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DETECTION OF VARIOUS HEALTH ISSUESUSING INTERNET OF THINGS SENSOR

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Abstract

IoT has been proven as a big achievable for qualifying and enhancing healthcare services; such as monitoring at every time and anyplace. These services gather more than a few bio-indicators the usage of one of a kind sensors, together with electroencephalogram (EEG), electrocardiogram (ECG), electrical signal of the heart, electromyogram (EMG), electrical sign of muscles, Respiratory Rate (RR), and body motion. The accumulated statistics from these sensors can be processed, stored, or broadcast to a remote gadget (e.g. Cloud server). This paper gives an overview of the important medical sensors inIoT and a review of the modern state-of-the-art of IoT projects, and applied sciences required for healthcare services. The paper specifically, focuses on the using of IoT technologies in the healthcare region nowadays. A conclusion regarding the modern stage of improvement and open problems are obtained.

Keywords—Internet of Things (IoT); Healthcare; Alzheimer diseases; Quality of Life (QoL); Embedded Systems; Sensors; RFID; NFC; Big data.

I. INTRODUCTION

Today, the use of technology to progress the satisfactory of lifestyles is turning into a frequent attribute of modern society. When the science is oriented to enhance the Quality of Life (QoL), it is referred to the Internet of Things (IoT) [1]. IoT is a network of interconnected 'smart' devices, allowing collecting facts and managing physical objects [1]. According to the Cisco lookup groups, the wide variety of net linked units grew to be large than the range of the humans on the Earth, as many suppose, is the genuine changeover to the Internet-of-Things [2]. The tons consumption of these devices and structures that join to the IoT affect the commercial enterprise in a number of industries such as medicinal drug and healthcare [3]. According to the World Health Organization (WHO) study, it is determined that from fifty seven million global deaths, 63 % are dying of ailments such as; continual diseases, pulmonary diseases, coronary heart failure, cancer, Blood pressure, and Glucose. apparently, Standard mannequin of periodic care in the medical institution and hospital- based settings is suboptimal for improving these disorder results [4]. Indeed, in daily life, the prevention and cure of the vital ailments like persistent diseases, Alzheimer diseases, Blood pressure, and coronary heart failure take place outdoor of typical medical settings. From this point, IoT affords a number of blessings to the medical area for example; shrewd IoT wearable devices, in combination with mobile clinical purposes that allow sufferers to capture their fitness data remotely as proven in Fig. 1. Additionally, IoT healthcare offerings are predicted to increase the high-quality of lifestyles and reduce costs [23].

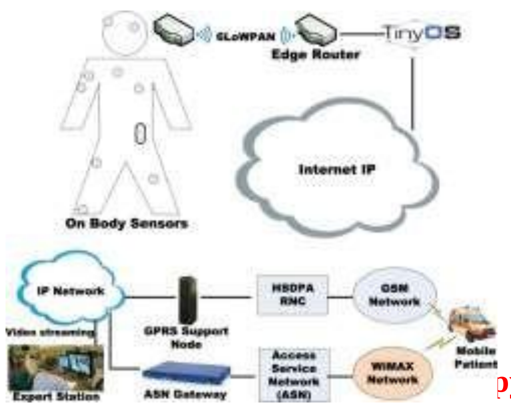

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Fig. 1 wearable sensors and personalized healthcare [4].

Healthcare uses IoT for real-time tracking of patients and medical strategies. Examples of IoT Healthcare use cases comprise the following; (1) Fall detection, which is viewed a principal public fitness concern. Over recent years, the number of businesses that offer systems and offerings meant at detecting falls has elevated drastically. Fall detection systems, usually worn around the waist or neck; encompass intelligent accelerometers that differentiate normal activities from actual true falls. These structures are already improving the pleasant of lifestyles of many disabled or elderly people residing independently. (2) Tracking of clinical devices, it is very fundamental for hospitals, especially in crowded emergency rooms with massive scientific staff. IoT options are being used to discover the genuine vicinity of such devices, discover last user.
The the rest of the paper is prepared as follows. Section II indicates a short overview of the most essential applied sciences related to IoT. Section III gives the modern IoT tasks in the healthcare area. Section IV gives the IoT structure for healthcare systems. In part V, a survey about the most essential issues in IoT for healthcare. Finally, concluding remarks and future work are stated in part VI.

II. IOT TECHNOLOGIES FOR HEALTHCARE

IoT-based healthcare systems involve a number of technologies that allow IoT devices to obtain data from the physical world; such as wireless medical sensors, Radio-Frequency Identification (RFID), Cloud Computing, Near- Field Communication (NFC), Big data, Integrated IPv6 core network, Wi-Fi, ZigBee, Bluetooth, two-dimensional code equipment, and so on [5]. This section will focus on several core technologies that have the potential revolution to IoT- based healthcare services.

A. Radio-Frequency Identification (RFID)

The cellular technology, RFID enables and assists in improving the purposes of IoT healthcare. It reduces the caregiver's hundreds in domestic monitoring, and helps them to reveal the sufferers suffering from continual diseases [18]. The RFID device in healthcare consists of two principal components; radio sign transponder (tag) attached to an object (patient or scientific devices) and the reader. The tag consists of two components: a chip to store the unique identity of the object and an antenna to enable the chip to talk with the reader the usage of the wireless medium. The reader generates a radio frequency area to become aware of objects via mirrored radio waves of the tag. RFID works by using sending the tag's number to the reader the use of radio waves as is shown in Fig. 5 [47]. Finally, the reader passes that variety to a specific utility called the Object-Naming Services (ONS). An ONS looks up the tag's important points from a database such as when and where it was once manufactured [47].

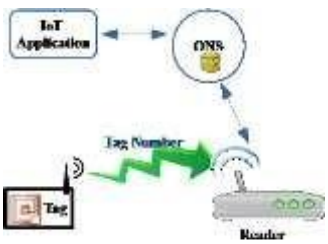

Fig.5 RFID System [47]

B. Medical Sensors

Rapidly evolving new applications for healthcare discipline are based totally on understanding the prerequisites of objects (e.g., temperature, stress, strain, pressure, trace, shock). Even though RFID

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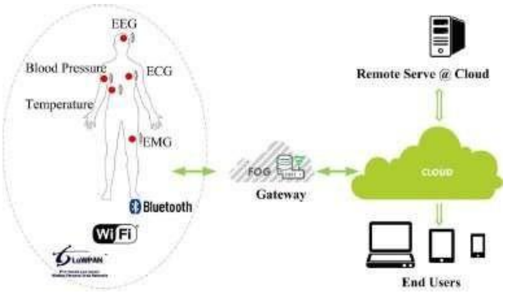
is an necessary technology in the recognition of a clean hyperlink among medical, bodily objects and their digital representations, it cannot grant the situation records that healthcare applications require.

A sensor is a very large time period used to describe an object that can collect records [51]. Sensor applied sciences are a massive part of IoT in healthcare. It has attracted a noticeably recent popularity due to their capacity to assemble contextual and medical data like temperature, location, humidity, SpO2, ECG, EMG, and EEG and then transmitting the data to a gateway by means of a precise communication protocol like Wi-Fi, Bluetooth, ZigBee or 6LoWPAN as revealed in Fig. 6[50].

Fig. 6 IoT healthcare sensors [50].



In this regard, current lookup efforts pursue the transmission of sensor data via radio hyperlinks aiming to facilitate sensor deployment. There are quite a few sorts of medical sensors as shown in Table 1 [50]. Both RFID and sensor applied sciences are key enablers of the IoT due to the fact they furnish the ability to identify objects and to acquire their condition.

TABLE I. TYPICAL WEARABLE AND MEDICAL SENSORS [48][51][52].

List of Medical Sensors and Their Usage	
Name of Sensor	*Uses*
Heart Rate	To detect the heart rate (and consequently heart rate variability).
ECG (Electrocardiography)	To measure the electrical activity of the heart, this conveys essential information about the status of heart and the function of its muscular contractions.
EMG (Electromyography)	To measure the electrical signal causes by muscular activity for gesture recognition, detection of neuromuscular diseases, etc..
EEG (Electroencephalography)	To capture the electrical voltages which represent the brain activity.
Blood Pressure (BP)	To measure systolic and diastolic pressure
Respiration Rate	To measure the rate of breathing.
SpO2	The arterial oxygen saturation or the amount of oxygen dissolved in blood.
Skin Conductivity	To measure the conductivity of the skin to detect psychological or physiological arousal or the moisture level of the skin.
GSR (Galvanic Skin Response)	Perspiration
Co_2 Gas	Measuring the carbon dioxide level from mixed gas.
Glucometer	Sensors record glucose levels continuously around the clock.
Motion sensors	To trace taking medicine, sleeping, or steps.
Stress sensor	Measuring the pressure changes of the underside of the foot.
Accelerometer	Measuring the human energy expenditure.

C. Big data

Medical sensors accumulate large quantities of necessary fitness data. Big data furnish equipment for examining these statistics and growing the efficiency of relevant fitness analysis and monitoring methods. A list of Big data tools which are used with the aid of famous corporations is introduced in Table I [19].

TABLE II. THE MOST USED BIG DATA TOOLS [19]

No.	List of Tools	
	Big data area	*Tools*
1	Data Cleaning	OpenRefine, DataCleaner
2	Data Analysis	Qubole, BigML, Statwing

D. Cloud Computing

Cloud computing is the notion of net based totally technology, which provides a variety of faraway offerings over the internet such as infrastructure, records storage, software, and hardware. The combination of cloud computing into IoT- primarily based healthcare applied sciences should provide facilities via get entry to shared resources, delivering services over the internet and allowing customers to perform normal tasks as revealed in Fig. 2 [6].

Fig. 2 IoT with Cloud Computing for healthcareservices [15].

III. IOT PROJECTS FOR HEALTHCARE

The IoT provides a super market chance for gear manufacturers, developers, and Internet service carriers in a number of fields. By the end of 2020, the IoT smart matters are predicted to attain 212 billion entities deployed globally [47]. IoT projects and associated IoT-based offerings on the topic of healthcare has been constantly growing and symbolize the largest proportion as proven in Fig. three [47]. It aimed to set up IoT in the healthcare area. This part will supply an overview of the modern day IoT

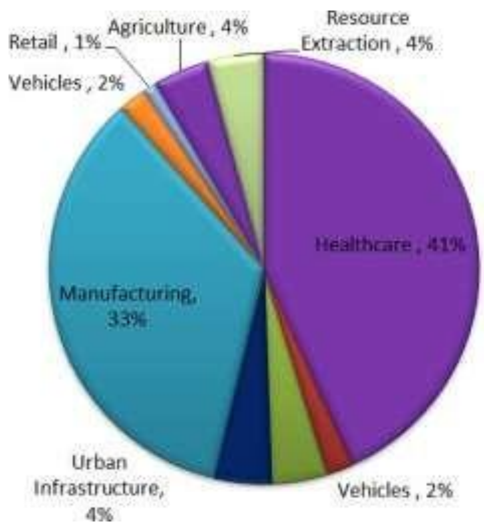


Fig. 3 Projected market share of dominant IoTapplications by 2025 [47].

A. E-Care@Home

The reason of the E-Care@Home project is to make an infrastructure for IoT with the inspiration to provide automated information congregation and processing on apex of which e-

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services in favor of the citizenry in their homes. The E- Care@Home scheme aims to provide an comprehensive IoT- based healthcare system, with high-level analysis of data from different types of sensors, and state-of-the-art communicationprocedures [9].

B. The 'Smart Mirror'

The 'Smart Mirror' scheme introduces non-contact based totally technological upgrades at the households wherever its exercising can be as international as 'looking at a mirror' while presenting fundamental actionable insights thereby main to beautify care and results. The key objectives is to aware of physiological markers such as Blood Pressure (BP), Heart Rate (HR), Inter- beat-interval (IBI) and Respiration Rate (RR), also drowsiness the usage of the video enter of the character standing in front of the mirror and exhibit the effects in real-time. An splendid stage of accuracy has been done with appreciate to the sensor signal [10].

C. Technology-Enhanced Emergency Management (TEEM) TEEM used to be designed for supporting records recording andtransmission for the duration of affected individual transportation by means of ambulance. Paramedic personnel use TEEM to record the most important affected person data (which gathered by means of monitoring gadgets or directly measured), and to immediately ship them to the fitness hub, where the consultants can test the records themselves, therefore having a greater inclusive understanding of the patient' s state of affairs thru transportation [12] [13].

D. Embedded Sensor Systems for Health (ESS-H)

The telehealth market was valued at $2.2 billion in 2015 and anticipated to reach $6.5 billion via 2020, with an annual growth rate of 24.2% [35]. The domestic healthcareenterprise is also trying out tele-homecare and tele-monitoring services that characterize a treasured possibility to balance quality of carewith cost control. According to [36], more than 10,000 healthcare applications are handy in the Apple/Google store. These statistics additionally disclose that approximately 85% of docs use smartphones and scientific applications, and 80% of them would like their patients to screen their health status at home.

The Embedded Sensor Systems for Health (ESS-H) is an important gadget oriented project in the lookup area. It makes use of the desires of the caregivers and sufferers to perceive their problems, and locate the solutions while they are at their home. In addition, ESS-H includes five tasks [14]:

- Biomedical Signal Processing
- Biomedical Sensor Systems
- Reliable Data communication
- Intelligent Decision Support.
- Software testing

E. Telemetry scheme for analysis of Asthma and Chronical Obstructive Pulmonary Disease (COPD)

This device is designed for human beings who live in far flung areas or rural, which alas frequently outcomes in death. Moreover, it increases consciousness amongst human beings and reduce demise rates. Telemetry device performs a very vital function in the healthcare area. This gadget consists of Expert System and cellular application; which interacts with the affected person thru the person interface in 5 steps: (1) take a look at is conducted, (2) measured parameters are stored in the cell phone,
(3) signs of sickness for sufferers are indicated in mobile application, (4) dimension effects and symptom symptoms are transferred to the server, (5) Input vector for Expert System is shaped After that a classification is performed, and the check effects are despatched to user's cellular phone. The architecture of COPD machine is presented in Fig. three [17].

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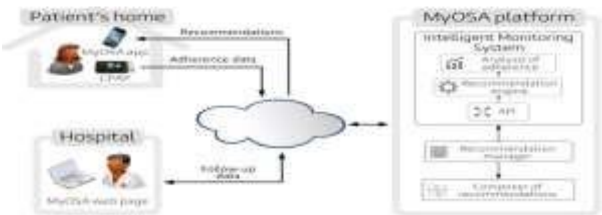
Fig. 3 The architecture of Telemetry System [17].

F. CAMI project

CAMI is a fully integrated answer for healthcare, which supports the predominant functionalities of IoT-based healthcare systems, like health-data monitoring, supervised physical exercising, fall detection, and smart domestic facilities. CAMI task includes partners from five countries; Poland, Sweden, Romania, Denmark, and Switzerland [20].

G. IoT- supported myOSA system

Obstructive Sleep Apnea (OSA) is one such sleep sickness in which breathing is briefly and persistently interrupted at some stage in sleep. OSA takes place when the muscle tissues in the



lower back of the throat fail to keep the airway open, despite efforts to breathe. When this happens, the affected individual can also additionally snore loudly or make choking noises as he/she tries to breathe. Subsequently, the brain and physique grow to be oxygen deprived and the patient may also moreover wake up. This can also moreover show up a few cases a night, or in more severe cases, countless hundred times a night. OSA can motive fragmented sleep and low blood oxygen ranges [21]. For people with OSA, the aggregate of disturbed sleep and oxygen starvation may additionally also lead to chest pain, irregular heartbeats, hypertension, coronary coronary heart disease, stroke, diabetes, despair and temper and reminiscence problems. Therefore, MyOSA is an IoT-based device that collects recordsof victims with OSA and sends it to the cloud to be analyzed for supplying a terrific remarks to lung experts (see Fig. 4) [22].

Fig. 4 The architecture of IoT-based myOSA System [22].

H. An Augmented Reality (AR) scheme

The low imaginative and prescient and blindness had arisen from a vast variety of disorder conditions and anatomical anomalies that have been recognized via the clinical community [25]. One of these illnesses is night-blindness, in which a character cannot see when mild sources are little, but can see with large quantities of light. The AR gadget provides an IoT technological machine that improves studying skills for people with low vision or night-blind [26] [27]..

I. UpTech Project

Alzheimer Disease (AD) can be regarded a slowly innovative brain ailment that, starts offevolved before medical signs and symptoms emerge [28]. The early signs of AD are; subject in remembering current conversations, names or events, apathy and depression. Later signs consist of impaired communication, disorientation, confusion, bad judgment, behavior changes and, ultimately, concern speaking, swallowing and taking walks [29].

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According to the World Alzheimer document 2015, it is estimated that over 46 million people live with dementia worldwide, two and this variety is two expected to make bigger up to 131.5 million by way of 2050 [30]. The impact of AD disease on the functionality of making day-to-day lifestyles things to do is nicely known, and it has been established that AD may additionally strongly affect now not only the existence of the affected person, however additionally the surrounding household [31]. In fact, in the majority of the cases, the caregiver of a individual with two AD is a family member, two who generally loses the possibility to run a regular life, due to the fact of two the burden of assistance. As a consequence, a number of research tasks has been carried out such as; UpTech [32]. UpTech was oriented to the household caregivers, who are frequently subjected plenty stress due to the effort and the worry about the patients' safety. The primarymission goals have been to limit the burden of the assistance for the caregivers, keep AD sufferers at their homes, and enhance the quality of existence of all the customers [33]. A crew of nurses and social fitness operators carried out periodical visits to the patients' houses to supply assistance. In addition, a technological kit was once supplied and mounted in the residences of a group of participants, with the goal to always display the security of the patients [34].

J. Run-Time Assurance (RTA) in the E-care@home system

Making IoT networks greater dependable is a quintessential element in healthcare applications [4]. One way towardsattaining this aim is to expand the visibility into the operation of the network to system operators, researchers, and developers [41]. Run-time assurance project offers a service in the E- care@home system. This carrier consistently tries to discover and file performance troubles and gadget errors. In addition, the core functionality of the RTA assignment can be summarized as follows: (1) screen a range of internal and exterior working conditions periodically, (2) analyze the accrued data to discover modern-day performance degradations, or modifications in the environment that would possibly affect future performance, and
(3) report vital information to a machine operator [42]. The confronts of building an infrastructure for RTA are:
(1) Recognizing which protocols and factors must be monitored, with small overlapping of data that explain the same condition,
(2) the supervising must be conducted with low transparency and with minimum interlude of regular Ecare@home application- layer data packets, (3) the RTA must encompass parallel monitoring efforts on the server-side.

The infrastructure of the RTA scheme consists of four different mechanisms that address these challenges: (a) RTA for sensor platforms, (b) database storage of RTA information,
(c) RTA at the server-side, and (d) a graphical user interface for RTA. These mechanisms provide a service for every parts of an e-health system, with static sensor nodes for environmental scrutinizing, mobile sensor nodes for health parameter scrutinizing, and the data compilation server for the aforementioned sensor nodes [43].

III. THE ARCHITECTURE OF IOT FORHEALTHCARE

IoT connect billions or trillions of heterogeneous units thru the Internet, so that there is a quintessential need for a secured and bendy architecture. In IoT healthcare services, the architecture is one of the most integral elements. It helps to get entry to the backbone, and receipt the clinical records by using quite a few functions [23]. It consists of five layers as proven in Fig. 5

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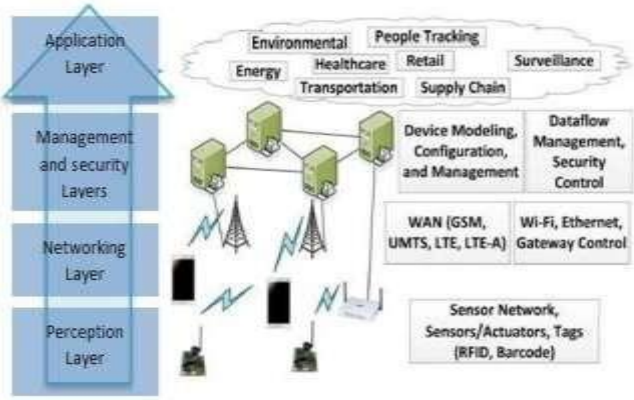

[22].

Fig. 5 The Architecture of Internet of Things for Healthcare [22].

A. Perception Layer

In this layer, units and clinical sensors are connected collectively for patients. It is accountable for changing patient's information into indicators that can be transmitted in networks and study by clinical applications. This layer needs Standardized plug- and- play mechanisms to configure heterogeneous devices. Moreover, it wants impenetrable channels to digitize and transfer information between other layers.

B. Networking Layer

This layer is responsible for transferring the gathered patient's information from medical sensors and devices to the cloud or any facts processing system via a variety of applied sciences such as RFID, LTE, LTE-A, GSM, UMTS, WiFi, Bluetooth,infrared,ZigBee, etc.

C. Management layer

This layer permits the IoT healthcare functions to work with heterogeneous devices barring consideration to a specific hardware platform. In addition, this layer approaches the facts which received from the Application layer, manages the ordinary IoT healthcare system, makes decisions, and can provide the required offerings over the network wire protocols [45].

D. Security Layer

There are great amounts of sensitive patient's statistics crossing the IoT healthcare community every minute. Monitoring and controlling these records and the underlying layers is accomplished at this layer of IoT network. This layer is extraordinarily vital for IoT, it accountable for data handling, facts administration, service subscriptions, information transfer, information access control, and identity protection. It also compares the output of each layer with the anticipated output to enhance offerings and keep users' privacy [46]. Moreover, this layer must achieve the IoT high-level protection requirements which are: (1) Data Confidentiality: It ensures that the exchanged messages can be understood solely with the aid of the meant entities. (2) Data Integrity: It ensures that the exchanged messages were now not altered/tampered with by means of a 1/3 party. (3) Authentication: It ensures that the entities worried in any operation are who they declare to be. A masquerade assault or an impersonation assault usually pursuits this requirement the place an entity claims to be any other entity.

E. Application Layer

Healthcare carriers and patients can have interaction with devices and query for interesting statistics and one-of-a-kind offerings through this layer through using healthcare application. It additionally offers an interface to the management Layer where high-level evaluation and reports can be produced. This layer performs complicated and tremendous computational desires so it is hosted on effective devices [45]. In different words, this

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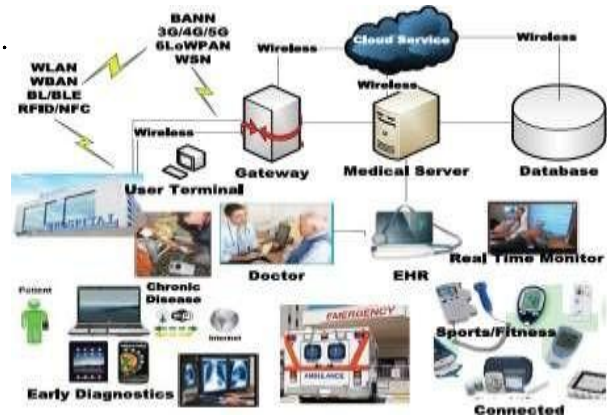
layer presents a common set of services that permits a healthcare software to interface with potentially any system barring appreciation a priori the specifics and internals of that device.

V. THE CURRENT TRENDS IN IOT FOR HEALTHCARE Numerous services for healthcare can be carried out with the aid of the use of quite a number IoT requirements and protocols. Each carrier affords a set of healthcare solutions. In spite of these services' advantages, there are some challenges for IoT structures in the healthcare area. One of the essential challenges is the value of deployment due to the high priced system when constructing bodily surroundings with specific sensors and units[37].
Furthermore, patients' information should be secured all through transferring, accessing, and storing as proven in Fig. 6[4]. On the different hand, privateness and security problems are the foremost obstacle in the way of the IoT development. Therefore, protection at all tiers of IoT structure is viewed an vital problem to the functioning of IoT based healthcare systems. Numerous research accomplishments in the IT security concerns applied in the IoT based healthcare structures [38].
Utilizing Cloud Computing for the IoT in healthcare is not an simple task due to the following challenges [47] [52]:

- ***Standardization***; Normalizing the Cloud Computing presents a sizable task for IoT cloud-based healthcare contributions due having to interoperate with a variety of vendors.
- ***Synchronization***; Synchronization among different cloud vendors nearby a challenge to offer real-time healthcare services because services are built on pinnacle of various cloud platforms
- ***Management***; Managing Cloud Computing and IoT healthcare systems is also a challenging problem due to the truth that both have one-of-a-kind assets and components.
- ***Balancing***; Making a stability between common cloud provider environments and IoT necessities for healthcare gives every other assignment due to the fact of the variations in infrastructure.

Fig.



security trends of Internet of Things for Healthcare [4].

In addition, the Quality of Service (QoS) ensures are required for healthcare services in terms of giant parameters such as availability, reliability, maintainability, and the carrier level [39]. Healthcare machine availability and robustness are central to imparting QoS ensures because any type of system disaster can put lives in threat in clinical conditions [52].
The IoT will join quite a few sensors to supply healthcare services. Each sensor desires to have a special identity over the internet. Thus, an environment friendly naming and identity administration machine is required that can dynamically assign and manage special identification for such a giant range of sensors. Moreover, the standardization of IoT healthcare is very essential to supply higher interoperability for all sensors [50].

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VI. CONCLUSION AND FUTURE WORK

Due to the speedy advances in science and industrial infrastructure, IoT is predicted to be widely utilized to the industries. IoT integrates a number units geared up with sensing, identification, processing, communication, and networking capabilities. Industries have a sturdy interest in deploying IoT devices in the healthcare location to boost healthcare functions and offerings such as automated monitoring. The main contribution of this review paper is to inspect how IoT could be beneficial and make a contribution to enhance the high-quality of life. It focuses on the ultra-modern IoT applied sciences for healthcare such as; Big data, Cloud Computing, RFID, WSN, Bluetooth, Wi-Fi, and the necessary medical sensors. Moreover, the present day initiatives in the healthcare area are discussed. Finally, it highlights the necessary challenges in IoT-based structures for healthcare. The performance of the exiting IoT healthcare structures need to be extended by means of introducing enhancement methods and methodologies.

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