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Smart Technologies for Smart Healthcare Information System – A review

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Abstract

The Internet of Things (IoT) has swept the commercial world with applications ranging from agriculture to healthcare to transportation and beyond. A hospital setting can be quite stressful, particularly for seniors and children. The traditional patient-doctor appointment has lost its usefulness as the world population grows. As a result, smart healthcare becomes a critical instrument to investigate. The impacts of smart health cuts across from monitoring babies' temperatures to monitoring vital signs in the elderly, smart healthcare is flexible and may be adopted at all levels. The complexity and expense of implementation vary depending on the precision required of specific devices, their functions, and the intricacy of the application for which they are utilized. Very large-scale integration (VLSI), embedded systems, big data, machine learning, cloud computing, and Artificial Intelligence are all vertical areas that smart healthcare falls under. This article discusses the importance, requirements, and applications of smart healthcare along with the current industry trends and products. It gives a deeper insight into the different platforms across which more research can be pursued in this dynamic domain.

Keywords: Healthcare, smart, technology, IoT, VLSI

Introduction

Due to the massive increase in population, traditional healthcare is unable to meet everyone's needs. Medical services are not accessible or inexpensive to everyone, despite having superb infrastructure and cutting-edge technologies (Seena & Sudarshan, 2019). One of the purposes of smart healthcare is to assist consumers by informing them about their medical conditions and keeping them informed about their health. Users of smart healthcare can self-manage some emergency circumstances (Shuo, et al. 2019). The system focuses on increasing the user's quality of life and experience (Islam et al., 2020). Smart healthcare enables the most efficient use of available resources. It gives room for remote patient monitoring and lowers the cost of treatment for the user. It also enables medical professionals to expand their services across geographical boundaries (Rahaman et al., 2019). With the growing trend toward smart cities, a functional smart healthcare system ensures that its residents live healthy lives (Lin et al., 2017). In general, connected health refers to any digital healthcare solution that can operate remotely, and it is a catch-all term for subsets like telemedicine and mobile-health, but with the addition of continuous health monitoring, emergency detection, and automatically alerting appropriate individuals (Al-Ali, et al 2017). Smart healthcare refers to solutions that can run totally on their own, whereas connected healthcare refers to systems that allow consumers to receive feedback from clinicians (Mois et al., 2017). The end-user market is the most crucial classification that defines the smart healthcare economy (Rahaman et al., 2019). The cost, power, and architecture of a healthcare network differ greatly depending on whether it is to be built for individuals or hospitals (Chen et al., 2018; Ayaz et al., 2019).

Smart Health Information System

Smart health with sensors and intelligent terminals is a subset of a smart city based on cloud, Internet of Things, and associated technologies synthesis. The goal is for administrators, doctors, nurses, and patients to communicate strategically in a more complex environment to improve healthcare delivery, share experiences, and communicate successfully (Ayaz et al., 2019; Chen et al., 2018; Hasan et al., 2019)

Based on the services, medical devices, technologies employed, applications, system administration, and end-users, (Nooruddin et al., 2020; Islam et al., 2019) Figure 1 depicts the characteristics of smart healthcare. Connectivity technologies used to be critical in broadening the range of applications for which the healthcare system was built (Mahmud et al., 2019). Remote health monitoring via the Internet of Things (IoT) can be made easier with the efficient integration of small devices via wireless technologies (Mahmud et al., 2020). A Bluetooth module, 6LowPAN, or RFID can be used to connect a customizable monitoring gadget, such as a wrist band, to the internet (Yang et al., 2020; Patil et al., 2019). However, to maintain consistent internet connectivity and sustain large data traffic in a hospital setting where a healthcare network is maintained, Wi-Fi and ground cables are required (Ayon et al., 2020; Islam & Islam, 2019). On-body sensors and stationary medical devices are two types of medical equipment used to achieve smart healthcare (Islam et al., 2017). Biosensors that are attached to the human body for physiological monitoring are known as on-body sensors (Hasan, Islam & Hashem, 2016). In-vitro and in-vivo sensors are two different types of sensors (Haque et al., 2018). In-vitro sensors are externally attached to the human body, decreasing the need for lab or hospital facilities in healthcare (Tamilselvi et al., 2020). In-vivo sensors are implantable devices that are inserted into the body after meeting all sterilizing requirements (Acharya & Patil, 2020).

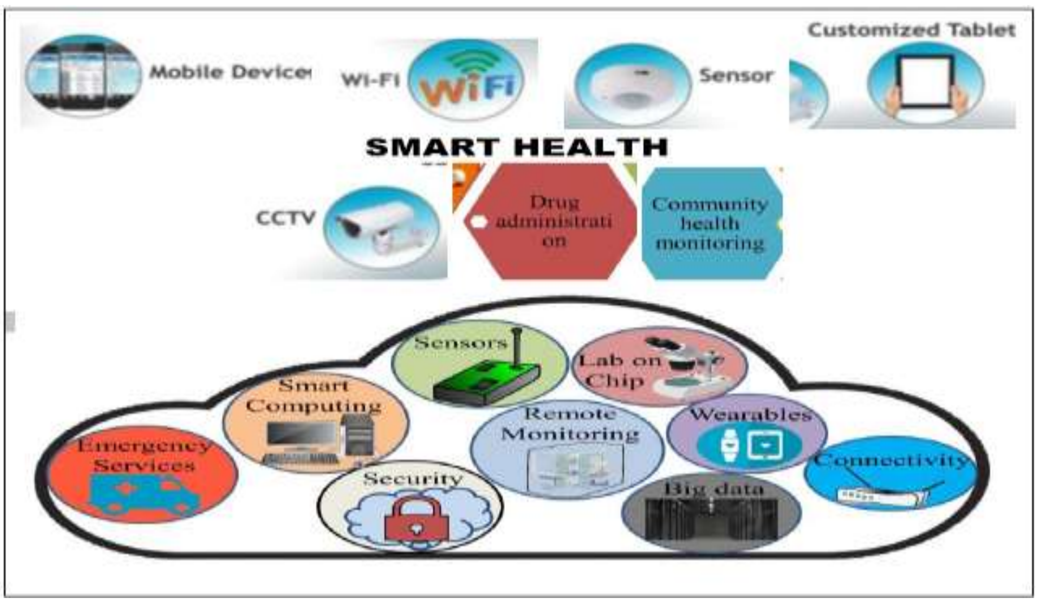

Figure 1: A typical Smart Health (Acharya & Patil, 2020; Haque et al., 2018; Tamilselvi et al., 2020)

Smart Apps

This is a mobile and online application that allows devices on smart health to communicate with one another. The smart apps serve as a communication and sensing interface between the user and the devices (Liu et al., 2018; Pan, 2019).

The Internet of Things

Sensors, controllers, machines, people, and objects make up the Internet of Things, which allows for intelligent identification, location, tracking, monitoring, and administration. Smart communication, combines intelligent sensors, identification technologies, a wired network, and mobile Internet (Farahani et al., 2018; Esteva et al., 2017)

Cloud Computing

Cloud computing is a new computer model that has shifted the way healthcare is delivered. Healthcare providers and industry specialists are both interested in this innovative technology (Qi & Lyu, 2018). Cloud computing is a model for providing ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or interaction from service providers (Somashekhar et al., 2018; Wang & Lang, 2018).

Grid computing, high-performance computing, parallel computing, distributed computing, powerful integrated computing, and only the use of open, integrated, collaborative information architecture and dynamically configurable resources, high scalability, and on-demand services can provide communication in a smart campus setting (Peters et al., 2018; Ye & Wu, 2018).

Big Data

Big data is the driving force behind the storage, analysis, and processing of large amounts of data (Merck, 2017). A smart campus is a network of intelligent terminals, information systems, and sensing devices that generate a vast amount of data (Akmandor & Jha, 2017). This new technology can gather, store, analyze, and process enormous amounts of data for intelligent applications and devices that assist decision-making processes (Yin &, Jha, 2017).

Smart Knowledge Management

Smart Health's most important technology is knowledge management (Gagnon et al., 2016). It is the most significant and common activity of a skilled individual (healthcare provider) and the health system (Redfern, 2017). This includes knowledge about planning and management, creation, processing, and application (Yang & Fu, 2016; Zhang et al., 2018).

Related Works

Several analogous smart systems have been built in the literature, including (Li et al., 2018; Álvarez López et al., 2018), which established an android Health website for smart health setting to aid engagement (Chen & Lu, 2018). The proposed system-aided caretakers in keeping track of records and conserving natural resources. In comparison to an existing system, the job was completed in less time (Bakkar et al., 2018). Due to the suggested system's real-time use, users receive information without delay (Liu & Liu, 2018). It makes it possible to contact every patient and caregiver in a short amount of time (Geller et al., 2016). The data in the database assists management in forecasting and making choices (Nugent et al., 2016). Understanding the features of smart healthcare delivery environments, combining formal and informal consultation, and taking patients' opinions and healing habits into account are all important factors to consider (Boulos et al., 2018). For more appealing, individualized, and autonomous healing, look into more effective healing methods, tools, and design space (Xiang et al.,, 2016); Mohanty et al., 2016). The Smart Health environment is more than just about using technology; it also allows for the integration of therapy and technology to create an ecosystem in which healthcare providers and patients may interact more effectively (Mohanty, 2015). In a smart health setting, there is a need for therapy breakthroughs to enable smart consulting, as well as emerging technologies that offer limitless healthcare delivery options and communication (Ullah et al., 2016). Smart Health is concerned with providing better healthcare in the digital age. A smart education conceptual framework was proposed, which included three key elements: Smart settings, as a technology aid; smart therapy, as a treatment option, as methodological support; and smart patient, as the goal of smart Health (Bader et al., 2016); Banerjee & Gupta, 2015). The authors investigated the influence of smart health, which plays a key role in the development of an e-health system and the transformation of hospitals into part of the e-society vision. Developing new skills, providing efficient healthcare, allowing patients to have flexible and easy access to healthcare assistance, and enhancing integrated healthcare are all beneficial elements (Zhu et al., 2016).

However, several factors must be considered, such as the necessity to redefine hospital models and the capacity to employ smart design (Zhang et al., 2012). Jara et al., (2010) created study groups via a mobile application, locate the groups using a hybrid Bluetooth Low Energy and Wi-Fi indoor location system, and promote the groups to other patients via a server-based infrastructure to stimulate group cooperation in smart consulting (Díaz et al., 2012) . To accommodate different types of end-users, a prototype of a hospital-wide supersensory network was constructed and deployed around the hospital. The supersensory has a higher computational capability, allowing for more flexible data collecting, processing, and reaction (Zhu et al., 2016). This technology creates a smart hospital setting for smart consulting (Mukhopadhyay, 2015) proposed an ingenious hospital, the idea of establishing a "Smart field" using an Android-based SmartPhone suggests that the institution can use modern ICT (Information Communication Technologies) to mechanically monitor and administer the health facility. Hijazi et al. (2016) Portal architecture, management, service, smart management, infrastructure, and other aspects of the smart hospital are included (Wang et al., 2011). To improve communication in a hospital, the Smart hospital system integrates hardware devices for digital healthcare with cloud storage as a means of data storage (Istepanian et al., 2011). The simulation's findings reveal that the system can be accessed without the internet, has a low power consumption, is user-friendly, mobile controllable, and defect detection can be recognized quickly. Smart Health is still being developed, experimented with, and implemented, as evidenced by the preceding literature. This new computing paradigm provides a more intelligent environment for hospitals to improve intelligence. Several architectures have been proposed, each with a distinct level of design and implementation levels (Solanas, 2014). The five layers of conceptual architecture for smart campuses are discussed in the next section.

Conceptual Design Layers for a Smart Health System

The physical and digital spaces are typically integrated with smart health (Xu et al., 2014; Mayer et al., 2016). To create personalized and collaborative engagement for the business of smart health information systems, the big data interface between smart devices (intelligent device layer & application layer) and communication layers (cloud computing and network layer) is used. The proposed smart health paradigm is depicted in Figure 2. The following are the layers of the proposed model:

Smart Device Layer

Smart health uses the application layer to create a smart health information system by integrating smart devices and existing application systems. Traditional mobile apps, web-based, PCs, smart terminals, self-service devices, and wearable devices are just a few of the terminal access technologies that provide users with a seamless, adaptive environment, personalized human-computer interaction model for specific application scenarios based on different environments, enhanced user access to healthcare, and service experience for Health information technology applications to provide integrated, seamless access and support (Xu et al., 2014; Mayer et al., 2016)

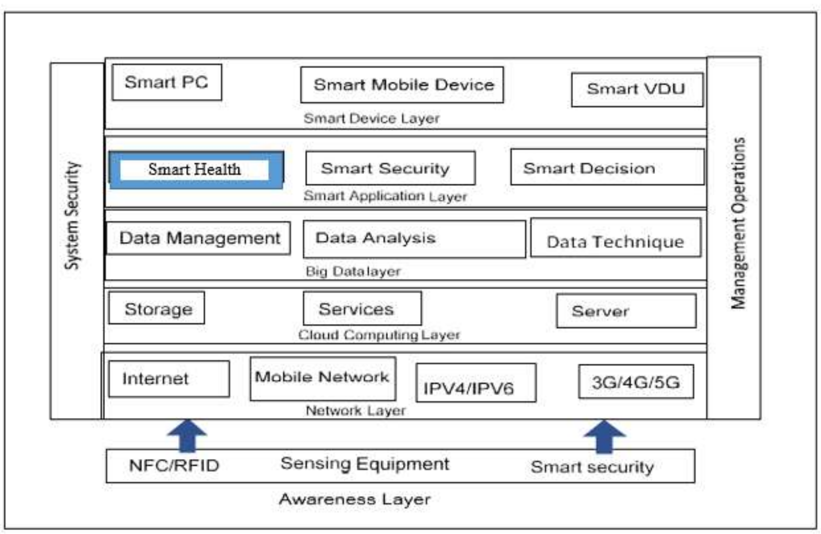

Figure 2: The proposed smart health model

Smart Application Layer

The smart applications allow healthcare providers and patients to support and provide health management with comprehensive and appropriate service functions, management decisions, smart security, and smart health amenities to ensure that smart health operations run smoothly (Sprint et al., 2016).

Cloud Computing Layer

This is a computing paradigm that uses related technologies including virtualization, distributed computing, high-performance computing, centralized storage, distributed storage, and other storage technologies to create an efficient, transparent, and dependable infrastructure. Big data processing and intelligent applications in health care enable universal, on-demand computing and storage (Spanò et al., 2016)

Big Data Layer

The Big Data layer is a major driver of smart health development. The information gathered in the hospital environment, activities, business, interaction, and other information must adhere to information standards and standardization, as well as establish data sharing and exchange mechanisms, database infrastructure themes, unified data platform application construction, and connect in cyberspace and campus Intelligent virtual images Zhu, 2015). In a smart health setting, this technology allows for the capture, storage, analysis, and processing of data for decision-making (Acampora, 2013).

Network Communication Layer

Hospital wired network, WIFI wireless network, 4G mobile network, and other communication technology are all part of this. The intelligent perception layer is tasked with collecting various sorts of environmental and activity data for patients and healthcare providers at any time and from any location, thanks to the Internet's high-coverage transmission services for high-speed access (Kougianos, 2016). In a smart health setting, this layer facilitates communication.

System Security and Operations

For a smart health environment, this sector provides safety operations and security. The support system provides the foundation for delivering high-quality services consistently. The components include an information security system that protects the security and reliability of health information, as well as an operation and maintenance service system that ensures the park infrastructure and application system run smoothly. To provide practical protection, the operation must be safe, stable, and efficient (David, 2013).

Awareness Layer

This system integrates everything via RFID, sensor, QR code, and real-time positioning technology, allowing for intelligent identification, location, and management for smooth smart health operations (Milon et al., 2020).

Conclusion and Further Work

Understanding conceptual design and structural analysis from the standpoint of smart technologies is required for the building of a smart hospital. This is achievable if big data technology aspects for storage and analysis are incorporated into decision-making within the context of an intelligent environment. To provide information services and management for effective hospital - information - systems, the building of a smart campus also necessitates smart equipment, networks, smart applications, and cloud computing technologies. To develop a sustainable healthcare delivery system, various relevant technologies must be integrated to design a smart hospital. Many objects, including humans, are beginning to communicate with smart technology to build a smart and intelligent environment for effective communication and decision-making in a medical setting.

For manageability and security, this conceptual paper proposes a five-layer architecture. A smart campus mobile app will be built in the future based on these layers to better understand the applicability and practicability of smart campus.

Competing Interests

Authors have declared that no competing interests exist.

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