including architectures, services, and applications. They also talked about a number of issues, like standardization and security, that need more research. However, this paper has not been published in four years.

Many new technologies and cutting-edge research ideas have been proposed over the past four years. As a result, in order to analyze and summarize them, a new survey must be carried out. Additionally, healthcare applications based on cloud computing have grown significantly in recent years, as has cloud computing. Consequently, it has emerged as an essential component of IoT in the healthcare sector.

A number of studies [21–24] examined various aspects of fog computing and fog applications for healthcare and addressed a number of challenges that researchers must overcome.

In contrast, the authors of [25] examined previous cloud computing architectures and applications in healthcare and identified significant issues that require extensive research. The authors of [26] examined various sensor types and standard communication methods from a different point of view. Farahani conducted an IoT in healthcare hardware and software survey in 2018 [27]. The authors then looked into hardware and software security issues and came up with appropriate solutions that need to be implemented to keep healthcare systems safe.

The fact that the healthcare industry is still adopting IoT and cloud computing leads to the promotion of several fundamental concepts, frameworks, and applications in each of the reviews that focus on a specific aspect of IoT or cloud computing in healthcare. For various groups, including researchers, physicians, and stakeholders who plan to integrate IoT and cloud computing into healthcare or conduct additional research, an in-depth review of previous research on the topic is essential at this point.

II INTERNET OF THINGS AND BENEFITS IN HEALTHCARE

The healthcare industry is in a state of great despair. Healthcare services are costlier than ever, the global population is ageing and the number of chronic diseases is on a rise.What we are approaching is a world where basic healthcare would become out of reach to most people, a large section of society would go unproductive owing to old age and people would be more prone to chronic disease.While technology can't stop the population from ageing or eradicate chronic diseases at once, it can at least make healthcare easier by equipping the users with pocket friendly medical facilities.

Medical diagnostic consumes a large part of hospital bills. Technology can move the routines of medical checks from a hospital (hospital-centric) to the patient's home (home-centric).The right patient outcomes will result into the reduced cost of hospitalization.A new paradigm, known as the Internet of Things (IoT), has an extensive applicability in numerous areas, including healthcare.

2.1 Benefits

2.1.1 Simultaneous reporting and monitoring

Remote health monitoring monitoring via connected devices can save lives in event of a medical emergency like heart failure, diabetes, asthma attacks, etc.

With real-time monitoring of the health condition in place by means of a smart medical device connected to a smartphone app, connected medical devices can collect medical and other required health data and use the data connection of the smartphone to transfer collected information to a physician or to a cloud platform.Center of Connected Health Policy conducted a study that indicates that there was a 50% reduction in 30-day readmission rate because of remote patient monitoring on heart failure patients.The IoT device collects and transfers health data: blood pressure, oxygen and blood sugar levels, weight, and ECGs.These data are stored in the cloud and can be shared with an authorized person, who could be a physician, your insurance company, a participating health firm or an external consultant, to allow them to look at the collected data regardless of their place, time, or device.

2.1.2 End-to-end connectivity and affordability

IoT can automate patient care workflow with the help healthcare mobility solution and other new IoT technologies, and next-gen healthcare facilities. IoT in healthcare enables interoperability, artificial intelligence machine-to-machine communication, information exchange, and data movement that makes healthcare service delivery effective. Connectivity protocols: Bluetooth LE, Wi-Fi, Z-wave, ZigBee, and other modern protocols, healthcare personnel can change the way they spot illness and ailments in patients and can also innovate revolutionary ways of treating across different healthcare fields.Consequently, technology-driven setup brings down the healthcare cost, by cutting down unnecessary visits, utilizing better quality resources, and improving the allocation and planning.

2.1.3 Data assortment and analysis

Vast amount of data that a healthcare device sends in a very short time owing to their real-time application is hard to store and manage if the access to cloud is unavailable.

Even for healthcare professionals to acquire data originating from multiple devices and sources and analyze it manually is a tough bet.IoT devices can collect, report and analyses the real time information and cut the need to store the raw data.This all can happen overcloud with the providers only getting access to final reports with graphs.Moreover, healthcare operations allow organizations to get vital healthcare analytics and data-driven insights which speed up decision-making and is less prone to errors.

2.1.4 Tracking and alerts

On-time alert is critical in chronic condition. Medical IoT devices gather vital signs of any disease and transfer that data to doctors for real-time tracking, while dropping notifications to people about critical parts via mobile apps and smart sensors.

Reports and alerts give a firm opinion about a patient's condition, irrespective of place and time.It also helps healthcare providers to make well-versed decisions and provide on-time treatment.Thus, IoT enables real-time alerting, tracking, and monitoring, which permits hands-on treatments, better accuracy, apt intervention by doctors and

improve complete patient care delivery results.

2.1.5 Remote medical assistance

In event of an emergency, patients can contact a doctor who is many kilometers away with a smart mobile apps.With mobility solutions in healthcare, the medics can instantly check the patients and identify the ailments on-the-go.Also, numerous IoT-based healthcare delivery chains that are forecasting to build machines that can distribute drugs on the basis of patient's prescription and ailment-related data available via linked devices.IoT will Improve the patient's care In hospital. This in turn, will cut on people's expense on healthcare

III CHALLENGES AND ISSUES WHILE INCORPORATING IOT IN HEALTHCARE

Since the Internet of Things (IoT) and cloud computing have been incorporated into healthcare, many aspects of the health industry have changed. Connected medical devices, for example, make it possible for seniors to take care of themselves safely and lessen the demand on nursing homes. In addition, the Internet of Things (IoT) and cloud computing enable health professionals

and specialists worldwide to remotely observe and consult patients. However, in order to fully integrate IoT and cloud computing in healthcare, a number of obstacles must be overcome. The seven obstacles that impede the growth of IoT and cloud computing in healthcare are outlined in the sections that follow. Additionally, potential solutions to these problems are discussed.

Accessibility and speed of communication are two main factors that encourage organizations and businesses to use the Internet of Things and cloud computing in healthcare. However, a 2017 study by Cisco [187] revealed that only 26% of all IoT and cloud computing projects in healthcare were completed. However, difficulties at the proof-of-concept stage afflicted 60% of projects.CISCO made the point that forming partnerships with other partners was an important part of a successful project by looking at all of the projects. When attempting to incorporate IoT and cloud computing into healthcare projects, businesses must exercise caution. They might start with specific, small projects that meet the needs of patients or the goals of the business.

Resource Management is the primary concern arises when three distinct concepts—IoT, cloud computing, and healthcare—are integrated into a single system [53]. When compared to cloud computing, fog computing has less computing power and storage available, making resource management even more difficult. To avoid wasting precious resources, systems must be able to reduce redundant data when multiple IoT devices are included in the system and collected data is transmitted and processed in the cloud computing layer. The fact that healthcare systems typically have a large number of users using the same resources illustrates the significance of resource management in IoT and cloud computing. Therefore, resource management is essential to minimizing delays. Consequently, when implementing IoT and cloud computing in a healthcare system, a thorough analysis of the various factors that affect resource allocation is required. Because poor resource management will result in poor QoS, another important aspect of resource management is quality of service (QoS). Interoperability, Normalization and Administrative Issues.Lately, as the quantity of IoT gadgets soared, the normalization concern has emerged.When IoT devices are

used in a wide range of fields that are governed by various regulatory bodies, the issues of standardization are brought up. Due to the stringent regulations and medical standards, the complexity of IoT and cloud computing in healthcare increases.

Consequently, in order to ensure standardization, manufacturers of IoT devices and various regulatory bodies must establish standard policies and guidelines. The growing number of sensors, smart devices, and "things" that are connected show that a lot of data is being created every day. As a result, it is challenging for IoT and cloud computing to analyze all of it and extract knowledge in healthcare systems. Data complexity, huge amounts of data, and data analysis challenges are the three main obstacles.In recent years, the immense volume of data generated by sensors and wearable devices has raised concerns regarding computing resources and the lengthy process of data analysis. Consequently, it is fundamental for associations to apply as of late arisen advances, for example, mist registering and huge information to stay aware of this enormous inundation of information.

Complexity of the Data Another issue is the intricate nature of the data gathered from sensors and wearable devices. When more data is generated at a faster rate, the complexity rises. In order to meet the challenge posed by the complexity of the data, the implemented system must focus more on fog computing layers to boost computing power and make use of available resources by employing effective data preprocessing and analysis algorithms.

Security and Privacy in IoT devices and fog computing nodes in healthcare systems are becoming more valuable targets for attackers due to their increased processing power and availability. Cyberattacks are also on the rise as a result of these technologies, allowing hackers to exploit a system and target the most valuable data. Hackers are able to successfully infiltrate the hospital network or cause devices to malfunction, affecting patient care, thanks to the information they acquire from attacking fog computing nodes or IoT medical devices. However, by normalizing secure protocols and strengthening standards, a collaboration between providers, vendors, and security experts can prevent cyberattacks. As a result, healthcare facilities that want to use IoT and cloud computing must design a security model to shield networks and devices from potential cyberattacks and be

fully aware of the threats and vulnerabilities that already exist.

IV CONCLUSION

To ensure that the Internet of Things (IoT) and cloud computing bring a seamless transformation to the healthcare industry, organizations, administration, and research communities around the world collaborate closely.Readers who are interested in learning about various aspects of the Internet of Things and cloud computing in healthcare will find this study useful. It provides a comprehensive framework for the Internet of Things and cloud computing in healthcare that supports applications in utilizing the Internet of Things and cloud computing backbone and provides a platform for facilitating the transmission of medical data between medical devices and remote servers or cloud computing platforms. This survey also briefly categorizes and summarizes the numerous concepts and applications that are continuously added during the IoT and cloud computing integration process in healthcare. Then, we conduct a comprehensive examination of cloud computing, specifically fog computing, including standard architectures and previously conducted research on fog computing in healthcare applications. After that,

significant accomplishments that demonstrate the efficacy of integrating IoT and cloud computing in healthcare were described, and we then grouped the existing processes of research and development in the healthcare industry according to components, applications, and end-users. In order to avoid potential security risks, the paper also analyzes and summarizes relevant security models and takes into account a variety of threats, vulnerabilities, and attacks. The inclusion of IoT and cloud computing-related healthcare policies from around the world is also mentioned. Finally, a number of obstacles, including data security, system development procedures, and business models, stymie the growth of IoT and cloud computing in healthcare.

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