Technological Applications of Internet of Things in Health Monitoring System

Suraj V. Kurde, R. Suguna, Jayant Shimpi, Ashish Mulajkar, Sarla Chimegawe

Abstract*: The Internet of things (IoT) is new era of set of techniques and tools, which is built as interconnection of physical objects and cyber objects. The physical objects can be loaded with ubiquitous intelligence for smart behavior. Each object can interact with human being and other connected devices through the embedded system or embedded applications. With the help of IOT researchers are promising tremendous improvement in quality of service of human lives. IoT can be thought of as cyber-physical framework. It is an pervasive framework designed for smart systems. This survey paper presents advances in IoT based healthcare system, network architectures, some applications and security threats in such applications.*ase download *TEMPLATE HELP FILE from the website.

***Index Terms*: Healthcare System, Internet of Things, Cloud, Data security, startups.**

I. INTRODUCTION

Healthcare monitoring is critical point now days. Healthcare cost is increasing day by day. Healthcare spending is to be expected to be at least 3 percent of GDP by 2022. Medical field is considered as one of the waste application area of IOT. The IOT is considered to be more potential to support number of applications in healthcare system. Due to use of various devices in IoT for healthcare systems, these devices are said to be smart devices. Various devices that are used for designing system are sensors, imaging devices, transmission devices, and diagnostic devices. Extending internet infrastructure for IoT applications introduce new advantages like good quality of service for users, increased quality of life, less timeouts of machines or devices, faster analysis, and advanced connectivity between devices and so on.

IoT can identify the time of supply for each device that will help for smooth operation of devices and system. As resources are limited we can schedule device or resource utilization efficiently for better quality of service to patient. Fig. 1 depicts the general architecture of healthcare system. Cost effective interaction is central idea behind utilization of IoT for healthcare system. Secure and seamless connectivity between individual patients, hospitals and other healthcare organizations is supported by the use of various technology trends in the system. The network with updated support for each component of system will help to provide adequate features to monitor patient health. Gateways to connect and exchange data, medical servers to maintain record of patient history and standard health databases for monitoring purpose are the key components to provide on demand health service.

In the last few years, many researchers have contributed in this area by identifying various advantages of IoT for healthcare system. Various potentials has been identified and various challenges were studied by researchers for effective and efficient system design. As a consequence, one can find many applications designed by researchers for monitoring patient health, to diagnose various diseases, to transfer dynamic records of patient's health to medical servers and so on. Many protocols are available to support secure and seamless connectivity, and many services are supported by these system. Network architecture, security, interoperability and services, platforms and applications for all of the services are included in research trends. Many countries and organizations has developed guidelines and policies for use of IOT technology in the area of medical field. However we can see immaturity in the IoT for healthcare or medical field. This paper is useful to understand various issues and trends related to IoT for healthcare system. S. M. Riazul Islam, Daehan Kwak, MD. Humaun Kabir Mahmud Hossain, and Kyung-Sup Kwak did survey on healthcare system and presented a list of IOT trends and issues to be addressed for healthcare services to be effective, efficient and secure [1]. The survey paper presents classifications of IOT healthcare system into three trends or components, extended survey of services and applications, efforts by industry to design and develop IOT compatible healthcare products and prototypes[2-3]. The paper also provide insight into security issues, core technology growth, policies and strategies, challenges that need to be addressed for robust healthcare technology. Wireless Sensor network can be considered as initial IoT research work for development of IOT healthcare system. Current scenario is to shift from registered standards to IPv6 based Wireless personal area network[4-5].

II. HEALTHCARE SERVICES

The IOT is anticipated to support variety of services. Each service shall provide a set of solutions. We cannot define IOT service in the context of healthcare. However we

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cannot differentiate any service from any applications

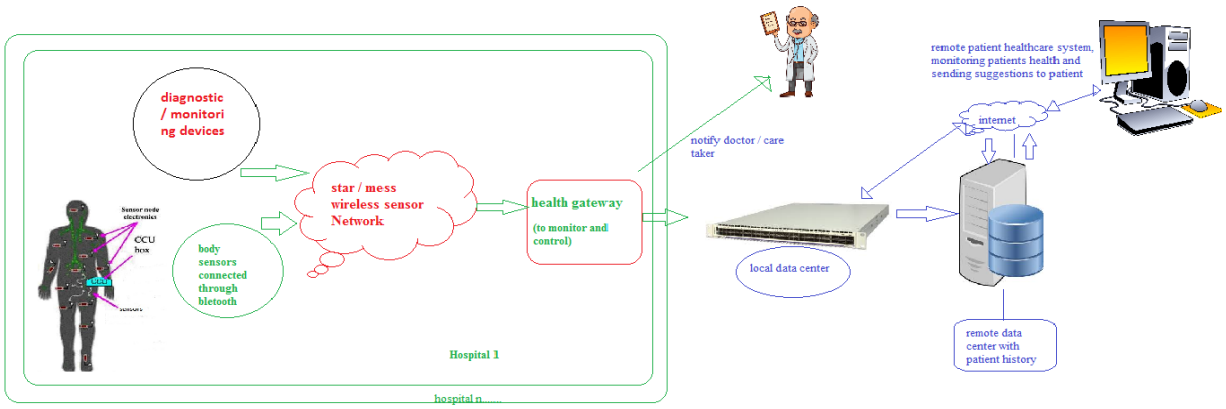

Figure 1. General architecture of Healthcare system using IoT

or solution. For proper functioning, services and protocols need slight modification in its context. A list of modification may include notification services, resource sharing service, devices with cross connectivity protocols, link protocols used for major connectivity, internet service and devices and services those with low power, easy, fast and secure properties.

Table 1. List of startups in Healthcare system

Startup	**Services and area of research**
Practo Practo Ray	Healthcare solutions for healthcare providers and consumers, Patients can search doctor and can book appointment, Practo Ray allow patient data management and digital record management, Operative in India in 35 cities.
NetMeds	Licensed online pharmacist, Offer prescribed generic medicines at low cost, Cover Tier 2 and 3 cities and villages
Portea	Marketplace for in-Home healthcare services, Services provided by them include consultation, eldercare, postnatal care, lab test, etc., Some medicinal products are offered on rent, Operative in 25 Indian cities
MedGenome	Work on genomic-focused research and diagnostics, Vision is to improve global health by decoding the genetic information contained in an individual's genome, Provide support for research in pharma companies, Provide a HiseQ 4000 NGS machine, Provide facility for non-invasive prenatal testing for chromosomal testing
Goqii	The fitness wearable company, Company provide a free fitness band, Funded roughly Rs. 89.4 crores
Lybrate	Platform for consultation, Consultation by Doctors from 30 cities across India
Attute	Cloud based patient data sharing for clinics
welcomeCure	Platform for online tele-consultation, Startup claims to have largest database of patients and diseases cured
1mg	Online pharmacy, Online consultation, Appointment booking
Relisys	Develops and manufacture stents systems and angiographic catheters, Based in hydrabad

Major services that are supported by IOT can be listed as[6-18]:

- Child health information
- Emergency Healthcare
- Wearable device access for health monitoring
- Semantic Medical service access (SMA)
- Internet of m-health
- Embedded context prediction
- Drug identification and reactions

IOT applications and IoT services have brought attention of researchers towards this filed. One can find that, all the services are used to design IOT application. These applications are used by user, that is, patient and ultimately they are using IOT services [19-24]. All services can be considered as developer centric whereas all applications are user-centric. Various innovations by IOT technology consist of wearable, gadgets, and other healthcare devices.

Some of the IOT healthcare applications are:

- ECG Monitoring
- Monitor patient / user blood pressure
- Body temperature monitoring
- Smart healthcare solutions
- Wheelchair management

- ➢ Medication management
- ➢ Medication or medical service management
- ➢ Rehabilitation system

According to World Bank, 2012 report, there's only one doctor for 1700 people in India. Through telemedicine and advances in technology, the deficit of doctors in India is to be addressed. Global funding for health startups in 2015 was $5.8billion. According to data about highest funded healthcare startups, here are some healthcare startups that are centralized around appointment booking, healthcare information system sharing through cloud system, online medicine selling, online disease cure system, and some startups busy with hardware and genomic research.

III. INTERNET OF THINGS (IoT)

Internet of things (IoT) refers to any network of physical connected devices capable of exchanging information or data collected using various cyber physical devices like sensors,

raspberry pi, LAN network, mobile workstations, cell phones, machines, central data processing devices and so on. With the help of recent developments in Technology we can design efficient, cost effective and timely system for healthcare. IOT allows sharing data among devices connected in network with low cost of sharing. The Cloud system can be used to collect all this information and analyze this data very fast. The analysis is more accurate and reaches the required limits of accuracy. That suggest more possibilities of applications across industrial areas : automatic time calculation for public transport vehicles & display same on system, vehicles like car can sense wear & tear, cars that can sense pollution quality by engine, and so on. As we can find various areas where IOT promise best quality of service, in this nowhere is healthcare system. The principles of IOT that are applied to the field of healthcare are telehealth care, monitoring health from remote location, providing care for patients at remote locations through some devices that can be operated using internet[25]. Kevin Ashton coined the term Internet of things. Kevin explained explained about the term at a business meeting in 1999- "Today computers – that is Internet, is completely dependent on human beings for information. As people have limited resources for data collection and analysis, along with limited time. Its better to design devices that can collect information automatically and analyze it for human being, without any intervention of human". IoT has become advanced technology for healthcare systems because of two reasons[26]:

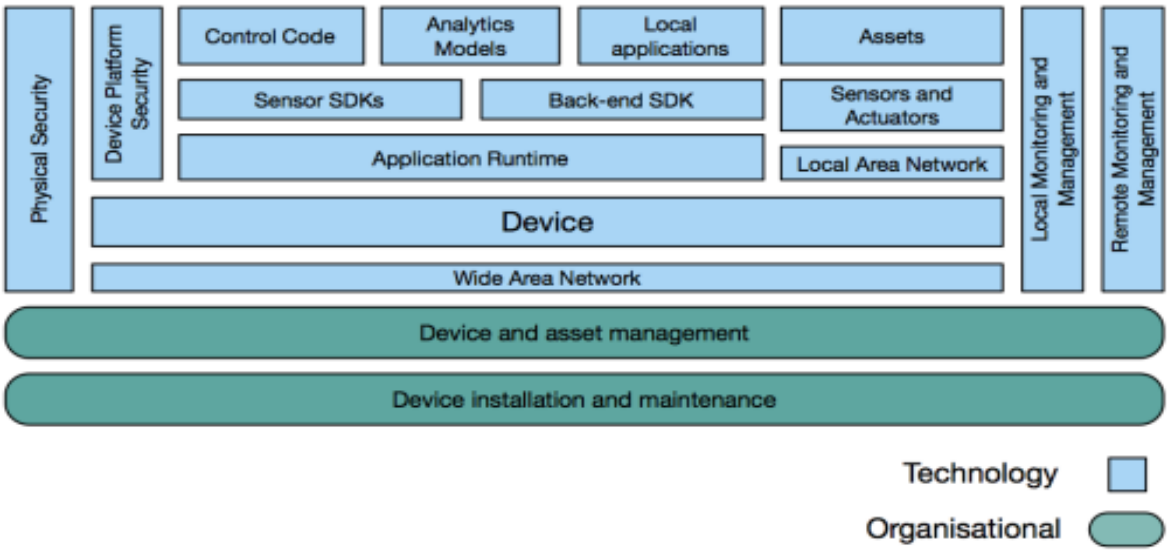

Figure 2. Sample architecture for IoT services[31]

- Sensors technology and connectivity technology advancements have made it possible to collect, record and analyze data on control servers which was not possible earlier. In healthcare this enables to collect patient data over time for better understanding of improvements in patient health on diagnosis with prescribed therapy.
- Automatic data gathering reduce data errors of patients and remove limitations of data entry by human. Data is collected dynamically whenever and whatever is required by Doctors. Fewer errors results in more efficiency, less cost and improved quality in any industry.

A. *Applications Areas of IoT*

Even though in today's time only upto 2 percent devices are connected through internet technology, in coming years, according to Joseph Bradley, number of businesses are establishing building blocks of the IoT infrastructure. Some of the application areas are listed below[27-29]:

- home environment, energy control, temperature

management, home equipment control, etc.

- Building automation: control building environment, monitoring of building health or infrastructure.

- Automotive design and manufacturing: design of applications for vehicle monitoring, monitoring the maintenance, vehicle & machine fuel and mileage management, security and driving control to prevent accidents, automatic registration for servicing on appropriate time.

- Agricultural automation / Applications Smart retail
- Supply chain Wearable
- Connected cars Healthcare
- Security and surveillance Insurance
- Banking
- Government

IV. ISSUES WITH IOT IN HEALTHCARE

Many researchers are working on design and implementation of IoT based healthcare services. Many are working on solving various issues and problems associated with IoT technology and requires architectural support. Some of the problems that are of major concern are standardization of device and data formats, platforms for IoT based healthcare services, cost of system, app acceptance by doctors and clinics, integration of current devices with IoT system, compatibility of existing devices, time of service in network layers may differ for different devices, power requirement for protocols (should be low), type of network (patient centric or data centric), identification of patient and caretakers or doctors, security of data on cloud system, model for user friendly approach for users like patients, pharmacy company, doctors and nurses; addition of new diseases and disorders; mobility.

V. CONCLUSION

Researchers across world have started to enhance IoT technology to extend current features for healthcare services. This paper surveys existing architectures of healthcare system, general architecture of IoT for various services, challenges in IoT and basics for IoT technology in healthcare system, and platform for IoT in healthcare. R&D efforts have shown results in healthcare services and applications using IoT technology and other medical devices. For better understanding of security in healthcare system, this paper has considered various security issues related to patient data. This paper also presents view on various devices, internet based health care applications, various startups working in IoT area. The discussion on standardization, network type for system, and quality of services introduce with basic facility to be provided by any application or service designed using IoT.

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