IoT Based Early Warning Model for Healthcare System

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Abstract – As the saying goes, health is wealth, and as the number of various diseases have increased in the past few decades, it is very important to monitor the health of the patients on daily basis. Internet of Things(IoT) has become one of the popular area for various applications. IoT will create technological revolution in a large number of applications, such as, smart living, smart home, healthcare systems, smart manufacturing and environment monitoring and within these, healthcare system is one of the most important challenge that our society faces today. Now a days there is ever growing demand for healthcare system to improve human health. In this paper we have discuss various methods adopted for healthcare issues in the IoT by a number of researchers. The majority of the survey is mainly focused on the different healthcare techniques used in the IoT, such as,Wireless health monitoring, U-healthcare, E-healthcare, Age-friendly healthcare systems and some security techniques for healthcare applications.

Index Terms – Environment Monitoring, E-Healthcare, Smart living, Security Techniques, U-Healthcare.

1. INTRODUCTION

While the networks of associated gadgets are developing and expanding, Internet of Things (IoT) is venturing into every aspects of life. IoT gives a capable and structured approach to enhance health and prosperity of humankind. The consequences of IoT innovations entering to medicinal and healthcare parts are shaping another organized communication route amongst parental figures and patients [1]. In such systems, an arrangement of associated wearable or implantable sensors continuously read patient's essential signs empowering parental figures to access the information through the Internet [2]. IoT-empowered health monitoring frameworks often work in away that wireless body area network (WBAN), which is a set of therapeutic sensors connected to patient's body, records physiological parameters and crucial signs[3] and sends them to a cloud server for additionally handling and capacity.

Considering each sensor in WBAN as an IP-based associated node,an IoT-empowered healthcare framework offers the open door to serve patients requiring constant monitoring outside hospital environment.

It has been accounted for that the quantity of basically sick patients is developing and numerous patients leaving healing center are still at the danger of decay at home [4]. A few of those patients might experience health crumbling when there are some irregular changes showing up in their imperative signs [5].

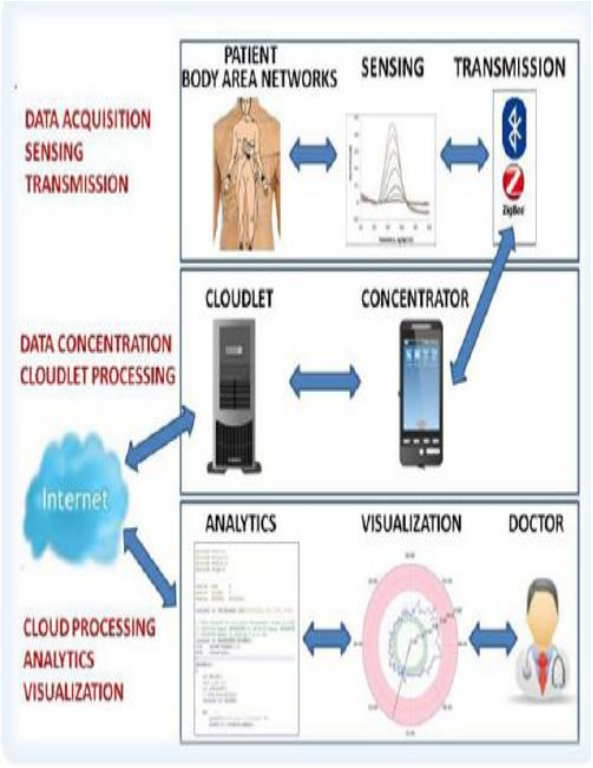

Fig 1 Remote patient monitoring based on IoT-cloud architecture

Keeping in mind the end goal to anticipate health weakening, a strategy called Early warning score (EWS) [6] has been proposed. In this system, medical attendants record the patients' key signs in an observation chart at certain time interims and

relegate a score to the estimation of each sign in its range. The general patient score,which is the aggregate of every individual score, is then used to decide whether the patient is falling apart or not. The process of recording and figuring EWS is generally still paper based and manual in healing facilities. Paper-based and inaccurate data accumulation leads frequently to erroneous estimation of warning score making health specialists to misdiagnose the situation. Furthermore, manual paper-based approach is slow and requires work-time assets frame the parental figures. Recently ,early warning frameworks have started to move toward automated electronic stages. IoT-empowered wearable sensor networks can help the procedure of EWS computerization to be reached out for in-home utilize cases.

In Fig: 1, the architecture describes for a remote health monitoring system. It explains about the major components introduced in the system architecture:

a. **Data Acquisition:** Data Acquisition is executed by several wearable sensors that measures key parameters, for example, skin temperature, respiratory rate, ECG and gait (posture). The sensors associated with the system relate a transitional data, for example collector or concentrator, that is typically an advanced mobile phone arranged inside the neighborhood of the patient.

b. **Data Transmission:** The Data Transmission parts of the framework are responsible for movement of recordings of the patient from the patient's home (or any remote location) to the info center of the Healthcare Organization (HCO) with guaranteed security and protection.

c. **Cloud based data storage:** Cloud based data storage is used in capturing patient's medical information. Since huge volume of data are gathered in cloud it would be difficult for doctors to take a decision, therefore analytics and visualization techniques are used to make data in digestible format.

2. EARLY WARNING SYSTEM

Early Warning System is an approach for early detection of health disintegration to limit the effect of sudden severe changes in health. Such a framework utilizes a process called Early Warning Score (EWS) to compute distinctive scores from patient's perception outline in view of repetitive physiological estimation of crucial signs to determine a composite score which is utilized to distinguish if a patient is at a risk of crumbling. Concentrates in this field have hinted at that patients often have clinical decay up to 24hours before a genuine clinical case requiring a full intervention[7]. The easiest kind of score can be calculate during ve physiological parameters: level of consciousness ,pulse rate, systolic circulatory strain, breath rate, body temperature, and blood oxygen immersion. Each parameter has a greatest score of 3 and a base score of 0from which the last score can be ascertained. Lower scores lead to change in perception recurrence and higher scores results is giving a more elevated amount of therapeutic tend to the patient such as evaluation by health master or exchanging to the intensive care unit.

2.1 System Architecture

The system architecture includes3 main components:

Sensor Network: In the sensor network therapeutic parameters are recorded by wearable sensors. Sensors are categorized into three gatherings in light of their information change rate and their capacity. The primary gathering of sensors includes high date rate sensors utilized for gushing like constant parameters(e.g., ECG flag). The second gathering comprised of sensors that read and record information at a lower information rate such as body temperature and condition sensors. The last aggregate incorporates sensors which are not completely automated and are occasionally utilized by patients or home care givers .The esteems read by these sensors (e.g., circulatory strain) are added to the framework physically.

E-Health Gateway: The portal, gets information from several sensors, performs convention change, and provides some administrations, for example, information pressure and capacity in offline mode. At the entryway layer, there can be two diverse kinds of approaches relying upon the accessibility of Internet connection. If the e-Health door has the Internet get to, it will send the ongoing non-pre-handled signs (e.g., ECG signal) to the cloud server.

In this approach, other information from the main sensor compose can be pre-handled and the numerical results alongside other information from the second kind sensors will be sent to the cloud server. On the off chance that inaccessibility of Internet at the passage, the e-Health portal will store the compressed crude information and aftereffects of neighborhood pre-handling's in its nearby database. When the entryway is reconnected to Internet, it will send first the figured esteems and then compressed crude information bundles to the cloud server.

Back-End System: The back-end framework has two different sections: 1) a cloud-based back-end foundation including data capacity, information examination, basic leadership, and so forth, 2)user interface which goes about as a dashboard for restorative care givers together with performing client control and information perception. The cloud server gets distinctive kinds of sensor data utilizing comparing convention and stores it in the database. At this stage, early warning score is computable when the server has gotten each and every piece of parameters needed for estimation of EWS and in view of the final score, legitimate alarms will _re in the event of crisis. Cloud server is likewise in charge of giving the administration control board to health specialists with continuous health data visualizers and UI for patients and in-home guardians[8]

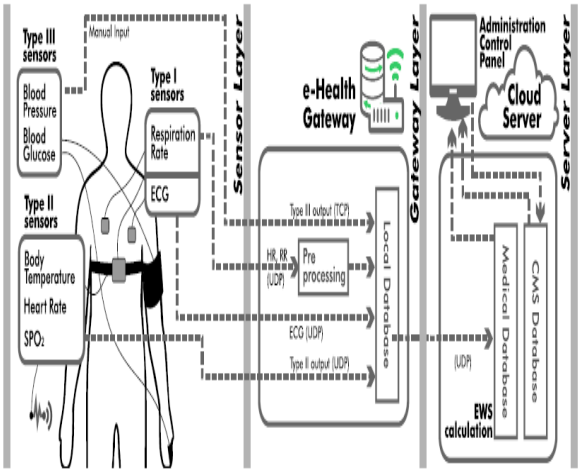

Figure 1: Architecture of the proposed IoT-based clinical early warning system[8]

3. EXISTING TECHNIQUES IN HEALTH CARE SYSTEM

A. Real Time Wireless Health Monitoring: The components of this technique are as follows:

1) ECG Electrodes: It is a gadget appended to specific parts of the patient's body like arms, legs and chest amid testing system. It recognizes electrical driving forces when each time heart pulsates. The power that terminal recognizes is transmitted through wire to a machine, which makes an interpretation of the power into wavy lines recorded on a bit of paper [9].

2) LM35 Temperature Sensor: The LM35 temperature sensors yield voltage is linearly corresponding to the temperature in Celsius.

3) Blood Pressure Sensor: It is a gadget that measures the weight of the blood in the courses as it is pumped around the body by the heart.

4) Blood Glucose Sensor: It is a therapeutic gadget uses to figure the blood glucose level.

5) Microsoft Pro Tablet: It is a versatile PC incorporates show, battery and hardware in a solitary unit.

The framework works as the therapeutic professional utilized three cathodes of ECG on the patient's body and associate the arduino shield with a temperature sensor, a blood glucose level sensor and a circulatory strain sensor. From the arduino shield we interface a wireless node and the Tablet or the Smartphone that has Lab View software running on it to take perusing of the patient's physiological data[10].The information are spared by the time and introduced in a report design and the information is then distributed in the internet by utilizing tablet or cell phone so the patient's report can be gotten to by the approved healthcare people from remote areas whenever[11].

B. U-Healthcare System:

1) Body Area Network (BAN):In this System Sensors are connected to body area to catch bio-signals, circulatory strain, body temperature, heartbeat and relaxing. It additionally isolated into two sections that is, Wireless Body Area Network (WBAN) and Personal Monitoring Devices (PMD). The patient's PMD can be a PC or cell phone. It gets data from WBAN and it contains coordination’s to decide if to send this data to Intelligent Medical Server (IMS) or not through internet.

2) Intelligent Medical Server (IMS): It is a spine of the whole framework and fills in as a center point between the patient and healing facility. In light of the information got from the BAN an operator decides if persistent is in a basic or ordinary condition. In the event that it decides the patient is in a basic condition, the information is exchanged to the healing center framework. On the off chance that it isn't crisis, the information is essentially put away in the IMS.

C. Intelligent E-Health Gateway Based U-Healthcare Systems:

1) Intelligent E-Health Gateway: The principle necessity of a portal is to help distinctive wireless conventions andinter-gadget correspondence. It is utilized to help a few highlights, for example, an incidentally store sensors and clients data by carrying insight and improving with information combination, accumulation, and elucidation procedures by fundamental to give preparatory nearby handling of sensors information to turning into an Intelligent E-health entryway. It gets information from various sub-networks, performs convention transformation.

2) Medical Sensor Network: In universal distinguishing proof and detecting correspondence limit, biomedical and setting signals are caught from the body utilized for treatment and analysis of restorative states. At that point the signs are transmitted to the portal through wired or wireless correspondence conventions, for example, Serial, Bluetooth, SPI, IEEE 802.15.4 or WI-FI. 3) Intelligent Medical Packaging: Some of them senior residents have perpetual illnesses and it is basic to take after the specialist’s recommendation to take their endorsed medication at the correct time. However rebelliousness with pharmaceutical is ending up more common. The levels of resistance might be influenced by mental factors, for example, the patient’s level of tension, state of mind towards their disease, inspiration to recuperate, and the way that numerous senior nationals experiencing amnesia often neglect to take the recommended solution on time. Recommending clinicians every now and again don’t often distinguish or get some information about resistance and are not generally great at perceiving when patients quit taking their prescription. On the off chance that conceivable, it is vital to keep up routine contact with the specialist to talk about, in addition to other things, consistence

issues. A savvy solution organization framework is alluring to auspicious remind and administer the pharmaceutical to people, and meanwhile, enroll and track their prescription history[11].

Infirmity/condition	Sensors used; operations; IoT roles/connections
Diabetes	A non-invasive opto-physiological sensor; the sensor's output is connected to the TelosB mote that converts an analog signal to a digital one; IPV6 and 6LoWPAN protocol architectures enabling wireless sensor devices for all IP-based wireless nodes.
Wound analysis for advanced diabetes patients	A smartphone camera; image decompression and segmentation; the app runs on the software platform in the smartphone's system-on-chip (SoC) to drive the IoT.
Heart rate monitoring	Capacitive electrodes fabricated on a printed circuit board; digitized right on top of the electrode and transmitted in a digital chain connected to a wireless transmitter; BLE and Wi-Fi connect smart devices through an appropriate gateway.
BP monitoring	A wearable BP sensor; oscillometric and automatic inflation and measurement; WBAN connects smart devices through an appropriate gateway.
Body temperature monitoring	A wearable body temperature sensor; skin-based temperature measurement; WBAN connects smart devices through an appropriate gateway.
Rehabilitation system	A wide range of wearable and smart home sensors; cooperation, coordination, event detection, tracking, reporting, and feedback to the system itself; Interactive heterogeneous wireless networks enable sensor devices to have various access points.
Medication management	Delamination materials and a suit of wireless biomedical sensors (touch, humidity, and CO_2); the diagnosis and prognosis of vitals recorded by wearable sensors; the global positioning system (GPS), database access, web access, RFIDs, wireless links, and multimedia transmission.
Wheelchair management	WBAN sensors (e.g., accelerometers, and ECG, and pressure); nodes process signals, realize abnormality, communicate with sink nodes wirelessly, and perceive surroundings; smart devices and data center layers with heterogeneous connectivity.
Oxygen saturation monitoring	A pulse oximeter wrist by Nonin; intelligent pulse-by-pulse filtering; ubiquitous integrated clinical environments.
Eye disorder, skin infection	Smartphone cameras; visual inspection and/or pattern matching with a standard library of images; the cloud-aided app runs on the software platform in the smartphone's SoC to drive the IoT.
Asthma, chronic obstructive pulmonary disease, cystic fibrosis	A built-in microphone audio system in the smartphone; calculates the air flow rate and produces flow-time, volume-time, and flow-volume graphs; the app runs on the software platform in the smartphone's SoC to drive the IoT.
Cough detection	A built-in microphone audio system in the smartphone; an analysis of recorded spectrograms and the classification of rainforest machine learning; the app runs on the software platform in the smartphone's SoC to drive the IoT.
Allergic rhinitis and nose-related symptoms	A built-in microphone audio system in the smartphone; speech recognition and vector machine classification; the app runs on the software platform in the smartphone's SoC to drive the IoT.
Melanoma detection	A smartphone camera; the matching of suspicious image patterns with a library of images of cancerous skin; the app runs on the software platform in the smartphone's SoC to drive the IoT.
Remote surgery	Surgical robot systems and augmented reality sensors; robot arms, a master controller, and a feedback sensory system giving feedback to the user to ensure telepresence; real-time data connectivity and information management systems.

Figure 2: IoT applications in health care

4. CONCLUSION

In this day and age, health monitoring is winding up imperative as there is an expansion in health diagram because of different flighty sicknesses. In this paper we have talked about different a health monitoring frameworks, taking advanced mobile phone as a device. By utilizing such monitoring frameworks, the healthcare experts can screen, analyze, and counsel their patients from a remote area at constantly and specialist or patient can get to report through on the web. Likewise the examination investigations the U-healthcare framework regarding the IoT point of view. U-healthcare framework is the coordination of various innovations and processing framework. These incorporate sensor gadgets to assemble patient's physiological data.This paper additionally talked about some security strategies that are utilized as a part of information security for healthcare applications that can be connected in IoT condition security issues and displayed security keys for symmetric cryptography to guarantee the protection of the WBAN sensors with regards to IoT. It additionally proposes to display the well ordered advancement approach idea in prototyping the Intelligent E-health passage including astute therapeutic bundling and medicinal sensor systems. For reason for exhibiting the attainability of the approach, an exergaming stage and an ailment administration apparatus were utilized as an experiment situation.

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