Smart Healthcare Use Cases and Applications

A. R. Charulatha and R. Sujatha

Abstract The growth of IoT is tremendous and is making its presence into nearly every space from industries to health care. The healthcare industry is now getting embraced by technological innovations. IoT is making the promise of smart and connected care a reality. Leading technologies such as Big Data, IoT, advanced analytics, and many other technological modernizations have turned the old-style health care into smart health care. Smart health care can be defined as using mobile and electronic technology for efficient diagnosis of the disease, better-quality treatment of the patients, and improved quality of lives. The healthcare industry is rapidly adopting Internet of things technologies in everything from wearable's to patient monitoring, in order to improve precision, endorse efficiency, cut costs, and boost health and augment safety. The newest research conducted by industry experts shows how the market for smart healthcare solutions is growing at a tremendous pace. IoT is an enabler to drive better asset utilization; new revenues achieve improved care for patients and reduced costs. In addition, it has the potential to revolutionize how health care is delivered. The new features offered by distributed analytics and edge intelligence, if successfully applied for time-sensitive healthcare applications, have great potential to accelerate the discovery of early notification of emergency situations to support smart decision-making. Smart health care, which monitors users' living settings and health status using wearable sensing devices and collecting their data over a network under daily life, is expected as a new trend. It is getting more attention along with the increase of demands of preventive care. This chapter gives an overview on the range of applications for the Internet of Things, share examples that illustrate how IoT products and services are being deployed around the globe, by heathcare industry in some areas like image management, visualization, remote health and monitoring, healthcare asset tracking, health monitoring using wearable devices, enhanced drug management, and patient flow analysis. IoT customer case

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studies help to demonstrate the breadth of possibilities for IoT applications in health care.

Keywords Health care · Big data analytics · Distributed analytics · Edge intelligence · Hospital management

1 Introduction

1.1 Health Care

The health of human is primary for the growth of the nation in both technical level and economical level. Normally, health is classified into physical, emotional, mental, social, environmental, and spiritual. Ensuring ill-free pleasant state is called as health and in the process of maintaining and improving the same falls under health care. Health care is the largest sector in any nation and need for the well-being in ultimate need of all the people surviving in the world. A large amount of revenue flow is prevailing along with ample employment opportunities in all various phases. Health care encompasses clinics, devices, and gadgets to address the various issues, insurance sector, drugs, and so on. Digitalization and systemization of traditional healthcare unit made it support all the stakeholders in a big way. The proposed software framework in this chapter is a great step toward health surveillance [1]. The work carried out this challenging particularly for elderly people health by tracking and observing with the help of the multi-agent system and used efficient highly user-friendly interface along with reinforcement technique to strengthen the system [2–4]. Data sharing in health care is a significant and cumbersome process with various stakeholders from patient, hospital, private clinics, insurance, and pharmacies. Work insists on sharing data among cross-organization for providing best and timely service to all involved based on the time frame. Still, policies prevail for exchange of data but perfect designing of the system is required to smooth the process [5]. Data sharing comes with the issue of security. Various technologies used are authentication, encryption, data masking, and access control to tackle cross-organization in the process of sharing data. These have given a preview about laws governed in different places across the globe. Privacy-preserving is challenging due to the hefty data generated in each process [6]. The exponential growth of data made the decision-making process tough and at times impossible. Researchers normally use statistics and economy-related stuff to narrow down. But all this cumulated pave way for data mining and its highly interdisciplinary field that fetched ideas of various disciplines. Various tasks like anomaly detection, classification, clustering, association rule mining, regression, and summarization accumulated the data. Usage of data mining is inevitable and in the healthcare industry, it's widely used along with machine learning concept for faster decision-making [7]. Global healthcare outlook given by Deloitte in shaping the future indicates the need for care outside the walls of the hospital and also mentions it as an increasing trend. This could be aided with the

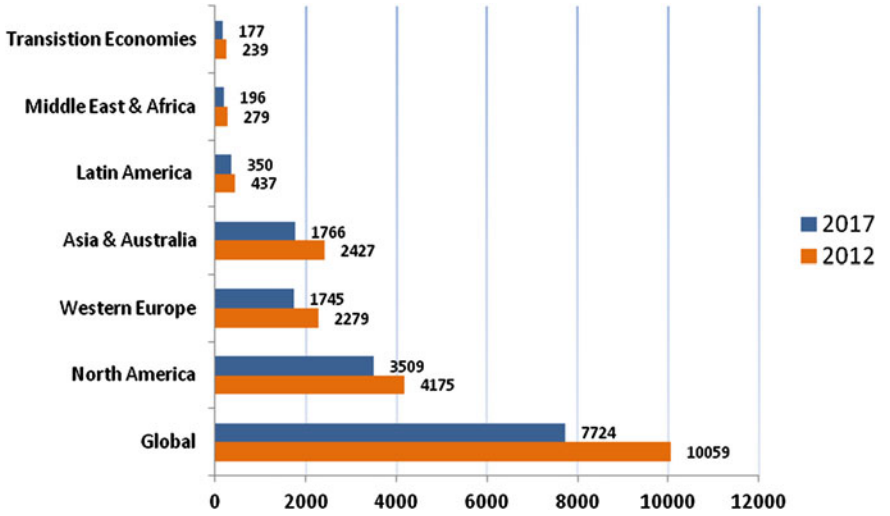

Fig. 1 Healthcare spending in USD Billion

help of virtual health. Digital reality—combination of augmented, mixed, and virtual reality component, IoMT—interconnected all devices with the patient for monitoring and tracking and so on to address the challenges in a medical environment for ensuring treatment at earliest. So many challenges are faced based on demographic and economic policies across the world. In spite of so many hurdles, the spending on a reliable system to serve patient is on a steep increase. Figure 1 illustrates the healthcare spending provided by economic intelligence unit [8].

1.2 IoT

Internet of things (IoT) is one of the main favorable technologies within the modern-day age. The worldview evaluation is taken into consideration by way of utilizing savvy and self-configuring items which could interact with each different by means of the worldwide setup framework. Ultimately, these unified in-built among large quantities of various gadgets talk to IoT as a taxing innovation that empowers plentiful and inescapable computing programs. Hence, the exact range of commercial enterprise IoT applications is developed and deployed in several domain names like transportation, agriculture, energy, health care, food technique business, military, environmental observance, or security police work. Eventually, IoT unites the devices and different gadgets to the Internet; it performs a core function to hold the development of smart facilities. The dynamic matters accumulate diverse varieties of statistics from this present reality circumstance [9]. Sometime later, the extraction of essential information from IoT data can be applied to improve and boost our

everyday lifestyles with setting aware applications that may, for example, display substance identified with the prevailing circumstance of the client. The combination of huge facts and IoT advances has made opportunities for the development of administrations for a few complex structures like clever cities. A few big record advances have developed to support the dealing with the extensive volumes of IoT records, which are collected from various sources within the savvy environment. But the progression of IoT and its programs in many exclusive spaces are causing a noteworthy increment of the massive amount and numerous kinds of statistics. Within the period in-between, massive facts and its advancements have opened new application openings for industries and the scholarly world to grow new IoT preparations. Consequently, the combination of large records and IoT, just because the particularly dynamic evolution of the two areas, make new research challenges, which anyway have up to now not been perceived and tended to by way of the explore community [10].

The essential motivation behind making use of IoT in social insurance is collectively and dissects nonstop restorative information with a purpose to limit the constraints of conventional healing remedy, except cloud ranges are utilized to keep and analyze the gathered medicinal facts circulate. Consequently, the assembled data approximately the patient's well-being repute permits the human offering institutions to create typical social coverage programs and advance the contemporary administrations and preparations, for instance, programs for far off observing, nourishment, therapeutic merchandise, scientific gadgets, restorative workplace, or clinical coverage. Consequently, the utility of IoT in human offering area allows discovering the satisfactory health situation and getting a better plan for patients [11].

1.3 Big Data Analytics

The growth of big data is well mentioned by Domo.

According to Domo, world's Internet usage has increased steeply. On comparison of the year 2016 with 2017, the global Internet population has grown 7.5%. Data never sleeps 6.0 that provides the insights of the generated data for every minute. It's predicted that by 2020, each resident on earth will create 1.7 MB of data each second [12].

- The weather channel receives 18,055,555 forecast requests.
- Giphy serves 1,388,889 GIFS.
- Netflix users stream 97,222 h of video.
- Snapchat users share 2,083,333 photos.
- LinkedIn gains 120+ new professionals.
- YouTube users watch 4,333,560 videos.
- Twitter users send 473,400 tweets.
- Texts sent 12,98,611.
- Skype users make 176,220 calls.

- Instagram users post 49,380 photos.
- Americans use 3,138.420 GB of Internet data.
- Spotify streams over 750,000 songs.
- Uber riders take 1,389 trips.
- Venmo processes $68,493 peer-to-peer transactions.
- Google conducts 3,877,140 searches.
- Bitcoin 1.25 new are created.
- Reddit receives 1,944 comments.
- Tumblr users publish 79,740 posts.
- Amazon delivers 1,111 packages.

The above stats show us that huge data is generated via various sectors [13].

Big data is retrieving of hefty data from various sources like web, mobile devices, and other sorts of electronic gadgets. Integrating the data and managing and analyzing the data are a challenging task. The characteristics of data are volume, veracity, velocity, and variety. Best practices are based on goals align big data, use the center of excellence to optimize the transfer of knowledge, and cloud operating makes it still more useful [14].

The ultimate need for big data analytics is that it provides the patient-centric facility, tracking the disease spread at earlier by analyzing data, hospital quality validating and optimize treatment strategy, and so on. Each and every researcher works with a different strategy and brings a versatile framework to ensure optimal usage of data among various stakeholders. Electronic health record acts as the base to serve all sorts of service for taking the decision and achieved by integrating the required algorithm in a tactical manner [15]. IoT is the important counterpart of big data. Sensors produce data at each time stamp and interconnection of various devices makes the framework potential resource for researchers. This chapter shows clearly the combination of IoT with big data in the manufacturing industry and similar happens in the healthcare industry [16].

Big data analytics relying on IoT finds great application in health care like health monitoring system in a real-time and remote fashion, ubiquitous recognizing using inference system, life care, and emergency system, treating the disease at earliest [17]. Research is carried out for analyzing big data with the healthcare wearable devices. Model is designed based on consumer and providers' perspective. Efficiency and privacy risk are taken into consideration in consumer and benefit and cost based on the provider's point of view, respectively. Scope of work is possible by taking into account all perspectives [18].

Gartner provided great insight into big data in various industries, and it illustrates medical and insurance having great hands in Fig. 2 [19].

1.4 Smart Health Care

Smart Health Care

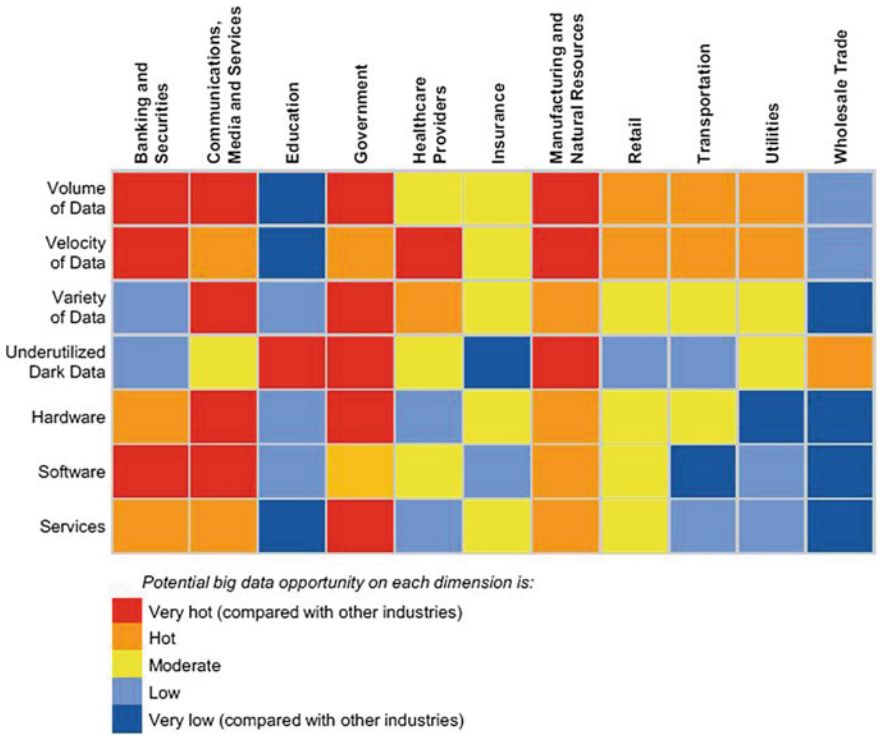

Fig. 2 Gartner—big data applications in industries

A smart cities concept joins hands with electronic health to provide smart health. Fascinating words like e-health, m-health, and s-health are made this era of ICT prudent. Machine learning concept is rocking s-health with its fast algorithms like deep learning, deep forest to make highly accurate decision-making in various places like glaucoma diagnosis, Alzheimer disease analysis, bacterial sepsis diagnose, and cataract treatment. Smart health is a framework comprising data acquisition, the flow of data, and processing of the same with trending algorithms [20]. Google trend illustrated in Fig. 3 shows that e-health, m-health, and s-health are active research terms in recent years. The interest of researchers and the popularity of the terms are

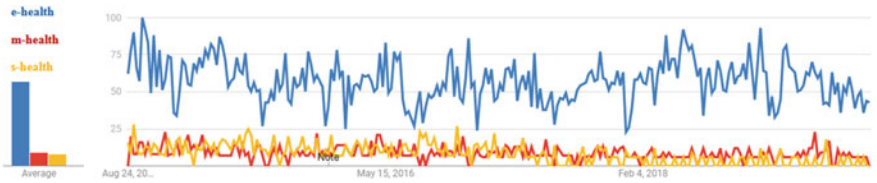

Fig. 3 e-health, m-health, and s-health based on Google trend

competing in nature. Technologies are making door to serve people at a faster phase in health industry [21].

Medical ontology is a great milestone in organizing the related terms under a single umbrella. Preparing ontology is a lengthy process after the number of discussions. Various steps are entity extraction and taxonomy formation, and interactions among concepts are mentioned as relationships and axioms creation. Consistency checking is made finally to ensure no redundancies. Ontology-based system is a great boon to the remote area and in absentee of medical experts to give preliminary guidance based on medical history and semantic of constructed ontology [22–24]. A smart home is an interesting phenomenon, and they have developed a home ontology that helps in providing semantics for the words exchanged via devices interconnected in the home. Knowledge sharing is performed by combining smart home with cloud computing to make the processing faster and accurate. Health monitoring system is optimized by incorporating cloud environment and patients get an immediate response [25].

1.5 Distributed Analytics and Edge Intelligence

In the current era, the data to be handled is large and faster processing is a quiet challenging task. To overcome this, edge along with distributed analytics is utilized. In the distributed analytics process, data is spread across multiple nodes and algorithms run and finally aggregated to get insights. In massive data scenario, a fast solution is possible by working on nodes. Smart farming and smart homework with the help of these technologies [26]. Decentralized way of handling data is the unique feature of edge computing process. The nearby spot is utilized for analyzing the data. Introduction of intelligence in the computing process is the great shift from the traditional way of handling data. Benefits of edge computing are decision-making is faster, communication cost is reduced, and based on requirement load balance is maintained. Characteristics like mobility, autonomy, security, local and WAN network bandwidth, prioritization, peer communication, and self-organization need all sectors resolved by using a tactical manner of intelligence with machine learning algorithms [27]. Slotted way of collecting the data is taken into consideration to make the environment hassle-free and efficient data analysis.

The work was carried out with edge of thing to make it cost-effective in nature [28]. By combining the idea of edge computing work carried out in all sectors and in this work, care is taken to consider the emergency situation of the patient and serving them at the fast phase to ensure safety. Integrated cognitive concept is based on data and resource along with cloud and edge platform based on the situation healthcare function [29].

2 Smart Healthcare Use Cases and Applications

The world population grows at a faster pace and so is the addition of new diseases in people. People of all ages are affected, and the hospitalization costs of health care for these diseases are more. The health monitoring of the common people without hospitalization is made possible with help of technologies like IoT, EoT, and CoT. More advancements and findings in sensing technologies create possibilities to develop wearable devices to monitor health and human behavior. These transformations through these technologies are a boon to elderly people in particular. The innovation of sensing technologies facilitates to develop smarter systems to monitor human behaviors regularly. In recent years, the mobile and wearable technologies which are developed to collect data from human based on their activities and vital signs have increased. Wrist wearables, accelerometer, pedometer as well as sensors which are used to calculate heart rate and those devices that provide important data are commonly available in market. Also, people use devices which monitor their sleep and stress levels to help people on the regulation of their activities [30].

The IoT concept in healthcare domain involves tracking, authentication, automatic data collection, and sensing. The medical condition data about a person is confidential, and data should not be exposed to unauthorized party. If there is no proper security mechanism, then data can be mishandled by malicious user leading to the doctor prescribing wrong medicines or giving bad treatments to their patient. For example, changes to a blood test result may exacerbate the patient's condition because of accepting a mismatched blood during blood transferring process [31].

2.1 Healthcare Monitoring

A typical healthcare architecture of wearable devices is shown in Fig. 4. Many researches are undertaken in identifying various sensors and algorithms to extract data from these wearables in an efficient way.

Md. Zia Uddin, in his work, proposes a sensor-based wearable system for foreseeing the activity by means of recurrent neural network on device like PC or laptop. Multiple wearable healthcare sensors supply the input data of the system with help of sensors like electrocardiography, magnetometer, etc. An recurrent neural network is trained based on the features, which is then used for predicting the activities [32].

Sun, Zang et al. proposed a study on emerging technology identity recognition with respect to gait pattern of an individual. Elderly patients tend to share their wearable devices with other family members or friends of their age. To access these wearable devices, it would be difficult for them to remember passwords. Also, the data present in these wearable devices should be secured. To protect the data as well as making it easily accessible by elderly, a gait-based identity recognition method used for the access control of aged people wearable healthcare devices is introduced. This lessens the problem that occurs because of gait fluctuation within a person and

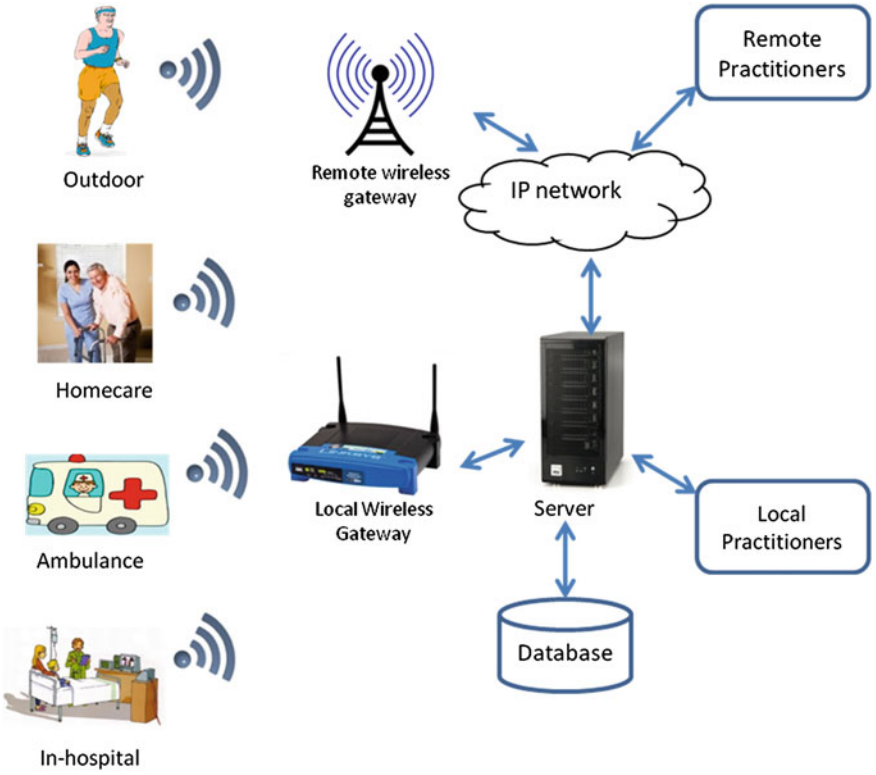

Fig. 4 Typical architecture of wearable devices in health care

provides a considerable access control recognition rate improvement more than 95% when compared to existing methods [33].

Romare et al. suggested that intensive care unit patient's conditions can change at a rapid rate, necessitating a quick and correct response from staff in charge of the unit to save life. For making proper decision on treatment to be offered to these patients, vital signs are important. Smart glasses are a relatively new platform for applications that works by touch or voice and can display text, images, take pictures, and transfer these data using Wi-Fi or Bluetooth to communicate, which thereby possibly improves observation and safety of patients in intensive care [34].

Zouka and Hosni aim at combining artificial technology in a healthcare monitoring system. This actually facilitates the system to work as an independent smart healthcare model which decides the treatment priority by itself depending on the collected health parameters from the sensors. The researcher proposes a model containing a trust environment which is in charge for collecting the physiological data from the patient's body. The collected data is communicated through mobile communication to IoT hub where the raw data using logic-based algorithm gets converted into linguistic form. The fuzzy-based algorithm is skilled in inference system to get

the patient status. The proposed system, then, provides reliable, accurate, secure, and real-time patient monitoring [35].

2.2 Other Healthcare Sectors

Drug management

To prevent any dysfunction or illness, patients have to take medicine on time. Elderly people often miss their medicine dosages at the correct time and also forget which medicine they have to take at that time. Minaam, D. S. A. and Abd-ELfattah build a pillbox for medicine monitoring and reminder system. The time the medicine has to be taken needs to be set. The pillbox will then remind the patients using an alarm and light. The details regarding the pill to be taken are displayed by a mobile application held by the client. The traditional pillbox needs to be stacked by the client or caretaker on a weekly or daily basis which is a cumbersome task. This model comes as an aid to elders to intake their medication on time [36].

Employee health management

Kati and Otto proposed an approach that will handle various problems taking into concern the characteristics and the limitations of the industry workers. Several devices for monitoring the workplace, discovering a varied range of biodata, which are analyzed based on objective details, are collected. The worker's biodata are sent to e-health server, which will be gone through by family doctor. The details are reviewed and suggestions are given based on the details collected over a period of time. This helps the industry to have a concern on their employees and also increase the employee's performance by taking care of his health issues at the correct moment [37].

Patient Identity management

Benjamin et al. proposed an algorithm to collect consistent patient's health data in a uniform and well-timed manner which is the prime factor in making healthcare decisions. Cloud infrastructure is proposed to maintain a consolidated view of data appropriate to patient for hospital management and doctors, an essential requirement for facilitating performance management of care processes. Cloud computing technologies help healthcare providers to communicate information, improve association, and reduce cost on computing infrastructure [38].

Remote health monitoring

Majeed et al. developed "CogSense" an IoT device system that uses conventional sensors to enable instantaneous concern for patients, and professional response with the caretakers and doctors in a combined framework. This researcher captures a person's emotions and approximate physiological changes using voice recorder and camera to identify the emotions of the person and to predict the physiological changes such as heartbeat and blood pressure [39].

2.3 Wearable Devices

Wearable devices have been life-changing for those with chronic disease like diabetes, pain, and heart ailments. Companies produce various wearable devices like fitness trackers, smartwatches, etc., as illustrated in Fig. 5.

In a survey conducted in 2017, 45% of the smartwatches are used for activity tracking (Fig. 6) which is one way of monitoring health.

Fig. 5 Innovation of health monitoring wearable devices

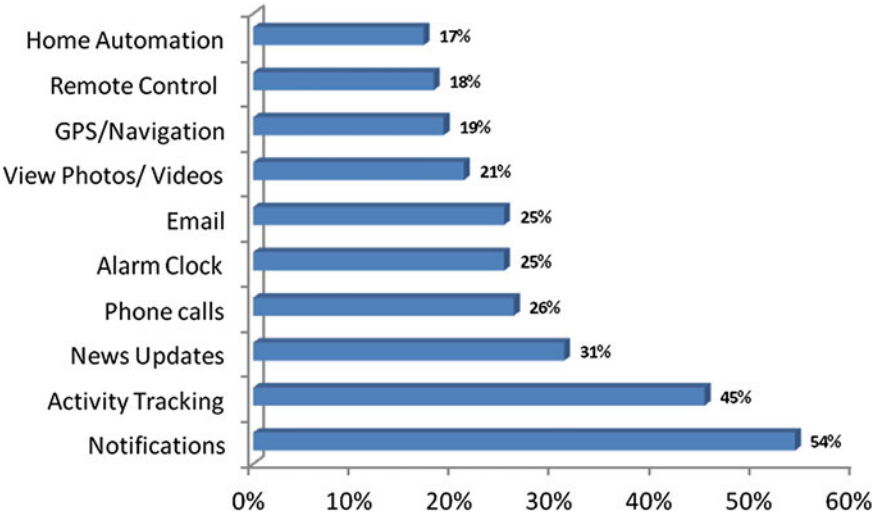

Fig. 6 Usage of smartwatches

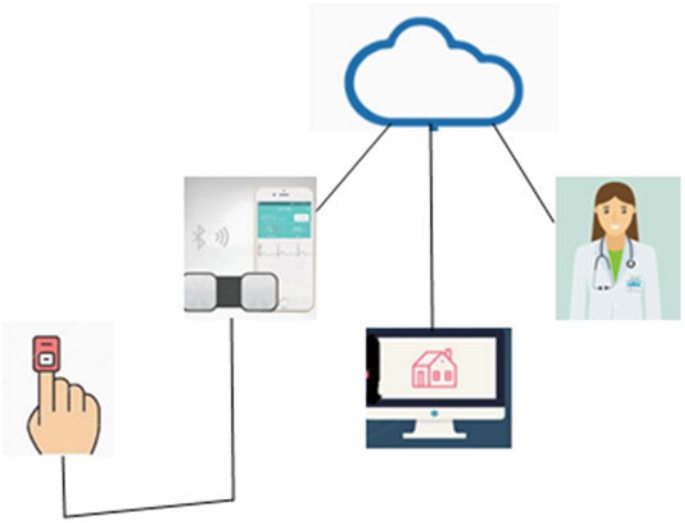

Fig. 7 Remote health monitoring through wearable

There are smart glucose monitors (Dexcom G5) which placed on the body and linked wirelessly with mobile devices to monitor blood sugar continuously. An electrical nerve stimulation wearable to relieve pain (Quell) can be used to track activities and sleep patterns to adjust pain-management intensity, as well as provide proper sleep and practical relief throughout the night for patients with severe pain. For elderly persons to monitor whether they have fallen and intimate to their relations or caretakers a vital-sign monitor wearable UnaliWear's Kanega with an accelerometer and GPS tracking is a voice-controlled watch which helps elderly to be independent.

The benefits of wearable devices are not restricted to only monitoring and notification but also for remote treatment and preventive care. A typical process flow is specified in Fig. 7.

In terms of remote treatment, wearable like OmniPod is used as insulin pump that automatically administers exact dosage required by coordinating with glucose monitor. LifeVest is used by patients who are at the risk of having heart attacks; it gives electrical shock to restore normal heart rhythms.

Many wearables with fitness tracking capabilities help people to maintain proper lifestyle and help them to keep track of their health and defend against chronic diseases. Also, these wearable devices come in an attractive shape, form, and ease functionality that people of all ages can wear it modestly and these devices are very much user-friendly.

Triboelectric nanogenerators (TENGs) which are sensors for extracting energy from the mechanical vibrations of humans have been the area of interest for many research groups working in nanotechnology worldwide. This extraction of energy from vibrations is done through medical devices and small systems which are

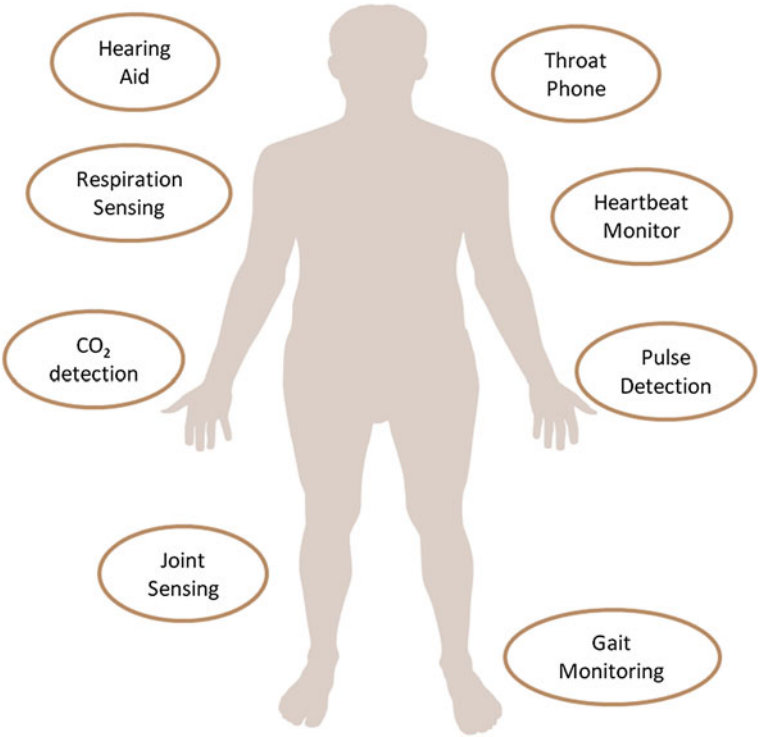

Fig. 8 Typical application of TNEGs in health monitoring

implanted in human body. Few of the TENG sensors which can be implanted in human body are shown in Fig. 8.

The review covers in-depth textile and non-textile TENGs as self-powered health monitors. Textile-based TENGs have advantages like fine air permeability, flexibility, and huge production, which make them very appropriate for wearable applications. Textile-based sensors are self-powered and used to monitor sleep and respiration, whereas non-textile sensors are generally placed on the skin or on outfits. Most non-textile sensors which are self-powered have the capability of multiple sensing abilities, while few have single sensing ability. Examining and supervising motion like joint, biceps, and abdominal respiration plays a major role in postoperative rehabilitation, particularly in the area of sports and fitness management. Heartbeat and pulse when compared to biceps have small amplitudes; thus, it requires the sensors to have high-pressure sensitivity and less detection limits to obtain the heartbeats and pulses information. These TENG sensors have also been useful to monitor voice and work as hearing aids which will be an important application in vocal rehabilitation. TENGs are also used to detect chemicals related to health care [40].

Though wearables are existing in market for longer period, the development of mobile technologies and the awareness on fitness and sport activities has led to gain

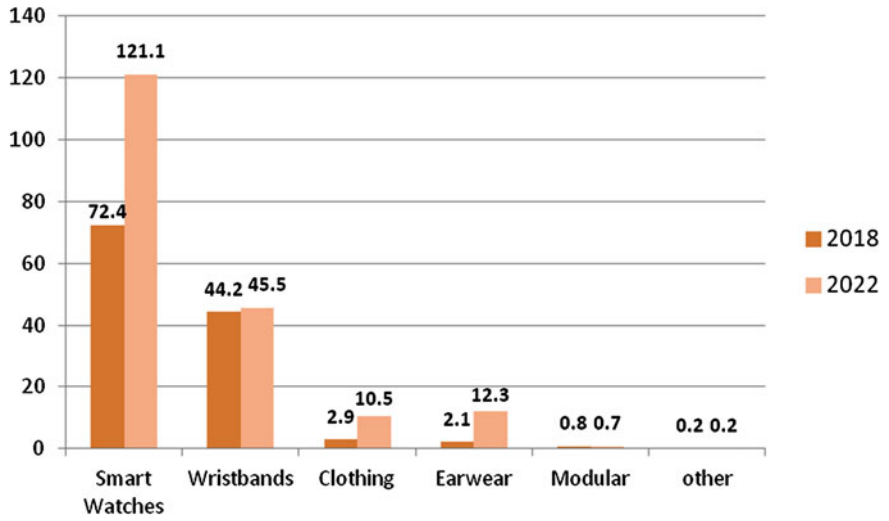

Fig. 9 Wrist wearable market share

a huge market share of wearable devices. Out of a wide range of wearable devices, smartwatches and wrist/fit bands appear to have major market share. Estimations indicate that by 2022 wrist wearables will attain 121 million sold units as shown in Fig. 9 [41]. In addition to their compact size and comfy use, wrist wearables also include sensors for providing constant data with regard to vital signs like heart rate, temperature, and environmental variables related to movements that can be used for a variety of purpose. Similarly, other wearable sensors, such as tattoos, outfits worn, or diapers, have a good market share.

3 Smart Home

It's latest in the IoT market to provide the comfortable life to elderly people. The population of elderly people is on an increasing level. Due to the lifestyle change, independence is required in all ways. It's time to ensure that elderly people are out of risk in all ways. To face this task, a number of sensors and devices are on the market. The main challenge in this group is a health issue. Constant monitoring and helping them with required assistance is on great demand. In these initial stages, home automation is the process involved remote control of lights, entertainment system, and other appliances. But recent days, it's incorporated with elderly care and research on progress with robotics for this purpose [42]. Great leap to this robotics-based work on the previous is the privacy deduction scheme and purely to handle attackers. Lot of work was carried out on using supervised and unsupervised algorithms for monitoring the activities happening inside the home. In this privacy-based system,

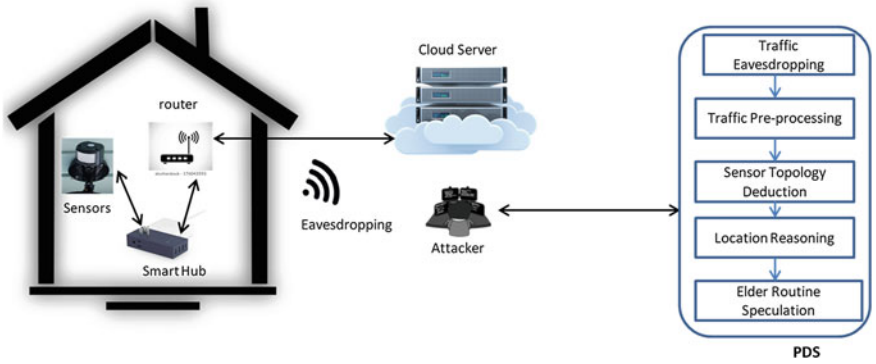

Fig. 10 PDS workflow

concern is with aiding privacy for elderly people and multiple sensors used for this purpose in his case study. He has made clear flow of task like shown in Fig. 10 [43, 44].

4 Benefits and Challenges of IoT in Health Care

Benefits

Joyia et al. explained that IoT has lots of benefits in the field of healthcare monitoring especially for aged people and those with chronic diseases. These devices are used in monitoring and as preventive care. Some of the benefits are listed below:

- Convenient lifestyle.
- Health care is economical.
- Survival rate of patient is improved.
- Disease management is instantaneous.
- Life's quality is improved.
- End user (patients) experience is enhanced.
- Patient care is better.
- Reduction in cost.

Major variation in patient's health will make an automatic alert to their caretakers, lifesavers, and different parties, thereby saving lives and time.

Challenges

The author lists some important challenges that need to be taken care in the healthcare domain of IoT. A huge growth and change in IoT and Internet communication field has also undergone a major change, contributing particularly in the healthcare sector. This has led way to reduce the gap between doctors, healthcare services provided by

them, and patients enabling ease to use, accuracy, and flexibility. Some of the major challenges are listed below:

- Managing device diversity scale, unstructured, growing, and diverse data at exponential rate;
- Flexibility and evolution of applications;
- Maintaining privacy of data;
- Expertise in medical field is required;
- Hardware-related issues like network performance or memory capacity has to be monitored, while data is shared and stored;
- Security challenges;
- Understanding the working of the wearable devices; and
- Power consumption needs to be less.

These are the challenges that need to be addressed in the field of medical care [45].

4.1 Privacy and Security

Data privacy is essential in the IoT-based health cloud. Healthcare cloud applications are planned and developed based on the different ways of acquiring data from IoT devices. Confidential information of patients are collected from smart devices, summarized through smartphones and uploaded to the healthcare cloud, or transmitted back to smartphones from the cloud. This patient information could also be passed on to third parties. Such information could indicate patients' preferences, behaviors, and habits. Therefore, all agencies who are working in collecting, storing, and communicating patient's information should protect the privacy and secrecy of patient information and avoid compliance and legal suits. Only encrypted details of patients should be shared in cloud.

Authorizing credentials to applications and patient's confidential information is the prime challenge. Cryptographic protocols in health cloud should be implemented and deployed correctly. There is a chance of security breach when the healthcare professionals bring personal devices to have access to medical applications and services.

Vulnerabilities caused in devices and deploying firmware patches is a challenge that causes a dilemma in cloud which maintains the patient data. Many smart applications are vulnerable to code injection attacks, thereby giving provision to attacker to take complete control of the program and memory.

Data packets which are lost during transmission flow through the networks which have to be identified and diagnosed in well-organized manner. Health networks need to be secured, and data loss has to be minimized [46].

5 Conclusion

With the growing population, increase in medical expenditure and new diseases more focus is given to the healthcare sector. With efficient monitoring, most sudden abnormalities in health or chronic diseases can be detected at right time and can be prevented too. These health monitoring tools/wearable devices help patients especially elders to have a check on their health and also help doctors to attend patients remotely, thereby attending immediately on emergency situations. These devices ease the diagnosis work with reference to the data collected from the patient [47].

The IoT also can be implemented in clinical care where critical care patients or patients hospitalized and whose physiological status needs to be monitored continuously can be done using IoT-driven smart devices. This noninvasive monitoring involves sensors to collect complete physiological data of the patients and makes use of gateways and cloud to store, analyze, and transmit the information to caretakers for further necessary analysis and assessment of the patient's health [48]. With proper adherence to privacy policies and an efficient security measures in data handling, the IoT in healthcare sector is definitely a boon to patients and doctors.

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