Understanding IoHT and Edge/Fog Computing Solutions for Smart In-Home Remote Healthcare

KUO-MING CHU
Department of Business Management
Cheng Shiu University
TAIWAN

Abstract: Healthcare information systems have been dominated by cloud technology and the Internet of Things (IoT) for decades today. In some urgent scenarios, we reveal a prevailing architectural framework that is based on fog/edge optimal computing approaches smart in-home remote healthcare solutions and architectures and recognize the challenges and requirements of IoHT devices for diverse utilization instances. Even with these upsides, conventional centralized access constraint confronts privacy problems and patient health data security. This study likewise constructs a “blockchain-enabled edge that computes” mechanism, through which smart contracts with the consensus protocol produced by Edge Intelligent Server are deployed to secure privacy topics and balance scalability in trustless surroundings. We expect this paper to be a significant guideline for the subsequent elaboration of fog/edge-based systems that compute solutions for smart in-home remote healthcare IoT applications. There will be a change of paradigm from “hospital-based” to “distributed patient in-home healthcare”.

Key-Words: Fog/Edge Computing; Internet of Health Things (IoHT); Smart In-Home Remote Healthcare; Blockchain-Enabled Edge Computing; Security and Privacy

Received: August 12, 2021. Revised: April 7, 2022. Accepted: May 4, 2022. Published: June 3, 2022.

1 Introduction

The Bureau of the Census pointed out that the ageing of the global population continues to accelerate, and it is calculated that it will reach 1.6 billion in 2050, which is equivalent to 1 in 5 people being a “silver tsunami”. Taiwan’s population is ageing at the fastest rate in the world. In 2016, the elderly population exceeded the younger population. It is expected that the population over 65 years old will confess over 20% of the total population in 2026, becoming a superaged society. These phenomena show that Taiwanese society is facing the hidden worries of “a sudden increase in the demand for care and a shortage of manpower for care”. The study also pointed out that there will be approximately 720,000 people in urgent need of long-term care in the next 10 years. Fueled by the aging trend and the wave of declining birth rates, the market for care needs has increased dramatically. As the concept of care quality changes, increasing attention will be paid to meticulous humanization and the local aging care model. How to use the application of intelligent technology to make up for the shortage of manpower and fill the huge and increasingly tight care manpower demand. Therefore, the governments of all countries are considering how to solve the problem of elderly care.

In recent times, healthcare has been leveraging the advancement of information technology and 5G mobile networks for distributing intelligent systems that are focused on speeding treatment and health diagnostics up. A couple of years ago, while the IoT was brought in with explicit architecture and mobile phones entered humans' daily routine, the brilliant increment is seen in IoT technology. Long-term care is one field that has already been contacted through the digital healthcare revolution, and we look forward to seeing further advancements have been issued as one of the most popular fields of IoT technology in the coming years. In this situation, the way healthcare is seen worldwide is drastically changed by forceful implanted hardware's broad pervasion together with intelligent medical sensors' evolution and apparatuses for widespread healthcare has made for smart IoT, so it is expected that the number of healthcare instruments that use wearable technologies and IoT will achieve 162 million by the end of 2020 [1]. The Internet of Health Things (IoHT) has been familiar with the combination of IoT and remote healthcare surroundings, where delicate data that are relevant to patients are communicated from IoT tools to the server [2]. Among them, IoT devices can assist in the provision of discrete, more independent/safer lives and are easy to use to seniors and people with special care needs, further helping limit overall healthcare costs. Aided living apparatuses are progressively dependent on the IoT to serve respect and monitor inhabitants. Regarding the IoT's increased adoption, we can anticipate the following profits and shifts in the healthcare area of elderly people: illness, injury prevention and increased efficiency, individualized care, and big data benefits.

Many countries around the world have become a superaged society; therefore, for caregivers, it may become the sandwich generation (elderly parents above, children below) under significant family, work, and financial stress. In-home remote healthcare is a kind of supportive care provided at home. In-home healthcare can reduce the time for family members to travel to and from the hospital, and by increasing the deployment of wireless medical devices, hospital staff can remotely monitor the health of patients. There is no need to be physically present, so more patients can be cared for. Therefore, in this article, we propose an inspection of edge/fog and smart IoHT computing solutions, concentrating on remote health care that improves healthcare personnel's ability to considerably comprehend the requirements and patterns of the people they take care of daily, permitting them to offer greater feedback, guidance, and support for keeping healthy. The article's remainder is arranged as follows. Section 2 offers the modular framework of smart IoHT that applies Fog/Edge computing for in-home healthcare, including its architecture and features, which are cautiously interpreted. Section 3 illustrates smart in-home remote healthcare in implementing the proposed framework. Section 4 shows the discussion and results related to the comparison and performance of the proposed framework. The concluding comments are contained in the last section and emphasize the open study trends for the combination of IoT, fog/edge and cloud in intelligent remote care.

2 Hospital-to-Home Model: In-home Remote Healthcare

With age, various healthcare troubles frequently requiring long-term and continuous medical care can put harsh pressure on healthcare resources and raise expenses. A scarcity of nursing assistants, in-home health assistants and healthcare givers, nevertheless, exceeds worldwide, which causes care for the elderly cost. Thus, regarding the rise in the number of patients (such as aged citizens) living home solely under the monitoring of their doctors, it is required to add equipment for remote supervision, as the patient must be diagnosed for fast involvement [3]. There is a growing prominence in discovering alternative nontraditional approaches, such as in-home healthcare, to take charge of patients to reduce the strain on healthcare services and manipulate expenses. Moreover, remote healthcare endures play a crucial role in decreasing physical contact, hospitalization, consultation time, queuing list and whole health expenditure for a patient when the strain, workload, and pressure on the medical worker decrease [4]. The fast advance of ICTs in in-home remote healthcare services likewise makes it conceivable for patients, particularly the elderly or disabled, to master inevitable home solutions with comfort from tools such as mobile phones, tablets, laptops, and the internet. Novel healthcare technologies' fulfilment has a function to play in-home healthcare, stimulated into fast utilization through the pandemic, with data integration, artificial intelligence and remote patient monitoring devices assisting virtual healthcare platform efforts, including healthcare for patients at home rather than in a hospital environment. Not only does this broaden healthcare from the hospital to the home, but it also gives a sense of consolation and security to their family and the patient that they are still being monitored outside of a hospital condition by a healthcare team.

The localized home-style and community-style services allow elders to obtain the services they need in a familiar life circle. The study likewise reveals that many elderly people do favor in-home healthcare with remote monitoring. For such examples, urgent needs are represented by smart healthcare systems. These systems adopted the technology to supervise patients at their hospital or homes and inform their caregivers, family persons or doctors of their requirements and health condition. By using IoT technology, telemedicine or remote healthcare will become realizable. It can help to deal with chronic diseases, yet for patients who live in remote areas. Another cause for remote health monitoring's growing popularity is that wearable medical instruments and assorted biosensors are currently readily available to consumers from diverse sources. Cloud computing, fog computing and IoT are involved in these technologies, as shown in Figure 1.

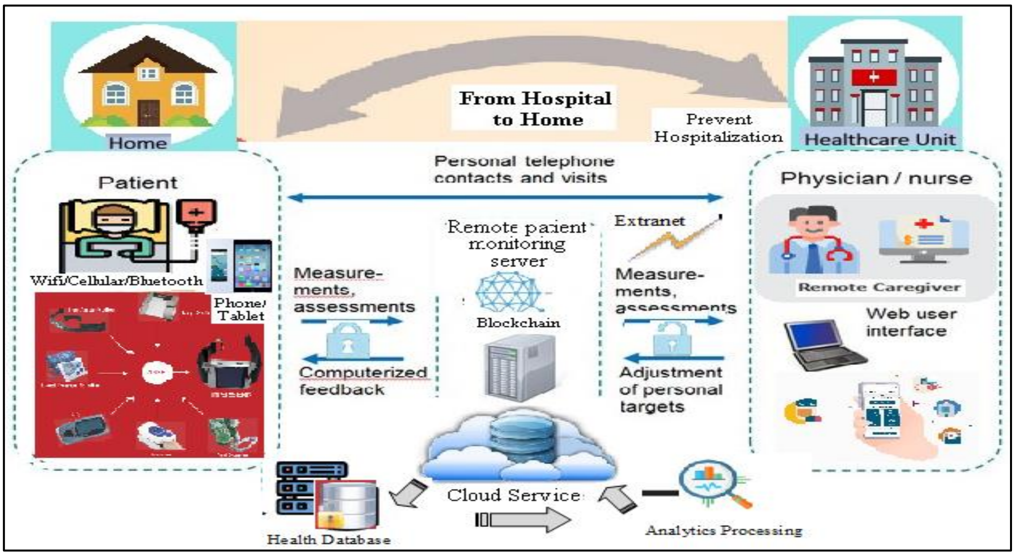

Figure 1. A generic In-home Remote Healthcare Architectures

3 A General Architecture for IoHT and Edge/Fog Computing Systems

The advent of 5G has prompted IoT technologies to develop several more intelligent applications that employ both network architectures and solution platforms fields and force IoMT applications' further development. Among them, big healthcare data are continually being augmented by information generated by intelligent edge devices such as wearable sensors. They offer information about patient health and transmit it directly to a network or through mobile devices to be available whenever and wherever they are needed. These wearable devices' greatest advantage is that they admit disease management and patient health monitoring in non-clinical settings such as private homes, nursing homes, and aided living. In recent times, to diminish service reaction time, enhance system quality, and enhance energy efficiency, combining fog/edge computing into the IoMT solutions has been suggested and accomplished several positive outcomes. The adoption of Fog/Edge, which computes applications in the healthcare field, usually copes with the intention of remote monitoring applications leveraging wearable and domain sensor networks for carrying out conservatory, preventative, and responsive systems out [1]. In this situation, most contributions involve fog nodes playing local servers collecting and treating health data to react to the service prerequisites rapidly [5]. We then reveal a prevalent architectural framework for fog/edge computing-based in-home healthcare applications. Both Edge and Fog Computing leverage the proximity to the user to offer excellent availability and diminished latency for location-aware health services. Several approaches that depend on hierarchical computing strategies have been suggested to assign and distribute the reasoning missions of AI and machine/deep learning techniques between the cloud, the fog and the edge layers (or fog/edge peers), attempting to drive the (limited) computational capabilities of edge apparatuses to their apex [6]. We convey an overall computing architecture of fog/edge-based smart IoHT solutions, as shown in Figure 2.

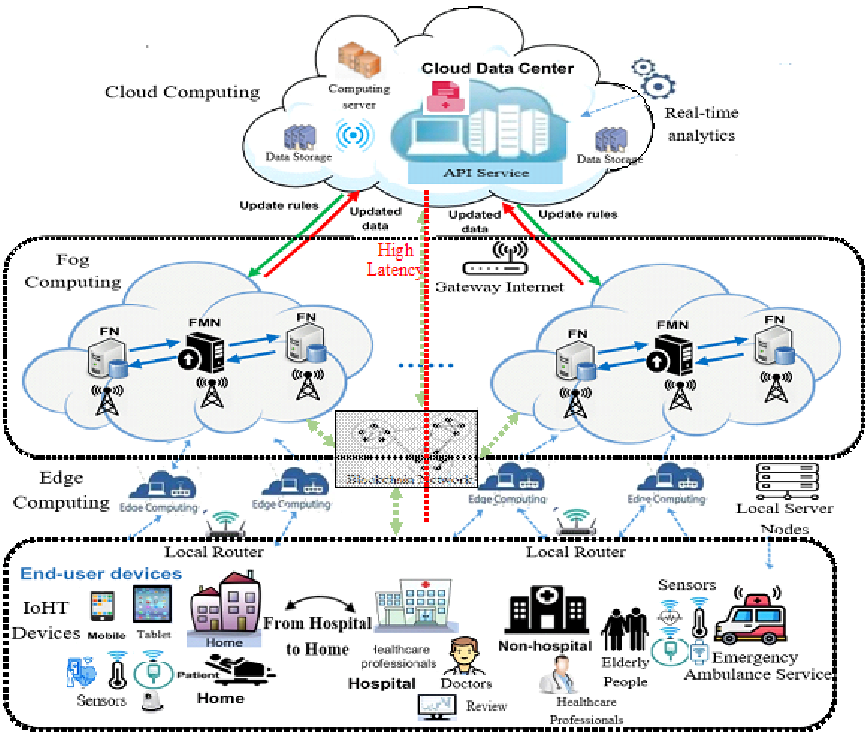

Figure 2. A General Architecture of Fog/Edge computing Based Smart IoHT applications

In this section, the proposed framework's principal architecture is depicted, called the smart in-home remote healthcare framework, and smart healthcare's general performance is improving. In the postcloud epoch, Figure 2 reveals the proposed framework architecture for monitoring elderly people and remote patients, which is composed of three principal layers: fog/edge, cloud layer and IoHT. Meanwhile, the non-falsify-proof, cryptonym and decentralization of blockchain technology can offer edge computing and fog new security that computes the surroundings. To a more beneficial comprehension, the functions, and principal requirements of the distinct layers in intelligent healthcare architecture are summarized in Figure 2.

3.1. Sensor Device Layer of IoHT Application

For a better apprehension to gather the patient and elder people's information reflecting his activity, several kinds of sensors and health states are required, such as medical sensors, activity sensors, surroundings sensors and intelligent cameras representing the sensor network layer. The sensor's elements detect the patient's presence, capture his picture, and transmit it to the fog devices via wireless and gathering readings or wired communication protocols. Sensors ought to be in all areas the patient can transfer to collect the information of the patient's critical signals or physiological signs such as temperature, heartbeat, brain indications, blood pressure, etc. Then, the information is sent by these sensors wirelessly to the base stations. The influence of the IoT in healthcare institutions is revolutionizing through providing very high and huge areas available for an advance. Aid to IoHT sectors such as machine learning, artificial intelligence, wireless sensor networks and cloud computing is provided by diverse supportive technologies. The transmitted information is obtained by remote healthcare centers or the cloud of intelligent healthcare applications. Wireless body area networks (WBANs) are the key network style in the deployment of IoT intelligent healthcare services exploiting technologies of ZigBee, WLAN, and Bluetooth, which reform the eventual destiny of medical services that are detected by offering elderly people checking and continuous patient and diagnosing numerous dangerous illnesses.

IoHTs services result in diverse storage of measured and analyzed information of the health condition of a patient occurring on cloud units to be subsequently assessed by healthcare professionals and doctors. Information through the cloud is treated for a smart healthcare services framework using artificial intelligence ideas and cognitive computing. The employment of smart remote care architectures with different IoT capabilities permits remote monitoring and uninterrupted following of medical matter of patients, a long-term inspection of wellbeing records of the patient, diminishing clinical expenses and widening the innovation for offering patient-driven care instead of medical hospital-driven therapy.

3.2. Cloud-Based Solutions

Cloud computing will forever own a place, e.g., whereas many IoT apparatuses need instant decision-making at the edge, medical institutions may require historical analysis for model development and process improvement. Alternative computing assistance is offered by cloud computing through the Internet. Compounding it with IoHT addresses many troubles, such as information management, data storage, communication, privacy, and security. The healthcare industry can likewise supply a widespread platform to obtain shared prevailing health data and can provide “Things as a Service” by combining the cloud concept with the IoHT. This works best when data from multiple edge apparatuses can be integrated centrally. It can permit interconnected relationships, and perceptiveness that is obtained from the historical analysis can be driven back to the edge so that IoT-enabled edge devices continue to evolve to create more excellent instant decisions. The computing architectures thus become an integration of edge and cloud computing, where IoT devices operate in real-time at the edge, where raw data are gathered and processed, and metadata are shared to the cloud for continuous process advance and comprehensive historical analysis.

Distant healthcare is one of the cardinal services of a digital and intelligent healthcare service that will decrease the burden on healthcare workers and crowded hospitals and would be more advantageous for offering healthcare to patients who reside in very distant regions. The cloud layer comprises servers with exceedingly enormous storage, and long-term treatment decisions are made by processing and analysis capacities assisting medical workers for patients. Cloud-based IoT programs have been smoothly arrayed in the last decade; nevertheless, Quy et al. [7] indicated that existing IoHT packages that are dependent on the cloud possess high service reaction time and restricted scalability. Cloud-only medical systems comprise wearable devices, cloud servers, and a network. These components may have large distances between elements, which further worsens high latency trouble (revealed in Figure 2). Transmitting information to the cloud frequently for calculation is the reason for higher power expenditure and related costs, even more so currently, when the amount of information that is produced through sensors is extremely large. Cloud-based solutions in a similar way do not offer low-cost mobile surroundings to the user, which is needed for numerous patient monitoring scenarios. Recently, many medical monitoring systems have embraced a contrast between conventional cloud systems and distributed or fog/edge approaches.

3.3. Edge- and Fog-Based Applications

Edge computing is a distributed computing system transferring digital data, services and programs from the network's cardinal node to the edge nodes on the network logic for processing. Edge computing resolves large-scale services originally dealt with by fundamental nodes, splits them into smaller and easier-to-manage portions, and distributes them to edge nodes for processing. The edge node approximates the user terminal device, which can accelerate the transmission and processing of data and decrease the delay. Thus, edge and fog computing are advantageous to serve localized healthcare solutions since settling the IoT devices next to the user or in the user declines the proximity of the network latency time and reaction to very low service. Fog that apparently computes will be one of the most feasible services for the IoHTs solutions in urgency save scenarios and in a number of instant patient monitoring systems, such as patients with records of stroke, heart disease and blood pressure. The combination of IoT devices with the edge/fog and cloud computing can be an assisting hand for the healthcare industries to decrease the care expense and network that processes intelligent IoT devices charge the same. The Internet gateway, local router, and fog servers are encompassed by the fog layer. This layer conveys and transmits information between the cloud and IoT sensor device layers. It employs offered information from the underlayer, federated learning, fog computing, and deep learning to create decisions for urgent medical scripts. Along with it, there are likewise some other advantages of fog and edge computing, such as scalability, usability, dependability, and performance. Hence, the major concept of combining IoHT with these techniques is to move from habitual forms of caring for the patients, inspecting the hospitals, etc. to smart in-home healthcare styles.

In recent times, fog computing's vast potential was presented by the boom of healthcare IoT solutions that were dependent on fog computing. Key traits and basic services, such as data analysis and big data storage, are provided by the cloud layer. Healthcare systems are one of the most suitable paradigms of those programs that require real-time processing of big data yield through medical apparatuses and sensors and with ultralow latency. It should be mentioned that the overall burden on the cloud system would be less in an IoT-Fog-Cloud combined system than in a system where there are merely IoT devices and cloud servers. This is because some of the tasks are executed at the fog layers, such as safety checking and data analysis. In a fog-based IoT healthcare architecture, cloud computing is used to assist fog services. There are a number of studies confirming fog's effectiveness in healthcare applications. The end user may be an individual, a system administrator, a medical specialist, a professional, or a patient.

To deal with the chaos in the distinction between edge and fog computing, we begin this controversy by depicting both edge and fog computing from distinct viewpoints. Several scholars ascertain edge and fog computing layers as the equal notion with disparity merely in their names, whereas others distinguish them as two distinct ideas [8]. Shukla et al. [9] claim that fog computing is a foundation of the IoT; it expands distinct services and cloud computing to devices such as switches, routers, multiplexers, etc. Edge computing promotes solutions, applications and data from the kernel to the network edge, depending on the core-edge topology. Smart in-home remote healthcare aims at permitting intelligent control of distinct intelligent end-user devices that are linked inside homes and non-hospital institutions. The linked smart healthcare devices produce plenty of information for intelligent control and decision-making in-home distant healthcare. The processing and the analysis of these data demand a vast volume of resources and storage needing a scalable application to warrant feature and progression of service without any degradation. Edge computing provides an extremely distributed application for developing intelligent in-home remote healthcare systems in an efficient approach by treating the data at the network edge that provides low latency, time-saving data processing and less energy expense. Edge computing-based intelligent home objectives at improving the succeeding IoHT architecture, particularly those requiring a short reaction time, such as observation and smart manipulation of smart devices inside the home.

3.4. Technology of Blockchain-Enabled Edge Computing

Smart in-home remote healthcare applications, however, create a significant provoke into fighting in preserving the security and privacy of patient care information. Because of the secret nature of location information and health, it is significant to warrant a high degree of safety to users [10]. Patients' health information at the network's edge, frequently on mobile devices, should be encrypted prior to transferal to other nodes. Because of resource restrictions, this should be performed in an efficient but effective approach. Many potential computing nodes provide novel approaches for acquiring a patient's information but could also permit a higher degree of privacy as a consequence of the distribution of important information. An excellent perspective for the integration of edge computing and blockchain has been evidenced accurately by the above discussion. On the one hand, it establishes full adoption of the edge in the edge computing cognate to the end-user to comprehend the administered instant processing technique; on the other hand, it uses the decentralized acceptability attribute of blockchains to even elevate the scalability of distributed construction. Furthermore, it is the collaborative logical and physical node of the edge computing blockchain network and network.

The principal properties of a blockchain as the underlying kernel technique have become an emerging broad-scale network data/information-sharing technology, and several types of edge nodes have been created to efficiently balance complexity in trustless surroundings. Manager nodes assisted through an Edge Intelligent Server (EIS) have solid computing and guaranty capacities and combine various types of equipment to establish diverse edge-cloud applications. It profits from EIS, where smart contracts by the concord protocol are allocated, which can accomplish information management and service customization. Complex logic is depicted by the smart contract that runs on the blockchain as code, which turns into contract-based automation protocol implementation. Data services that are based on tamper-proof features and distributed data storage can guarantee service process records' integrity. The smart contract then writes down the store event's execution as a block. Among them, the EIS nodes deal with it and inspect their data to the linkage following the agreement mechanism by using smart contracts. Finally, a novel block is replenished to the blockchain pursuant to the agreement algorithm. Consequently, blockchain-enabled edge computing comprises the end-user sensor layer, EIS, kernel roles of blockchain, cloud servers and their system portions, as demonstrated in Figure 3.

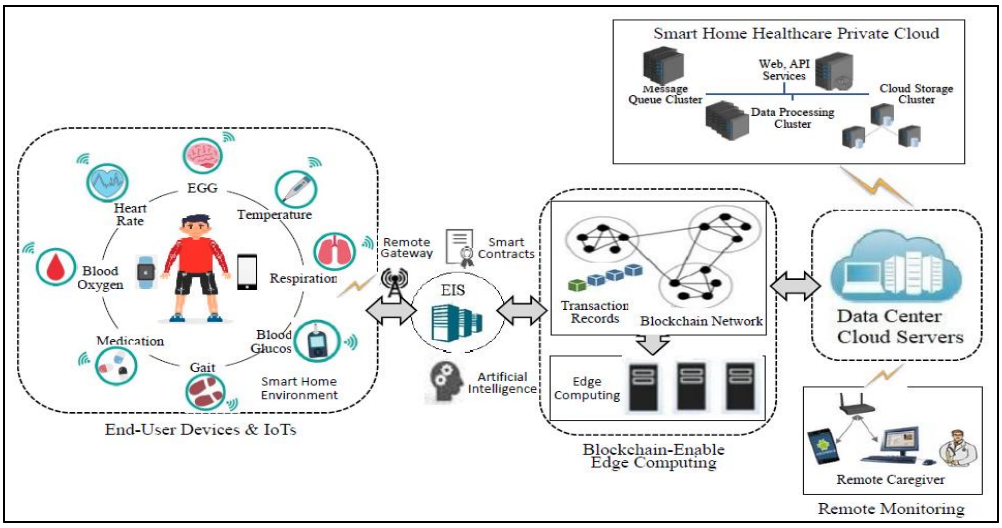

Figure 3. Diagram of blockchain-enabled edge computing

For the objective of offering a more elastic application, a blockchain-enabled system must be exploited for the manager to reach the resources in IoHT sensors and edge computing. The decentralized architecture carries several attributes: device nodes are controllable synchronously by multiple managers and belong to dissimilar management fields throughout their lifetime in the blockchain, the managers and device nodes are interrelated by the blockchain network, and constricted managers are able to control apparatus nodes well with Edge Smart Server. It in total is an intelligent strategy to allocate systems and crux applications. The edge layer is broadened by the edge computing layer on cloud computing.

4 Concluding Remarks and Future Work

Under the situation that the global low birth rate trend is difficult to reverse, it is obviously a luxury to increase the nursing manpower to improve the long-term care system. In the past, people used to regard ageing as a burden. The aim of smart in-home novel healthcare technologies is to permit intelligent control of distinct smart end-user devices linked inside nonhospital institutions and homes. Not only does this broaden healthcare from the hospital to the home, but it also gives a sense of consolation and security to their family and the patient that they are still being monitored outside of a hospital condition by a healthcare team. In this article, to decrease service reaction time and improve system quality and energy efficiency, we propose an overall architecture for fog/edge computing-based smart IoHT in-home healthcare applications. Therefore, smart in-home remote healthcare is an excellent alternative to be utilized at homes, aged care homes, or hospitals soon due to increased overall system intelligence, energy efficiency, less network usage, and quick reaction time. There will be a change of paradigm from “hospital-based” to “distributed patient in-home healthcare”.

First, depending on the IoT era, smart healthcare's notions will be a broad revolution of the next Internet in remote healthcare industries. In this transition, machine learning approaches and AI play a critical mission, but their fulfillment requires computational capability that is usually available merely with cloud services' means. To offer computing approaches for these services, many computational techniques have been provided, including cloud computing, edge computing, and fog computing. An accustomed healthcare solution that is based on the cloud has several limitations, such as high computing costs and service reaction time. To save or instant ambulance urgency and rescue solutions, these applications need instant service reactions. After all, completely local management's selection is even unrealistic because of limitations in treating storage and capacity, particularly in the example of real-time performance and dynamic monitoring. Therefore, fog/edge computing was born to emerge the energies of the cloud nearer to end-users to close in IoHT systems' requirements. Because the distance between the cloud database and the end-users center is curtailed, fog computing obtains prominent benefits over cloud computing and is particularly agreeable for instant IoHT solutions. It is expected that this article's achievements will be a major guideline for future research in the domain of the healthcare industry and fog computing.

Furthermore, we have revealed the associated applications, data operations, and the social capital perspective as detailed in the surveyed research. Edge computing and blockchain can be a complete match because of the supplementary features they unveil and the identified demerits that can be mended. This survey concentrates on the privacy facets and security of blockchain-based edges that compute networks. We dealt with the profits and challenges of these subareas of privacy and security. We have likewise investigated the research from the standpoint of blockchain-enabled edge computing, including expense, latency, safety, position awareness, and energy efficiency. The results indicate that authorization considers both security and efficiency with "blockchain-enabled edge computing" integration. Our completion is that blockchain-edge computing orchestration is forced to lead to a significant revolution in remote healthcare industries, extending the way for new distributed architectures and novel business models.

Finally, the principal properties of a blockchain as the underlying kernel application have become aborning broad-scale network data-sharing architecture, and several types of edge nodes are created to efficiently balance complexity in trustless surroundings. Manager nodes that are served through an EIS have storage capacities and solid computing and combine software and hardware to establish diverse IoT-edge-Fog-cloud applications. It profits from EIS, where smart contracts with the acceptability protocol are allocated, which can accomplish information management and service customization. Complex logic is depicted by the smart contract performing on the blockchain as code, which transforms the fulfillment of the contract-based automation protocol. Data services that are based on tamper-proof features and distributed data storage can guarantee service process records' integrity. The smart contract then records the store event's execution as a block. In this examination, we intend an all-in-one computing application solution. In addition, we recently investigated IoT systems that depend on edge and fog computing programs in remote care industries. Depending on the overview consequents, we resolved the challenges, next study orientations and solution feasibility. It is expected that this study's outcomes will be a significant direction for future research in the domain of the remote in-home healthcare industry and fog/edge computing.

References:

[1] Akmandor, A. O. and Jha, N. K., "Smart health care: an edge-side computing perspective", *IEEE Consum. Electron. Mag.* 7(1), 29–37 (2017).

[2] Wang, L., Ali, Y., Nazir, S. and Niazi, M., "ISA Evaluation framework for Security of Internet of Health Things system using AHP-TOPSIS methods", *IEEE Access*, 8, 152316-152332 (2020). doi: 10.1109/ACCESS.2020.3017221.

[3] Mshali, H., Lemlouma, T., Moloney, M. and Magoni, D., "A Survey on health monitoring systems for health smart homes", *International Journal of Industrial Ergonomics*. (2018).

[4] Taiwo, O. and Ezugwu, A. E., "Smart healthcare support for remote patient monitoring during covid-19 quarantine", *Informatics in Medicine Unlocked*. 20, 100428 (2020). https://doi.org/10.1016/j.imu.2020.100428

[5] Tang, M. S., Wu, X. R., Lee, H. W., Xia, Y., Deng, F. M., Moreira, A. L., Chen, L. C., Huang, W. C. and Lepor, H., "Electronic-cigarette smoke induces lung adenocarcinoma and bladder urothelial hyperplasia in mice", *Proceedings of the National Academy of Sciences*, 116(43), (2019). doi: 10.1073/pnas.1911321116.

[6] Abdellatif, A. A., Emam, A., Chiasserini, C. F., Mohamed, A., Jaoua, A. and Ward, R., "Edge-based compression and classification for smart healthcare systems: concept, implementation, and evaluation", *Expert Systems with Applications*, 117, pp. 1–14 (2019). https://doi.org/10.1016/j.eswa.2018.09.019

[7] Quy, V. K., Hau, N. V., Anh, D. V. and Ngoc, L. A., "Smart healthcare IoT applications based on fog computing: architecture, applications and challenges", *Complex & Intelligent Systems*. 17 (2021). https://doi.org/10.1007/s40747-021-00582-9

[8] Laroui, M., Nour, B., Moungla, H., Cherif, M. A., Afifi, H. and Guizani, M., "Edge and fog computing for IoT: A survey on current research activities & future directions", *Computer Communications*, 180, pp. 210-231 (2021). doi:10.1016/j.comcom.2021.09.003

[9] Shukla, S., Hassan, M. F., Khan, M. K., Jung, L. T. and Awang, A., "An analytical model to minimize the latency in healthcare internet-of-things in fog computing environment", *PLoS ONE*. 14(11): e0224934 (2019). https://doi.org/10.1371/journal.pone.0224934

[10] Hartmann, M., Hashmi, U. S. and Imran, A., "Edge computing in smart health care systems: Review, challenges, and research directions", *Trans Emerging Tel Tech.*, pp. 1-25 (2019). https://doi.org/10.1002/ett.3710

Data Availability

All data, models, and code generated or used during the study appear in the submitted article.

Conflict of Interest

The corresponding author (Kuo-Ming Chu) states that there is no conflict of interest.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

No funding is involved.