A Study on IoT approaches for Health applications

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Abstract: **I**n present world, balancing work and health have been a major concern for most of the people. Patients waiting for doctors for long hours or if patient staying in remote areas may not be getting proper treatment in case of emergency are well known issues. These kinds of issues require continuous health monitoring on daily routine by keeping track of various health parameters using GSM module. With fast growing of various technologies, providing the patients a chance of monitoring health issues continuously even if patient is staying in remote area is challenging. In our paper we have listed some of the applications of IoT in healthcare and how they are helpful in providing the better health monitoring system for the patients who are staying in remote areas. This paper tries to review and understand applications of IoT in healthcare. We have explained in brief about some of the applications of IoT in healthcare which uses tools, devices and applications to implement desired healthcare applications.

IndexTerms – **GSM- Global System for Mobile Communications**, **IOT-Internet of Things**, Raspberry-pi, Healthcare.

I. INTRODUCTION

During past years tracking health information was very challenging with some patients that might be taking data that is coming from fetal monitors, ECG Temperature monitors and many more. Tracking health information in olden days was compulsorily needed interactions with healthcare professionals. Examples like Bed adjustment, patient need to get up and make suitable adjustments. But now with the use of IoT in health care bed can automatically adjust itself with suitable user inputs through remotes or other applications from mobiles or systems [1]. IoT has changed our life style from cell phones to wearable from washing machines to monitors. IoT has been gaining more popularity in recent years. It can also be stated as network of physical objects that might include devices, vehicles, buildings etc., or in other words "things" which are combined with electronics, software, sensors and network connectivity which enables these objects to collect and exchange data [2]. IoT is process driven which includes Monitoring (Collect and record data) and Analyze (process, analyze and communicate data).

Figure 1: IoT in healthcare

The "things" can be stated as an entity which has a unique identifier, an embedded system and also has a ability to exchange data over a network. Examples might include automobiles with built in sensors , medical equipments like heart monitoring implants, biochip transponders on farm animals , DNA analysis devices and also includes field operation devices which are helpful in rescue operations and also fire fighters. IoT acts as a bridge between virtual and physical world. In our paper we are dealing with IoT in Health care and their applications. IoT providing wide variety of applications in maintaining patient's health data, which is to improve the health of the patients[3]. IoT has the potential to keep the patients safe and healthy. It also increases patient engagement and satisfaction by providing patients to spend more time interacting with doctors. There are few examples of IoT in health care like Headsets that measures brain waves, Clothes with sensing devices , BP monitors , Glucose monitors , ECG monitors , Pulse Oxi-meters , sensors embedded in medical equipment , dispensing systems , surgical robots and device implants.

Before IoT, Figure 2. Interactions with doctors and patients were less and it might be through visiting hospitals, communication through telephones and text messages. But there was a problem over there where doctors could not monitor the patient's health continuously [4]. When IoT and IoT enabled devices came in to existence healthcare became popular and got the potential to keep the patients and their records securely. IoT involves extending internet connectivity beyond standard devices such as, desktops, laptops, smart phones and tablets to any range of traditionally dumb or non-internet enabled physical devices and everyday objects. Embedded with technology these devices can communicate and interact over internet and they can be remotely monitored and controlled.
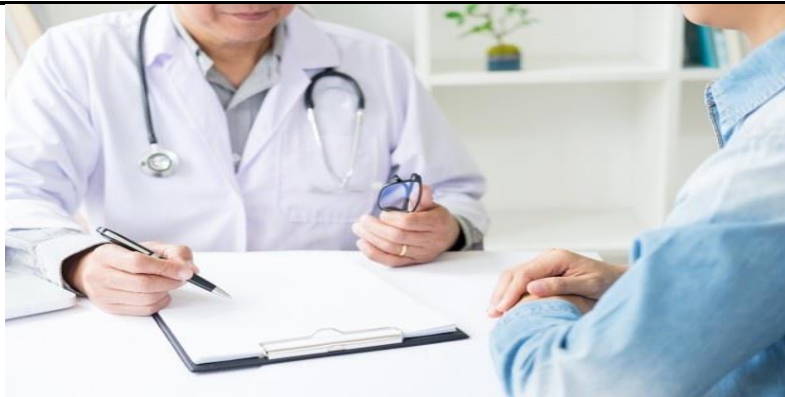
Figure 2: Traditional way of interactions with doctors and patients

It also increased satisfaction of patients by monitoring and reducing time to stay in hospitals. IoT transformed or redefined the entire healthcare by using many devices and providing the opportunities to interact with people. IoT got many applications by providing many benefits for patients, doctors or physicians, hospitals, health insurance companies and for families.

Patients: provides the patients with devices like BP machines, Heart rate monitoring devices, glucometer, wearables' like fitness bands etc., IoT helps to concentrate on elderly patients by monitoring their health issues using above mentioned devices, which provides some kind of alert messages if any various issues arises to patients.

Physicians: Provides the physicians about treatment plans , medical attention towards patients , information collected from IoT enabled devices which helps physicians to provide best treatment and give best recovery medicines.

IoT devices in hospitals contains sensors which are used to track medical equipments like nebulizers, oxygen pumps, wheel chairs etc., It also used in pharmacy inventory control , humidity and temperature control (like ICU) , environmental monitoring etc., A large amount of information that have been guaranteed in healthcare industry will have to follow these steps to analyze the data. Figure 3. This 4-step architecture of IoT in healthcare will take the data and process the data at one stage and send its value to next stage [4].

Figure 3: Architecture of IoT in healthcare

Classifying interconnected devices (monitors, actuators, detectors, sensors) for collecting information or data. Data received from IoT devices, which is analog, converted and collected for further processing of information. Once data converted in to digital form and collected together, it will be preprocessed which makes input data to understand easily and then data will be standardized and stored in cloud or data center.

Finally data will be managed and analyzed as per conditions which are helpful for decision making. IoT has made health care easy and more accessible to patients. In our paper we are mainly focusing on the applications of IoT in healthcare industry. IoT has gained much popularity in many applications in intelligent medicines that includes visualization of material management, Digitization of medical information and medical process.

II. APPLICATIONS OF IoT IN HEALTHCARE

1. **Patient monitoring using smart wheelchair using IoT :**

Figure 4. Smart wheel chairs have been designed to help the patients who are leaving in remote areas where they are leaving far from hospitals. It might be helpful for people who need to travel at-least an hour to reach the hospitals. This system has been designed in such a way that it can send information about patients like blood pressure readings, pulse rate, oxygen transfer rate, body temperature etc., which uses sensors for sending these information to doctors or physicians. These sensors in turn connected over Bluetooth by using micro processors (Raspberry-pi) that uses WLAN or GSM module and connected to cloud which helps to monitor and keep track about patient's health information [5]. Job of wheel chair is to safely deliver to destination. It also accepts users instruction along with that it also need to guide about how to avoid obstacles , route maps or navigations etc., It has been designed to provide safety, comfort to patients and ease of use.

Figure 4: Smart wheelchair using IoT

In this we will have three main parts , they are
 (i) **Sensor module:** It determines attitude and positional information of wheel chair, self positioning information have been provided with encoder, which determines displacement and distance.
 (ii) **Drive control module:** This will have rear wheel configuration of motor about controlling operations like front, back, left and right.
 (iii) **User interface module or human-computer interaction module:** It mainly concentrates on physical activities and controls done using joysticks or personal computers [5].

2. **Tele-Health in Healthcare using IoT**

Figure 5.Tele-Health is providing healthcare services and clinical information to remote places all over the globe [6]. It connects doctors and patients nationwide using internet, video chat, smart phones and electronic medical records (EMR clouds).

Figure 5: Tele-Health in Healthcare

It provides various services like
 (a) **Tele-monitoring:** It collects data of patients using IoT and send that data to healthcare professionals for the purpose of testing and diagnosis which informs patients health information to patients health providers about their health issues.
 (b) **Tele Surgery:** Uses technology called Tele-robotics to enable surgeon to do operation on patients who is staying in remote locations.
 (c) Providing remote medical education to the community from different geographical location.
 (d) Reduces cost which helps in using insurance premiums.
 (e) Using Tele-health, immediate medical attention can be given during emergency and natural calamities.
 (f) Tele-health can also eliminate geographical barriers.

3. **Wearable usage in health care using IoT**

Wearables may be anything which we wear like watches, devices, sweaters, glasses, hats and many more. Without obstructing our daily activities or restricting our mobility this wearable's in healthcare gained much popularity in many fields of monitoring like sports, fitness or many things.
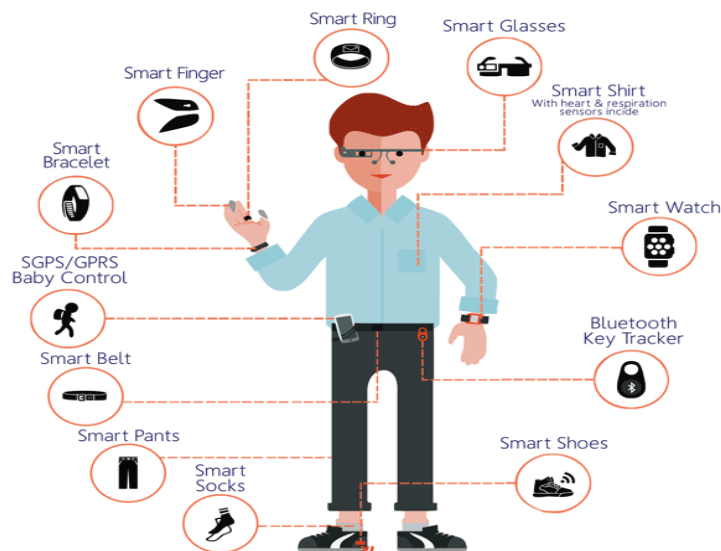

Figure 6: Wearable's usage in health care

These wearable's are based on conventional electronics means strong or bendable with batteries. But only thing still need to be improved in wearables is battery [7]. It also needs to focus on the factors like temperature, humidity and others, Wearable systems used to monitor and track patients health conditions for both who leave in rural areas and cities which reduces cost of healthcare services, reduces work for healthcare providers etc., by improving patients condition. For example in national and international athletes wearing garments which have sensors can improve performance, physiological aspects, body kinematics and their response to stimulated conditions. Wearable usage also helps in assessing and tracking respiratory function of a patients like arterial oxygen saturation, tracking and monitoring respiratory rate and breathing pattern, quality of air, arterial oxygen saturation .

4. **IoT for Health insurance companies**

There are plenty of options for the health insurers with IoT connected devices. These insurance companies can provide the information that has been taken from health monitoring devices for their claiming options. This information that have collected from health monitoring devices are helpful to identify for claims and identify prospects for under writing. These IoT devices helpful in providing the transparency between customers and insurers about pricing, claims handling, risk assessment processes and many others. Figure 8. Insurance companies may also offer certain incentives to the customers for sharing their health information generated by IoT devices. They also honor the customers for using IoT devices to monitor their routine activities and about their treatment plans, precautions given by physicians etc., which helps the insurers to reduce claims. Influence of IoT has replaced long term insurance policies with short term policies which are tuned based on customer needs and also reduce risks of loosing funds [8].
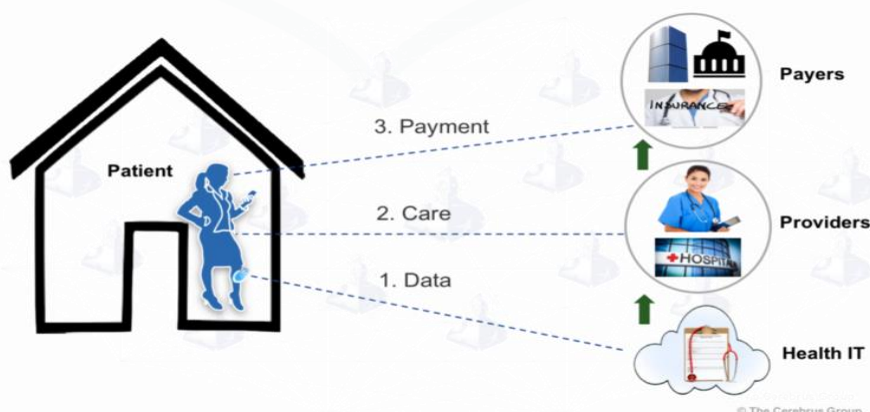

Figure 8: IoT for Health insurance companies

It deals with different processes

(a) **Monitoring:** Tracking patients behaviours, activities and their habits with sensors in wearable smart phones and connected devices by collecting the information and analyzing for decision making.

(b) **Care given by providers :** Analytical tools and Artificial intelligence are used to collect data where in insurers can tell which is the best clinical processes for patient's wellness.

(c) **Payment for payers:** Here many payers may be involved like government, insurance, firms and patients. Industrial IoT provides compensation for services they provide to policy holders.

5. IoT used smart inhalers :

Asthma is one of the leading diseases which are impacting millions of people across the globe. Influence of smart technology is helpful to control symptoms and treat the patient using inhalers [9]. The biggest manufacturer of smart inhalers is propeller which contains a sensor that attaches Bluetooth spirometer or inhaler. It in turn connects to an application and helps the patients to know about their symptoms, track the rescue medications etc., The advantage of using these kind of IoT connected inhaler is to provide the medications more consistently and often these kind of sensors generates the report that can be used to share information about patients to doctors who are staying in remote areas [10].
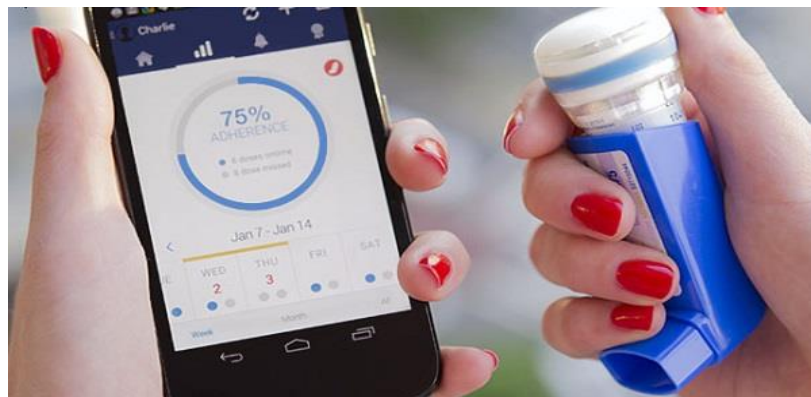
Figure 7: Smart inhalers

Today plenty of devices, machineries, appliances are connecting to internet. Inhaler is a device which provider measures the dosage of the medication to lungs and air pathways. Figure 7.This smart inhaler helps doctor to track inhalation technique and frequency range. Other factors like speed, volume, flow rate, time of inhalation based on patients age and usage. The main advantage of using this device is to help the patients to know their medication routine and allow doctors to track patients remotely (like timings of dosage taken). Patients may forget to take medications to generate reminders which help them to prevent hospitalization.

III. CONCLUSION

IoT has been redefining the entire healthcare industry by using many devices, applications and users to connect and interact with each other for providing better healthcare services. IoT is using tools and medical applications that build an integrated healthcare system for providing better healthcare at reduced costs. IoT is also helpful for healthcare providers including doctors, hospital, clinics to treat patients with appropriate treatment services. As the applications in this paper make us clear that IoT in healthcare will be helpful in increasing needs to digital world.

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