



A SURVEY RESEARCH ON E-HEALTH CARE: AN APPLICATION OF IOT

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Abstract: Internet of things with their growing knowledge domain applications has reworked our living. It's the advanced network infrastructure of connectivity, transportation, and technology. IoT smart devices will implement the facilities of remote health monitoring, and additionally emergency notification system. IoT has considerable application of smart health care system. Health care has become a significant socioeconomic concern once; it involves health expenses, demand, and accessibility of resources, and personal care particularly for senior section of society. In the health care system, the highlighted policies and methods that facilitate to the researchers, and scientists, and consultants who develop smart device that is the up-gradation to the prevailing technology. This survey paper states, however IoT interrelated to numerous system including the smart health care that is one among the prevailing system. Health care system has the surveillance that planned the requirement of smart devices and smart objects to decrease the inefficiency of accessible health care system. The IoT based health care has increased technology which is exclusive from the standard health care and whole medical system.

Index Terms - IoT, Smart Health care, IoT health care network, IoT health care application, industries, security, policies, open challenges and issues.

I. INTRODUCTION

Nowadays, around 2 billion individuals around the world use the Internet for browsing the Web, sending and receiving emails, accessing transmission content and services, taking part in games, using social networking applications and different tasks. Whereas a lot of people can gain access to such a global data and communication infrastructure, another big leap forward is coming, related to the use of the Internet as a world platform for letting machines and good objects communicate, dialogue, compute and coordinate. It's sure that, within the next decade, the Internet can exist as a seamless material of classic networks and networked objects. Content and services are going to be all around us, always accessible, paving the way to new applications, enabling new ways of working; new ways of interacting; new ways of entertainment; new ways of living [1]. Medical care and health care represent one and every of the foremost attractive application areas for the IoT. The IoT has the potential to give rise to several medical applications like remote health monitoring, fitness programs, chronic diseases, and elderly care. Compliance with treatment and medication at home, and by health care providers is another necessary potential application. Therefore, numerous medical devices, sensors, and diagnostic and imaging devices can be viewed as smart devices or good objects constituting a core part of the IoT [2] [3].

This paper includes the smart e-health care using internet of things. IoT allows numerous dynamic applications connecting machine-to-machine, sensor-to-device, patient-to-devices and patient-to-doctor and device-to-doctor communications. The health care IoT have several applications including remote monitoring, early prevention, chronic disease management, elderly care, medical treatment for institutionalized patients, etc. It permits us to establish intelligent connections assuring an effective health care system. However, with the advantages certain loopholes are associated relating to their security and privacy that are the key problems of concern for IoT applications. The health care application of remote monitoring [4] [5] [6] shown in figure 1, allows the doctors to stay connected to the patients remotely thus can provide care to them whenever the requirement arrive. The sensing devices are also wearable, implanted or the sensor present in the nearby environment is connected to the internet from where the doctors or caregivers can provide effective and timely medication to the patients.



fig. 1 shows remote health monitoring application.

For the old age population within society, health care could be major socioeconomic concern, so providing elderly care or personal health assistance to them could solve the problem to some extent. This paper survey the smart health care applications along with the major security issues and the prevailing open issues and challenges that are need to be overcome.

II. IOT HEALTH CARE NETWORKS

The IoT health care network or the IoT network for health care is one of the vital elements of the IoT in health care. It supports access to the IoT backbone, facilitates the transmission, and reception of medical information, and allows the utilization of health care-tailored communications. As shown in Fig. 2, this section discusses the IoT health care network topology, architecture, and platform. However, it should be mentioned that the planned architectures in [7] and [8] can be considered as a decent starting point for developing insights into the IoT network.

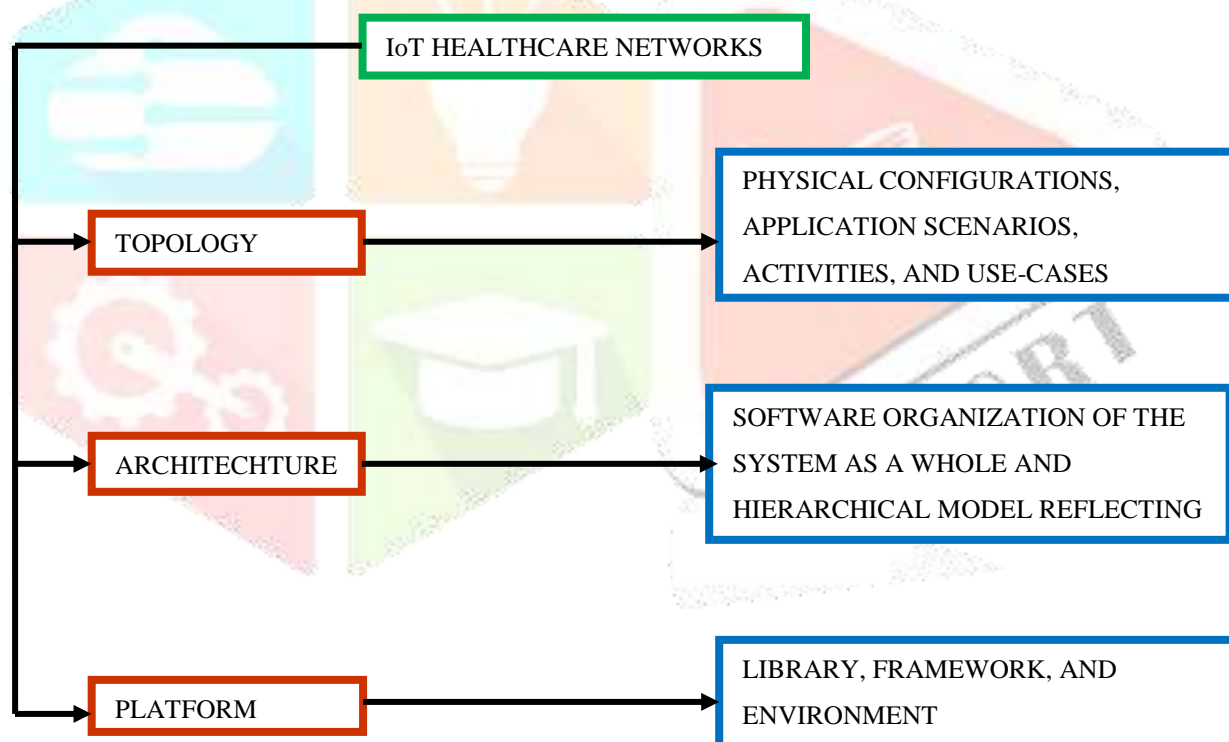


fig. 2 IoT health care network issues.

III. IOT HEALTH CARE APPLICATIONS

The section addresses various health care applications of remote monitoring of patients, elderly care, remote medication, telemedicine and providing a consultancy, through smart or sensible applications.

A. Remote patient monitoring: This application is deployed for remotely monitoring the patient's essential parameters through the utilization of sensors, devices, and objects surrounding them. In this, the real time critical information of the patient is transmitted and shared between the patient and the caregivers. Its main relevance is for chronic disease management like diabetes, cardiac disease monitoring, asthma, etc.

B. Mobile personal assistance: This application makes use of mobile technologies to change remote access to current clinical systems or care giving institutions. The smart mobile apps, portals, websites, etc easily available to all have made the automation of e-health systems straight forward.

C. Smart devices: Smart devices in health care are used to store and manage key care parameters and to manage the captured disease information. They're mainly deployed for providing fitness solutions by tracking target activities and diagnostic devices used for storing

data from devices. Mainly they are used as fitness solutions for tracking patient activities and smart diagnostic devices like blood pressure devices, pedometers, Google Glass, etc used for capturing the data from the sensors for further any analysis by doctor.

D. Telemedicine: This application provides virtual help through remote connectivity and efficient solutions enabling virtual care consultation, medicine delivery, education, etc. The diagnosis of providing a remote medicinal assistance such as teleconsultations, mobile video solutions has become a very common in few countries and markets.

E. Elderly care: This application clinically monitors the ageing population for creating them independent. These devices include wearable and implanted sensors for monitoring the elderly patients without requiring the individual intervention. The monitoring devices track the vital signs of elderly care, and transmit them to a standard mobile device which serves as a node for transmitting the real time information to the doctors. The information thus collected can be used to provide medical assistance to the elders, and in a case of emergencies, nearby hospital is alerted.

F. Smartphone apps-an effective solution: Smartphone apps will be used as an interface to provide care giving to the needful. Various open source apps for providing health care solutions are developed to provide efficient health care facilities. Few of them are diagnosis apps (Diagnose, 5MCC, Prognosis, 5-minute infectious disease consult), drug reference apps (Medical doctor: reference tool, Epocrates, FDA drugs, Lab values), calculator apps (MedCalc, caddy medical calculator, uBurn lite), clinical communication apps (Voalte one, mVisum, Vocera) etc. [6].

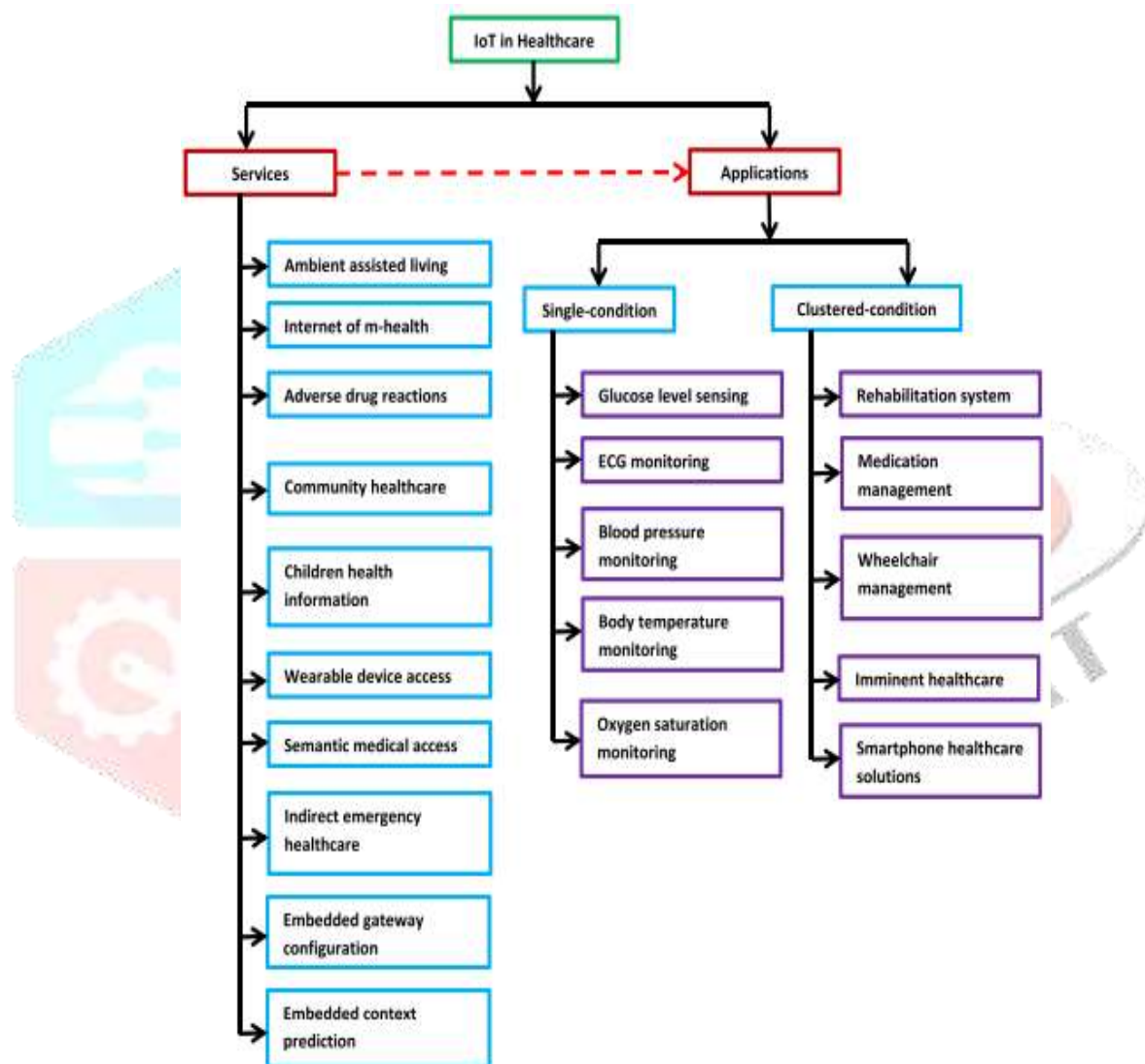


fig. 3 IoT health care applications.

IV. HEALTH CARE INDUSTRY TRENDS

The emerging IoT in the health care field has experienced a burst of activity and creativity, exciting entrepreneurs and venture capital firms. The space appears as an active group of new start-ups and large firms that are willing to be part of what may be a giant market as well as enabling products and technologies. This section provides an extensive list of these products and technologies for a better understanding of the IoT status. Edisse has a prototype wearable detector for real-time tracking, fall detection, and alerts. It basically combines the GPS, mobile data, short messaging services (SMSs), and an accelerometer to detect unusual movements such as a fall and then reports them to a third party such as adult children or other caregivers [9]. Withings has developed a number of health care devices [10], including a set of internet scales, a BP device/app, and a baby monitor. A Chinese firm has developed miPlatform, an integrated all-in-one medical imaging and information management platform supporting cloud-based image storage and computation, web-based 3D image post-processing and visualization, and integrated telemedicine competence [11]. Neusoft has provided broad IT solutions for China's medical industry and personal health care network services [12], and it also offers their services for hospitals, public health facilities, and health management. Neusoft has focused on IoT-based health care services. LiftMaster has developed products that make home access easier and put its owner in control of how he or she comes and goes [13]. It ensures full control and connectivity by staying connected to smart phones anywhere,

anytime. The potential of LiftMaster in the IoT field will be simply seen for home applications for elderly individuals. Garmin’s Vivo smart is a fitness band/smart watch that can issue smart notifications to let the user decide on taking action or continuing on her or her active way [14]. Jawbone’s UP3 is many state-of-the-art sensors offering the user a full picture of his or her health status and includes activity tracking, sleep tracking, smart coaching, and heart health sensing [15]. As shown in Fig. 15, Angel is designed to measure the user’s pulse, temperature, activity, and blood oxygen level [16]. This wrist band sends to the user’s Smartphone this important information. A group of researchers in Korea has introduced a sufficiently compact and subtle wearable BP sensor that can be used to deliver nonstop monitoring for a long period without disturbing the daily activity of the user [17]. An i-Health Lab team has developed a set of IoT health care devices including a wireless BP wrist monitor, a BP dock, a wireless body analysis scale, i-Health Lite, i-Health Edge, a wireless pulse oximeter, i-Health Align, and a wireless smart glucose-monitoring system [18]. Basis has developed a health tracker that can help the user improve his or her fitness, sleep, and stress [19]. The device comes with heart rate tracking and body intelligence quotient (IQ) intelligence. Phytode has introduced a health wristband that measures the user’s heart rate variability, infers the agility of the autonomic nervous system, and displays the user’s mental state [20]. Rejuven’s Rejiva monitors the user’s total health by measuring his or her ECG, heart rate variability, respiratory rate; sleep position, restfulness, breathing index, and energy level [21]. The device can also investigate the state of the autonomic nervous system.

V. SECURITY ISSUES

So far as the analysis work has been done, the safety and privacy of the patient are of major concern. The security requirements shown in figure 4 need to be fulfilled in order to ensure the security in IoT health care. Also, due to lack in fulfilling these security requirements, certain challenges or issues shown in figure 5 impose big problems.

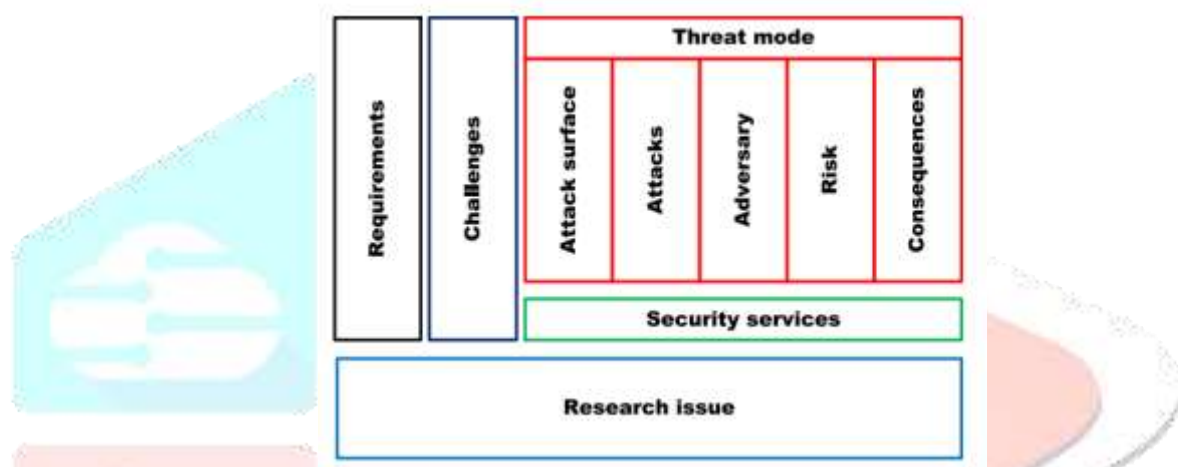


fig. 4 security issues.



fig. 5 security challenges.

Smart IoT devices are computationally constrained due to low-speed processors. Such systems are designed for restricted environments conducting cost-effective operations and the need for hour is to increase their effectiveness, a security solution minimizing resource consumption and optimizing protection. Same is the case with the memory computation additionally as these devices do have a restricted on-device memory and hence only lightweight protocols or programs can be executed. The smart devices used in IoT health care such as blood pressure sensor, temperature sensor etc have limited battery power, and thus, save power by activating sleep mode when no reading needs to be reported. Thus, an effective design solution should be implemented to handle with the energy, power and computational limitation of those devices. Other security issues related to mobility and scalability needs to be addressed [2].

VI. IOT HEALTH CARE POLICIES

Evidence-based policies and technologies can be seen to become a driver of all cases of practical implementations. Similarly, policies and regulations play vital roles in transforming the health care sector in the next several decades. Although IoT-based health care services have yet to be addressed by existing policies, e-Health policies and strategies have been a key goal for many policy initiatives across the world. It can be argued that an organization that aims to develop both IoT and e-Health policies is likely to tailor its policies to IoT-based health care services. This section briefly discusses those countries and organizations working frame both IoT and e-Health policies and strategies.

A. INDIA

India introduced an e-Health policy between 2000, and 2002 to promote the use of information and communication technology (ICT) in the health sector and provide comprehensive guidelines and recommendations for the country's information technology (IT) infrastructure in the health care field (2003) and creation of a telemedicine task force (2005) [22]. Under the Digital India Program, the Indian government plans to transform India into a digitally empowered society and a knowledge-based economy and thus has implemented various initiatives. The Indian government has allocated Rs. 70.6 billion in the current budget to develop 100 smart cities in the country [23] and plans to create a \$15 billion IoT industry in India by 2020 to increase the number of connected devices from around 200 million to over 2.7 billion [24]. These efforts are expected to boost the use of IoT in India's health care sector.

B. AUSTRALIA

In early 2008, the Australian health ministers' advisory council developed a strategic framework to guide national coordination and collaboration in e-Health based on a series of national consultation initiatives including commonwealth, state, and territory governments, general practitioners, medical specialists, nursing and allied health, pathology, radiology, and pharmacy sectors, health information specialists, health service managers, researchers, scholars, and consumers [25]. In addition, the Australian government has worked to develop a strategic plan for the IoT.

C. JAPAN

Japan's Ministry of Internal Affairs and Communications (MIC) has developed the u-Japan Policy early in 2004 to accelerate the realization of network access ubiquity [26]. For cost savings and improved clinical outcomes through health IT, the Japanese government has been working on some recommendations for e-Health-friendly policies [27].

D. FRANCE

In 2008, the French government supported the creation of an object-naming service (ONS) root server for the country to enable the advancement of the IoT [28]. Registered with GS1 France, every product is supposed to be uniquely identified using global standards. The discovery of information on these products is enabled through domestic ONS nodes and portals. In this way, consumers become convinced that product data are correct, authentic, and uniform across the country. Telemedicine services in France are widespread at the regional level and stimulate e-Health policy development. Electronic health records were formally introduced by legislation in 2004 [29]. The government has worked on advancing the IT infrastructure of hospitals, the use of e-Health, and solutions for challenges in semantic interoperability. The "Hopitaux 2012" plan and the Law on Hospitals, Patients, Health, and Territory (la loi HPST) are worth mentioning in this regard [29].

E. SWEDEN

In July 2010, GS1 Sweden, a worldwide organization that works with distribution standards, and SE announced that they would jointly develop an ONS root server for the advancement of the IoT to enable networking for all physical objects through the Internet [28]. The Swedish "National Strategy for e-Health" policy provides a detailed set of action areas and statements [30].

F. GERMANY

In 2003, Germany enshrined its core e-health activities in the legislation governing the health care sector [30]. Germany has an ambitious plan to play a leadership role in the engineering and manufacturing sector, including in the IoT domain [31]. According to High-Tech Strategy 2020 action plan, INDUSTRIE 4.0 is a strategic initiative in achieving this goal.

G. KOREA

South Korea is planning to expand its domestic market for the IoT from KRW 2.3 trillion in 2013 to KRW 30 trillion (\$28.9 billion) by 2020 [31]. In May 2014, the government confirmed a thought for developing IoT services and products by establishing an open IoT system consisting of service, platform, network, device, and IT security sectors. Korea introduced policies to promote inclusiveness and equitable access to e-health in 2008 [32]. Here the introduction of electronic medical records, e-Prescription, and telemedicine is considered a key initiative driving the use of ICT in the health care sector [32].

H. CHINA

In July 2010, China's Ministry of Industry and Information Technology (MIIT) announced that it would promote the formulation of a unified national strategic plan for the IoT. The Chinese government decided that the MIIT would establish a clear position, development goals, timetables and a road map for introduce the IoT and facilitate R&D, commercialization, the creation of foundational technologies, and network connections and use. These measures are expected to stimulate the development of the IoT [28]. China's "e-health E-development Strategy 2003-2010" has attracted increasing investment interest.

I. THE U.S.

In February 2014, the Federal Trade Commission (FTC) commissioners discussed policy and regulatory implications of the IoT. The FTC has targeted on 2 major areas of the IoT, namely the provision of notice and choice for non-consumer facing network devices and also the question of how devices that are part of the IoT is ensured to have reasonable data security.

J. THE E.U.

The European Commission's request that RAND Europe has worked to devise a European policy for the IoT. A research team has evaluated policy challenges to be addressed by policymakers from mid- and long-term perspectives and made some recommendations after assessing policy options for stimulating the development of the IoT in Europe [33]. In June 2010, the European Parliament proposed a resolution to help create the IoT. The E.U. parliament counselled the thorough assessment of any effects of this technology on health, privacy, and information protection. Under this resolution, a consumer enjoys the right to opt for a product that is not equipped or connected [28]. The European Council endorsed the e-health Action Plan in 2004 [30], which is the first formal commitment expressed by all member states to cooperate in the area of e-health. In April 2014, the European Commission launched a public consultation initiative for input from interested stakeholders on barriers and issues related to the use of m-Health in the E.U. [34].

K. THE W.H.O.

In both developing and developed countries, mobile phones are used for a large range of public health initiatives. In 2011, an initiative was taken to promote the use of m-Health for tobacco control in developing countries (WHO, 2011) [35]. However, most m-Health projects in developing countries have used text messages (SMS) mainly for increased awareness and communication campaigns and focused mainly on HIV, malaria, and MCH. It has been recommended that all target countries integrate the use of ICT in their national health information systems and infrastructure by 2015 [36].

VII. OPEN CHALLENGES AND ISSUES

This section highlights the trending open challenges and problems related to health care IoT:

1. With the fast advancement of IoT, billions of smart devices and good objects get connected to the internet. These smart devices collect huge amount of data that need to be processed, analyzed and even stored for future use. Hence, scalability of IoT network and devices tend to be a significant concern.
2. Technological convergence help in establishing a standardized framework for the IoT devices. Due to lack of standardization, ability of the things becomes a serious problem to consider and by working on it, we can achieve the vision of very-well connected interoperable smart devices. [37]
3. An active participation of the government bodies towards building rules for safety and security of objects, devices, and people associated should be considered.
4. In remote monitoring of the patients, sensors being implanted or wearable may sometimes refrain from attention may cause a threat to the security of patients that can become critical. [38].
5. Since IoT is an open network, security conditions such as confidentiality, fairness and availability of patient data should therefore be maintained such that security and privacy risks can be addressed.
6. As the IoT technology is improving at a quick pace, the challenges pertaining to design problems need to meet in the future. These challenges include overcoming energy limitation, memory and computational limitations in IoT smart devices [39].
7. Since effective health care is everyone's right. Hence, IoT-based health care services could also be perceived as a low-cost technology.

VIII. CONCLUSION

Innovative uses of IoT technology in health care not only bring benefits to doctors and managers to access wide ranges of information but also challenges in accessing heterogeneous IoT data. Researchers across the world have started to explore numerous technological solutions to enhance health care provision in a manner that complements existing services by mobilizing the potential of the IoT. In short, this paper reviews the advance trends in smart health care as IoT application that has transformed the traditional medical system. Smart health care systems have reduced the difficulty and the complications associated with the utilization of IoT surroundings. The important information regarding the patient's health is recorded by the deployed IoT objects leading to efficient decision-making. This paper addresses many ways in which the health care will be provided to the required patient through remote monitoring, elderly care management, virtual consultancy, etc. Also, there is a need to provide security and privacy of the health care data to improve quality of life of every person associated. This survey highlights the present security challenges beside the open problems imposing threats to the researchers. Hence, a standardized framework should be projected which will reduce security risk and overcome the open problems of constrained environments, cost-effectiveness, scalability and interoperability of health care applications.

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