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The Internet of Things for Health Care: A Comprehensive Survey for State-of-the-art Architecture

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Abstract: the internet of things (IoT), a massive area that makes smart gadgets and captures the development of smart cyberphysical networks. Healthcare is the most important factor which directly connected with the community and development of any country. Latest example is Covid-19 virus and it has directly affected the economy and the day-to-day life of most of the countries. This survey advances IoT based innovative solutions and technologies in healthcare and analyses applications, platforms, and network architectures (state-of-art), new industry trends in IoT based healthcare, and data security and privacy. As per now ambient intelligence, big data, wearable devices, and augmented reality are the new innovative things in the field. The survey is based on a literature review and with the information that the literature reviewer collected representing the data. In this survey, the authors will be reviewed the IoT based healthcare technologies, solutions, applications, issues, challenges in state-ofthe-art architecture and how IOT will affect sustainable development in the economy and society.

Keywords: Internet of things, health care services and applications, architectures, platforms, IoT security, industrial trends, challenges

Introduction

IoT or Internet of things is the internet connected billions of physical devices around the world and these devices collect and share data. The arrival of super-cheap computer chips and ubiquitous wireless networks make everything do possible today. By connecting different projects and using sensors to these will add a higher level of digital intelligence these projects and it will be helpful to communicate with real-time data without involvement of a human being. IoT will merge digital universe with physical universe and also it will fabric the world smarter and responsive. Benefits of using IoT includes improvement in safety and security, increase in productivity, enhancing asset utilization, efficiency in processes and cost saving.(Islam et al., 2015) Another benefit of IoT includes advanced connectivity of systems, projects, devices and systems. And also, IoT provides solutions for the problems related with applications such as Security, industrial control, health, road traffics control, logistics, waste management, retailing process, and smart city. Out of the above-mentioned applications, health care takes a major role as well as ad attractive interesting application which uses IoT these days. IoT has risen some medical applications like remote patient monitoring, wearable like fitness bands, fitness programs, elderly use, for chronic diseases and infectious diseases or a kind of epidemic situations in the world.[2] The latest example is the rise up of Covi-19 virus, many people including students, doctors and new inventers moved to prepare new gadgets using IoT and robotics. Within last few weeks a lot of IoT based applications came up to this world to find solution for giving treatments to Covid-19 patients without going to them. This will help to reduce the spreading of the virus to people who work in medical field.

Then the doctors can check and assign medicine and also nurses and attendants can provide all the necessary stuffs including food, medicine and others using these gadgets to the patients. This recent incident has tended Sri Lankan inventors to think innovatively and they have risen up with new brilliant innovations to this world. Smart devices such as diagnostic devices, imaging devices, medical devices and sensors are the core part of IoT. Main expectations of IoT based health care services are increasing the quality of life of patients, enhance or enrich the user's experience and reducing the cost.(Amendola et al., 2014) The contribution of this study is to give a review on IoT based applications and services and health care sector, architectures and networks used in IoT, Security and privacy related with IoT based healthcare and new trends and challenges in healthcare applications related to IoT.

Research Methodology

The Internet of things (IoT) is a massive area that consider the global technology in the world. Our workload is to determine the IoT technology used in healthcare. For these aspect research must focus to evaluate the technologies that are used past and current situations through the research materials which are published in the internet. And work projects did the participant observations for the government hospitals and private hospitals in different time periods. In that there are senior management and lower management. For these aspects overall use of technology high percent in the senior management staff. They are working with the technological machines with related to IoT. As the viewpoint there are various of technologies used with the IoT in Healthcare. Commonly, according to the research papers in past era they had been used manual use of testing in healthcare with different technologies and currently it can be vastly developed to the automate system using int the IoT based technologies. There are different kind of IoT architectures and platforms that are used in past era and presently. Development of architectures there can be security threat in the present situations. So, security aspects there can be security patches using any of these technologies with the IoT in healthcare. According to research analysis physical security is needed of any technology that we used in IoT Healthcare.

Healthcare Services and Applications

IoT based health care applications are most probably interact with IoT based healthcare services. These Applications are developed using these services. Here application is user-centric, and service is developer-centric. Proactive systems are converted to reactive systems using IoT applications. IoT will improve power, availability and accuracy of existing devices. Through this section health care devices, wearable and other gadgets available in the market of health care sector is revealed. Figure 1(Islam and Korea, 2018) will show the services and applications in IoT healthcare.

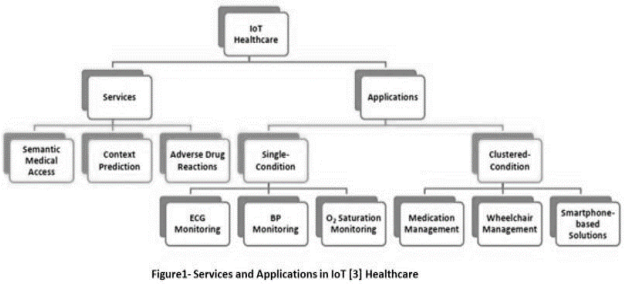

Figure1- Services and Applications in IoT [3] Healthcare

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These gadgets, products, applications and systems can be defined as innovative health care solutions. These IoT based systems consist of diverse fields such as single solutions, clustered-condition solutions, to care elderly patients and to care pediatrics. Some IoT based applications are reviewed here.

• Glucose level sensing an application used by diabetic patients. It will records blood

glucose level over a protracted period. Blood glucose level of an individual is recorded, and this will helps to manage the meals, and treatments. [1]

• Blood pressure monitoring is an integrated KIT of blood pressure (BP) and Near Field Communication (NFC) enabled mobile phone. From this application BP can be controlled remotely through communication structure between the patient and the hospital.

• Through Oxygen Saturation Monitoring, Heartbeat oximetry is required check blood oxygen immersion noninvasively. In this application it has combined IoT with Heartbeat Oximetry. This is a very useful IoT based health care application. The function of the wearable is to indicate oxygen level. This device is connected with a Bluetooth health device profile. Here the sensor is directly connected with the Monere platform.

• ECG Monitoring or Electrocardiogram monitoring is an electrical activity of the heart recorded by electrocardiography. Heart rate measurement is included in this and even a simple heart rate change or rhythm can be able to capture. This will be helpful to diagnose of multifaceted arrhythmias, myocardial ischemia, and protracted QT intervals.(Islam et al., 2015) With the rise of a smart phone-controlled sensor, smart phone can be identified as the driver for IoT. Most of the IoT based healthcare devices and applications are designed to use on smart phones. These include resource sharing services, cross-connectivity protocols for heterogeneous devices, notification services, internet services, and link protocols for major connectivity. Lowpower discovery of devices and services can be added to this service list with efficiency and security.

• Ambient Assisted living (AAL) is an IoT based platform combined or powered by Artificial Intelligence (AI) to address elderly incapacitated individuals. This will be more effective to solve problems associated with health care of aging and incapacitated individuals. This will Helps them to have their living in a convenient and safe manner. This may help to improve individuals confident by ensuring autonomy and giving them assistance similar to human servant in any situation.

• The Internet of m-Health things (m-IoT) is not anything else it is mobile computing, medical sensors and communication technologies for health care services. This model connects with 6LoWPAN with 4G networks. Conceptualization of m-IoT services leads for this.

• Adverse drug reaction or (ADR) is the injury of taking medicine. This will happen after a single dose of a drug or its prolonged administration or as a consequence of a combination of two or more drugs. Here the patient's terminal identified by using barcode and NFC enabled devices. Pharmaceutical information system is used to check whether the drug is compatible with electronic health record and allergy profile.(Sethi and Sarangi, 2017)

• The concept of establishing a network covering of an area is monitored under Community healthcare. This will be an IoT based network of a residential area, municipal hospital or a rural community. To materialize Community Health (CH), this network is integrated with Wireless Body Area Networks (WBAN). Sometimes CH can be called as a virtual hospital.

• Children Health Information is raising awareness about children's health and provide needs of children with mental problems as well as physical, behavioral and emotional problems. This situation has motivated researchers to do develop IoT based Children Health Information to address these needs in an effective way. Through this system it will be helpful to

encourage children to have nutritious food with nutritional habits.

• Embedded Context Prediction or ECP is used to build context-aware healthcare applications through IoT based networks. Some generic frameworks with some helpful mechanisms are required by the third-party developers is called ECP. Still there are some uncovered and unsolved research problems and challenges in context-aware ubiquitous healthcare systems.

Key Technologies of Iot Used In Healthcare

Healthcare is a key sector where today IoT is rapidly adopted to IoT solutions by creating IoT medical things. There are some supportive technologies which are helpful to IoT in developing these smart gadgets. Figure1- Services and Applications in IoT [3] Healthcare

A. Internet technology

Internet technology means the software, hardware, devices and transmission protocols used to connect to a network and send or receive data. To communicate any person with and object at any time at any place, the precondition required is Internet

B. Sensor Network Technology

This is considered as the core of the IoT and it can be operated with RFID systems to track status better. Sensor networks has a certain number to communicate in a wireless fashion. Continuous development of Science and technology and traditional sensors the procedure of microminiaturization, intellectualization, informationization and networked. Environmental monitoring, e-health, intelligent transportation systems, military, and industrial plant monitoring are the application scenarios where use sensor networks.(Yu, Lu and Zhu, 2012) The sensor network connects to the Internet, an enterprise WAN or LAN, or a specialized industrial network so that collected data can be transmitted to back-end systems for analysis and used in applications.

C. Wireless Communication Technology

Through Wireless communication technology it transmits information stored in RFID tag automatically to central information system. Therefore, this can be considered as core technology in IoT. Wireless communication technology includes Bluetooth, WIFI, UWD (Ultra wide band), Zigbee, IrDA (Infrared Data Association) and more. (Nazir, Ali and Ullah, 2019)

D. Embedded Technology

Based on internet, IoT is considered as an embedded system. Here more intellectual terminal products have requirements to network. Here it uses IoT concept for production. Output of the embedded technology development and it cannot do extensive use without embedded technology supporting is IoT. [5]

E. Cloud Computing

The integration of cloud computing with IoT will provide ubiquitous access to shared resources, and it will offer services or requests to the network. and also it will help to execute operations to meet certain needs.

F. Grid Computing

By introducing grid computing to the ubiquitous healthcare network, the problems related to insufficient computational capability of medical sensor nodes can be solved. When Grid computing is more accurate in cluster computing and it is viewed as backbone of cloud computing. (Islam et al., 2015)

G. Big Data

This includes large amount of essential data generated from sensors and other tools. This will increase efficiency in health diagnosis and monitoring. (Nazir, Ali and Ullah, 2019)

H. Ambient Intelligence

For the continuous learning of human behavior and to trigger a recognized event, ambient intelligence is used. The capability of IoT-aided healthcare services are enhanced by the integration of autonomous control and Human computer interaction (HCI) technologies into ambient intelligence.

I. Augmented Reality

It is a part of IoT. It plays major role in healthcare engineering. It is used for surgery and remote monitoring, among others.

J. Wearable

By embracing wearable medical devices can improve patient engagement and population health improvement. Benefits of wearable includes connected information and target-oriented healthcare communities. (Internet of Things and Advanced Application in Healthcare - Google Books, no date)

Iot Architecture and Platform Used In Healthcare Industry

The IoT architecture prefers the outline analysis of the organizational functions and working principles of their techniques. Architecture vary from organization to organization and they have built the system according to the situation of their concern factor. All the new technology we can process to the convert to architecture, but we have to concern the what the purpose we are using and what the benefit of this devices and get the maximum output of the IoT devices for the benefit of the organizations as show in Figure 1.

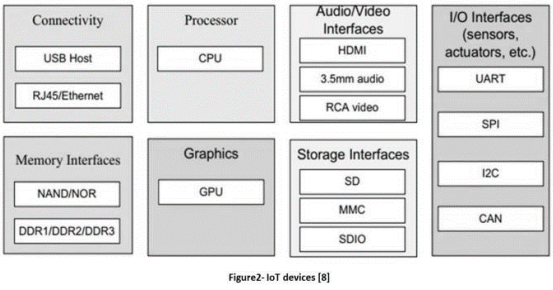

Figure 2: IoT devices

IoT platform refers to both the network platform model and computing platforms. Internet of Things (IoT) refers to the stringent connectedness between digital and physical word. Various researches have analysis IoT in different ways. The IoT architecture can be a system that can be physical, virtual or a mixture of two, consisting of a collection of several active physical things, networks, devices, actuators, cloud servers and specific protocols of IoT, developers, companies and customers. Using these devices, such as Figure. 2 Figure2- IoT devices (Ray, 2018) connects the base of the system and provides actuation, control and monitoring activities, and also the devices can exchange data between servers to obtain responses and deliver the responses to the relevant receivers. IoT devices have many interfaces to communicate between centralized servers, such as various types of portable sensors, smart watches, LED lights, cars, and industrial machines. (Ray, 2018)

Things, their interconnection to the Internet, by directly or through local area networks, and how they communicate with each other, with the cloud and with mobile device applications. This includes device identification and addressing as well as typical communication protocols to be come upon. The hardware architecture and implementation of a thing will be defined, including its sensors, actuators, intelligence, identification, communications, power, and hosting. Thing's firmware architecture and firmware implementation will be explored in a similar way, considering its operating system, sensor and actuator interface, communications protocol stack, configuration, and status monitoring. The architecture of the cloud system will be discovered, with virtual cloud servers, data warehousing, and services offered by providers such as Amazon Web Services and Microsoft Azure. This will contain the

procedure to establish a cloud-based server system.

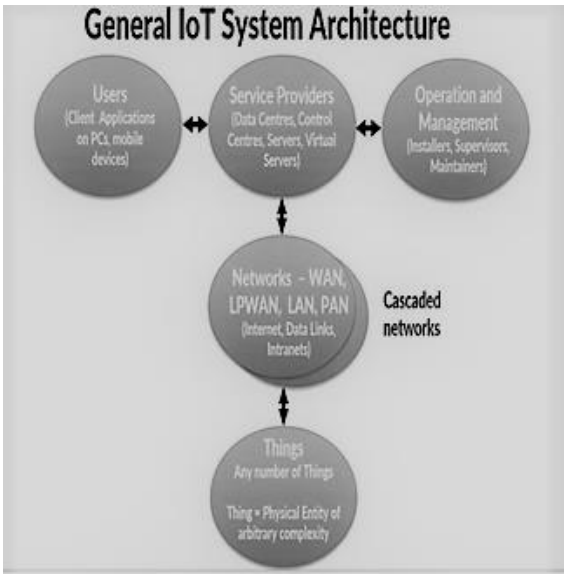

Figure 3- IoT System Architecture

As per author illustrated from figure. 3, general IoT system architecture, user access via the mobile applications, PCs, any devices to the relevant destination but there is route to process to cover. User can reach to the physical entity through the service providers controls. It will be enabling by the operation and management then it passed through the networks. Then user can reach to the physical entity without interference. The IoT is a global network that link with different types of objects anytime, anywhere and anyplace through current internet protocol called Internet Protocol (IP).

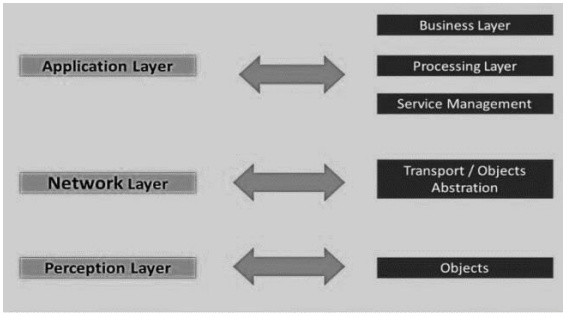

Figure4- Layers of IoT architecture

According to most researchers' views on conventional IoT architecture, it is measured as three layers: (Perception Layer, Network Layer, and Application Layer) and it is illustrated by the author from Figure 4.

The perception layer (recognition layer) is the deepest layer of conservative IoT architecture. The main accountability of this layer is to collect useful information / data about things or the situation and transform them in a digital setup. The main determination of the objects is the unique address identification and communication between short-range technologies like RFID, Bluetooth, Near-Field Communication (NFC), 6LoWPAN (Low Power Personal Area Network). (Sethi and Sarangi, 2017) The lower layer of the IoT architecture perception layer represents an object layer. The main responsibility of the object layer is to gather data from different devices of varied category and then procedure and digitize the data. It also transmissions the managed data to the upper layers of the IoT architecture.

Network layer is the intelligence of conventional IoT architecture. The main concern of network layer is to assistance and guarantee the transmission of data between the application and the IoT perception layer architecture. Network layer mainly gathers information and delivers it to the perception layer to various applications and servers. Basically, network layer is a junction of internet and communication-based networks. According to a existing study carried out in several based-on communication-based technologies, the researchers determined that the network layer is the most industrialized layer of conventional IoT architecture. It is the central layer (network layer) of IoT6 that is capable of proceeding information for relevant procedures and applicable for data processing tasks handled IoT management. (Iablonskaia, 1970) This layer also confirms unique routing and routing abilities for the unified addition of countless devices into a single cooperative network. Several types of

technologies are providing for this such as wired, wireless and satellite. The innovation of the 6LoWPAN protocol towards IPV6 for the unique addressing of IETF devices demonstrates a high degree of effort involved. The central layer of the conventional IoT architecture network layer represents an object abstraction layer. The object abstraction layer performances as a Figure3- IoT System Architecture (IoT System and Device Architecture and Implementation - Webinar - EA Books, no date) Figure4- Layers of IoT architecture intermediary layer between service management and the object layer. In the concept of objects, RFID, WIFI and Third Generation (3G) communication technologies are used. The transport layer transmits the device data from the perception layer to the processing layer and across networks.

The application layer is measured a top layer of the conventional IoT architecture. This layer provides personalized / customized services based on the relevant requirements of the user. This layer main responsibility is to connection the main gap between users and applications. This IoT layer trusts the industry to achieve high-level smart application type solutions such as disaster monitoring, health monitoring, transposition, wealth, medical and ecological environment, and managed relevant global management for all type smart applications. (Banu, 2018) The application layer is divided into sub three categories for their basic functionalities. The primary tasks of the service management layer are to enable information processing, decision making, and controller of union requestor information processing for relevant tasks. The application layer delivers customers with high-quality smart services according to customers' request. The business layer concern about the business model and the data that has been established from the application layer. The processing layer performs as a store, analyzes, and processes huge quantities of data that delivered from the transport layer. It can provide services to the lower layers. It services many technologies such as databases, cloud computing, and big data processing modules. The business layer achieves the entire IoT system, including applications, business and income models, and user's privacy.

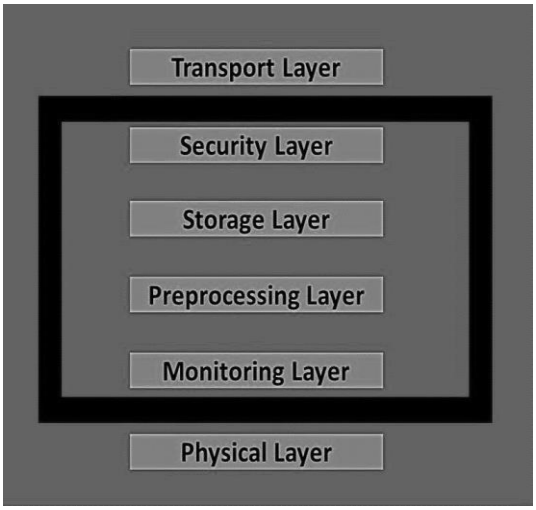

Figure 5- Fog architecture

In fact, some researchers observed at one more layer that is also included in IoT latest architecture which is a support layer between the application layer and the network as shown in Figure. 5. Some of the researcher's experiential of the IoT as consisting of four layers of architecture. The fourth layer is considered a support layer (the technologies used in this new layer are cloud computing, smart computing, fog computing etc.) that invention between perception and the conventional IoT network layer architecture. The support layer contains of fog computation and cloud computation. Cloud computing and fog computing are urban topic nowadays in research view of mostly finalized researchers on IoT architecture. Cloud and fog-based architectures.

Let us now discuss two types of system architectures: cloud computing and fog computing. We have been a bit vague about

the nature of the data generated by IoT devices and the nature of data processing. In some system architectures, data processing is done centrally by cloud computers such as cloud-centric architecture keeps the cloud at the center, applications. Cloud computing takes precedence because it provides great flexibility and scalability and provide services such as core infrastructure, platform, software, and storage. Developers can offer their storage tools, software tools, data mining and machine learning tools, and visualization tools concluded the cloud. Lately, there is a move towards another system architecture, namely fog computing where sensors and network gateways are a part of data processing and analysis. A fog architecture structures as a layered approach and it provide the monitoring, preprocessing, storage, and security layers between the physical and transport layers. The monitoring layer controls power, resources, responses, and services. The preprocessing layer makes filtering, processing, and analysis of the sensor data. The temporary storage layer offers storage functionalities such as data replication, distribution, and storage. Finally, the security layer performs encryption / decryption and guarantees the integrity and privacy of the data. Monitoring and preprocessing are done at the edge of the network before sending data to the cloud. (Sethi and Sarangi, 2017)

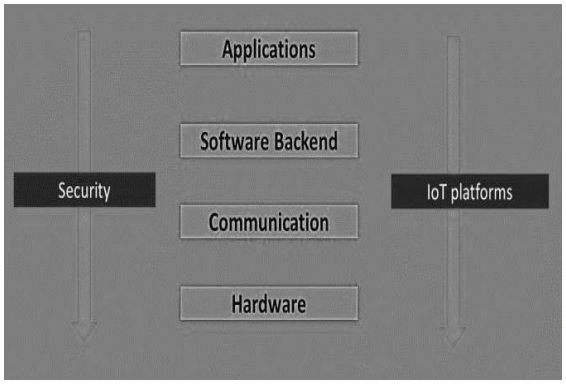

Figure6: IoT platforms

According to the Figure 6. IoT platforms are build up with the IoT architecture requirements. Hardware - The data is produced, and the hardware layer contains the physical devices with the integrated microprocessors, sensors, actuators, and communication hardware.

Communication: The data is transported, and this part of the technological infrastructure guarantees that the hardware is connected to the network, through patented or open source communication protocols.

Backend Software - The data is managed, and the software backend completes all connected devices and networks and platforms provides the necessary data integration as well as the interface to other systems.

Applications: The data is converted to value in the application layer and IoT use cases are provide to the user. Most applications run on smartphones, tablets, PCs or other devices and with the data. Security is vital element for all these basic components. The IoT infrastructure essential to be comprehensively designed because the threat of attacks is reduced at all levels. This includes protecting and encrypting data and metadata, managing device access, authenticating users. (IoT Analytics, 2015)

Security in Iot Based Healthcare

Article 12 in universal declaration of human rights, "No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honor and reputation. Everyone has the right to the protection of the law against such interference or attacks."(Assembly et al., 1948)

A major issue in today's technology driven world can be considered as security and privacy of data and information. Privacy means preventing from anonymous, unauthorized data access or data hiding. There are many data hiding techniques such as Anonymization, Generalization, Perturbation, Role Based Access Control,

Encryption and many more and still developing. Strong privacy techniques are open research problem.(Churi and Pawar, 2019) Data have many different phases in their life cycle. storage of data, transition of data, transfer of data and processing of data are the stages or the phases in life cycle of data.(CAJIGAL, 2008)

According to(Krishna, Gurumoorthy and Obaidat, 2019) health care industry is a most rapidly developing industry. There were huge changes last few decades in integrating Information communication technology. Latest technology of health care shifted from disease centered to patient centered. Where patient can choose. It generates huge amount of data on patient. To get effective results, industry needs to increase data utility. This means it transmit huge amount of sensitive data. So now you can understand how crucial data security and privacy important. Health care industry must manage and safeguard personal information to address those privacy issues to process and analyze those industries must follow specific rules and regulations. If not, we must develop such kind of rules and regulations or set protocols to follow. there are some rules carried different countries. (Abouelmehdi et al., 2017)

According to (Krishna, Gurumoorthy and Obaidat, 2019) Data encryption is a data protection method which avoiding any unauthorized user access. For that we can use encryption algorithms such as RSA, DES, RC4, AES. Authentication prevent unauthorized accessing of e-health records. secure socket layer (SSL) and transport layer protocol (TLP) are cryptographic protocols by applying these protocols we can strengthen security. Access control granted separate privilege to each user. These roles have different capabilities. Sequence access control (SAC) is another technique. These are initiated after authorized user access the system. Masking is hiding sensitive data values or convert into unidentifiable string. Which is not like in encryption. But it uses a unique decrypt method. Those are basic methods.

To provide best solution to health care industry smart systems are employed. To effective communication between machine to machine provided through cyber-physical system (CPS). It is a framework described in(Krishna, Gurumoorthy and Obaidat, 2019)

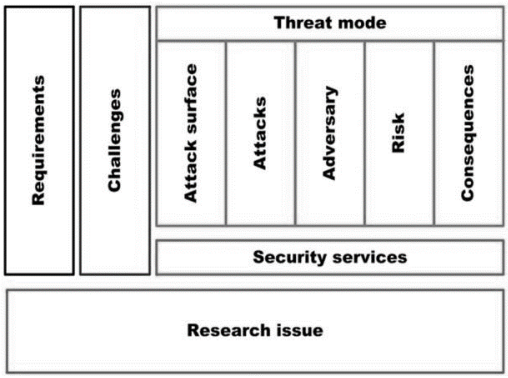

Figure 7: Security issues in IoT-based health care(Islam et al., 2015)

Figure 7 shows Security issues in IoT health care industry. Security requirements of standard communication scenariosand IoT based health care solutions are most similar. To achieve secure service these devices, need to apply security requirements like confidentiality, integrity, authentication, availability, data freshness, non-repudiation, authorization, resiliency, fault tolerance, self-healing.(Islam et al., 2015)

Traditional techniques won't work anymore with security of IoT. New countermeasures wanted to be introduced whenconsidering health care challenges there is some points thatwe should consider.

• IoT has less powerful CPUs which only uses for actuator or sensor. These devices are not designed for heavy computational operations. Find a security solution forlimited resources that lightweight solution is a big challenge.

• IoT has low memory it is not enough to run complicated security protocols.

• BP sensors and body temperature sensors those consumes huge amount of power. Even though when no need to report any sensor readings, device conserve in power saving mode. This is also a challenging property.

• IoTs are mobile and wearable. So that person who owned the device travel here and there. Home, office, market. So, device will connect internet with different networks which has different security configurations. So,designing a security solution such a device is more challenge.

• By now there is so many IoT devices connect with the internet. Designing a highly scalable security solution is a challenge.

• Normally IoTs are connected using Bluetooth, Zigbee, Z-Wave, WiFi, GSM, WiMax, and 3G/4G to the network. Traditional security protocols for wired media will not helpful for these devices. These protocols need to develop for catering both wired and wireless devices equally.

• IoT devices have variety of diversity from PCs to RFIDs in healthcare industry. Multiplicity of these devices are huge challenge in designing in security solution forcompatible with all the devices.

• In IoT health care devices can connect with the network anytime and anywhere. It may leave the network in same way. This reason make network dynamically. So,security should be providing into that also which is achallenge.

• IoT devices may communicate with other devices in the LAN same time it may communicate with IoT service provider over the IP network. It's difficult to develop a security solution for multi-protocol communication.

• IoT devices may have to update to date. Tomitigate vulnerabilities. Designing a update mechanism with security patches with dynamic installation is a challenge.

• Tamper resistant package will enable physicalsecurity of IoT devices. Intruder may tamper the device andextract cryptographic algorithms or replace malicious software with in it. So this package will resist such attacks and these kind of packages difficult to implement.(Islam etal., 2015)

Healthcare Industry and Status

Iot in health care field has experienced as well as comprehensive activity and creativity, researchers wish future market are willing to be part of these enabling products and technologies. Sensing interoperability, lifelogging mode and uncontrolled environment are the future research trends. Interoperability especially distributed in network layer and processing layer. Current days many approaches and bio medical platforms have been proposed for sensing interoperability. However, in this section mention an extensive list of IOT in health care product and technologies. The latest technology of real time tracking has many features such as GPS tracking, got updated alerts, mobile data and short messaging services. Using those technology developed number of healthcare devices. BP machine and app is one of the example, had develop baby monitor.

In recent years Chinese firm has developed MI platform and integrated telemedicine competence. They developed the platform supporting cloud-based image storage, 3D image post-processing and visualization. The main firm of Neusoft has focused on IOT based healthcare services. And they provide their services for hospitals and public health facilities and health management. (Islam et al., 2015) a resent time period society oriented by U-healthcare (Ubiquitous) which monitors man's health condition and provide health care services wherever it is needed. Ubiquitous health care that provide

healthcare services using remote medical technologies without any limitation in time and space. This system can monitor bio-information in real time using certain devices and mobile equipment in a home network. U-healthcare system can be classified as sensing, monitoring analyzing and alter according to the role in a system (Lee, 2016)

Ranging from pilot project to effective implementation of eHealth and IOHT (Internet of healthcare things) based health services and policies have been adopted successfully in many countries worldwide. In future countries will making new policies and shifting towards eHealth and IOHT enabled network. The newly concept in healthcare industry call High volume of data. It has contained the lifelogging collection of physical activity data of personal health information. These data collect by using heterogeneous devices connected in IOT environment (Albesher, 2019)

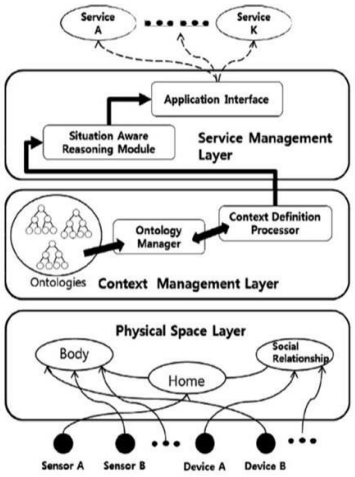

Figure8 - Platform of smart home-based healthcare system (Internet of Things and

Effectively and efficiently improving validity of these complex health related data and exploring is difficulty task. Researchers was experiment how to explore these healthrelated big data deal with IOT environment. Lee & Kwon, 2013 was proposed a platform for the smart home healthcare system as shown in Figure 8. It handles wide range of context generally occur in the house. After collecting various types of sensor data and define what situation currently happen at home space. The architecture of the proposed platform has main three layers: physical space layer, context management layer, and service management layer. (Internet of Things and Advanced Application in Healthcare - Google Books, no date)

Garmin's vivo smart is a fitness checking band or smart watch that can consider the user active way. Jawbone's UP3 is the same device of vivo smart band but UP3 is many state-of-the-art sensors and it can capture the full picture of Figure8 - Platform of smart home-based healthcare system (Internet of Things and Advanced Application in Healthcare - Google Books, no date) patient's health status. An iHealth lab team was found a set of extensive products such as wireless BP wrist monitor, BP dock, wireless body analysis scale iHealth lite, iHealth Edge, iHealth Align and wireless smart glucose-monitoring system. They basically developed a health tracker that can help tracking user's daily activities. (Islam et al., 2015)

Phyode's has introduced a smart health wrist band that can monitor the patient heart rate variability. Rejuwan's introduce by total health measuring ECG machine and also monitor heart rate variability, respiratory rate, sleep position, restfulness, breathing index and energy level. Those devices can investigate the state of the autonomic nervous system. Considering with globalization many countries are facing challengers of elder care, wearable sensors more related to consider elders heath measures meantime chronic diseases are becoming the major cause of death. Who felt chronic diseases most probably they want do surgeries then after the surgery they want proper monitoring system to measure their health condition? As a result measurement of vital signs and corresponding diagnosis are

carried out in controlled environment. However, wearable medical or healthcare devices are the key element that will catalyze the process. Wearable sensor devices can be connected directly to internet through an access point, or it may connect to an internet enable device through Bluetooth. Wearable sensor devices measure the health factors and it connected to internet or user's smartphone or tablets. Those are the IOT based devices. Wearable body area network are crucial component of the medical IOT. The term of (IOT) namely the concept of interconnecting physical object to each other or the internet to create domain-specific intelligence through seamless pervasive sensing, data analysis and information visualization (Qi et al., 2017)

With an increase in disease, medical support is also growing in today's social world. As a result, doctors' patients frequently increase. Most Asian countries and third generation countries can involve the public health sector and the lack of technological support in which health services are provided to patients. Smart home concept that integrates health function and environmental assisted living technologies In fact, providing healthcare facilities is one of the main functionalities that smart homes offer. This concept of sensors and actuators together with the backbone of communication from the central part. To capitalize on the versatility of wireless medical sensors, there are a growing number of studies looking to create application networks for a wider variety of conditions. These studies use sensors on a wireless body area network (WBAN) to monitor the patient's health. In some cases where devices can communicate via Bluetooth, the data is sent to a user's smartphone for processing and storage.(Pal et al., 2018)

The Medical Internet of Things can consist of many devices and is personalized according to the needs of the user. Common portable sensors measure heart rate, blood oxygen, blood glucose, body temperature, and gait. These devices can be connected directly to the Internet or to an Internetenabled device, such as a smartphone, laptop, or tablet. Wearable Body Area Networks (WBANs) are a crucial component of medical IoT. WBANs can be single-purpose sensors, such as pulse oximetry sensors that measure the oxygen level in a user's blood, or more complex devices comparable to Fitbits, which can track location, recording activity, and measuring heart rate. For patients in stable, noncritical conditions, WBAN monitoring enables recovery at home or in a caregiver's home rather than remaining in the hospital under observation after completing primary treatment.

The use of IOT allows multimedia to implement deep and rich communication and interaction between patients and specialists remotely and provides great developments for the industry. Users obtain vital signs with the use of small smart wireless sensors that are used as personal gateway (e.g. smartphones) based on different operating systems (e.g. Android) in small area networks with different protocols, like Bluetooth, ZigBee and WBAN.

Challenges

It is really a nice idea to use IoT in a fast developing and a highly required sector called health care. IoT based devices or IoT based smart gadgets can come up with a little processing speed and some functionalities are limited. In healthcare sector it is a place which deals with real time data transmission. (Nazir, Ali and Ullah, 2019) And there may be a slight delay when leading to a fatal situation. IoT devices can store a less amount of memory and it is a challenge to implement security protocols in these applications with the base of IoT. These IoT devices have the feature called mobility and they are connected with wireless technology and internet. Change in operating system in

mobile phones or changing platform and environments will create security compatibility issues. A global trend has attracted a great deal of attention in terms of integrating smart home technology for the purpose of aiding health monitoring in addition to real-time care in telemedicine. Patient psychological information should be collected in a timely manner and automatically transferred to remote specialists through the network to support and assist patients with the use of smart home technologies for a decent home life in real time. This information is extremely sensitive and private; Thus, most government authorities impose strict policies. (Linkous, Zohrabi and Abdelwahed, 2019)

Conclusion

Today researchers have moved to do more researches to enhance and improve the health sector by finding new innovative technological solutions with the advance use of IoT. This paper reviews how IoT deals in healthcare sector, technologies used in IoT based healthcare, network architecture and platforms used in IoT, applications and services in IoT based healthcare sector, Security issues, security requirements and security challenges connected with IoT based healthcare, healthcare industry, new trends and challenges in IoT based healthcare. This paper provides detailed research description of current IoT based applications and how people use them and the advantages or the key benefits of using IoT in healthcare. This review will show some new paths to researchers and it will help them to motivate them on these paths. The new technologies that can connect with IoT and use in future applications and services in IoT in healthcare is reviewed in a smooth way. IoT based applications will also help to provide smooth continuous service to patients and can helps to get maximum use from the limited resources through efficient scheduling. This will help more patients to get best use from resources. This paper will give a broad view of the architecture and network platform use in IoT based Healthcare. Security is the major problem that should be considered. Security requirements and challenges and how to overcome these challenges are surveys through this paper. In this survey, the authors will be reviewed the IoT based healthcare technologies, solutions, applications, issues, challenges in state-of-the-art architecture and how IOT will affect sustainable development in the economy and society. Finally, this paper is expected to be useful for researchers, innovators, doctors, students and health professionals.

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