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RESEARCH ARTICLE

HEALTH CARE DATA ANALYTICS FOR ADAPTABILITY IN E-HEALTH CARE NETWORKS

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ABSTRACT

Health is the essential part of human that individual has to feel, perceive and act effectively. And it is required to provide correspondent ways for proper health care delivery in real time manner. The arrival of new technologies especially the Internet of Things (IoT) Strengthen the health care system through Wireless Sensor Network (WSN). In the current health care environment the IoT enables to connect different stakeholders in the health care system like patients, physicians, hospital, emergency unit and patient well-wishers etc. regardless of their current location. The deploying of sensory devices and microcontrollers into health care system fetches an e-health care system. The existing health care system is usually unacceptable due to high operational cost and inconvenience user interface provided to the user. This paper focuses on implementing an e-health care system that collects the health data and processes it and performs the appropriate analysis to the collected data that enables to take the future decisions about individual patient by tracking and monitoring theirs previous health record.

INTRODUCTION

Internet of Things (IoT) becomes the most emerging technology of the 21st century. The IoT environment enables all the surrounding objects to communicate each other by using some computing capabilities such as transceivers, microcontrollers, sensors etc (Kaivan Karimi and Gary Atkinson, 2013). The characteristics of IoT can be categorized as 6 C's:

- Communication- Any place, Anywhere
- Connectivity- Any path, Any network
- Collection- Any service, Any business
- Convergence- Anything, Any device
- Computing- Anytime, Anybody
- Content- Anytime, Any context

IoT has not yet fixed for particular field and there is no definite boundary for this technology. Thus it has a good productive role in many fields of applications such as transportation, smart grids, smart health, home automation etc. and In health care system contains different wearable and implanted sensors in the system thus it enables to the people to enjoy the health care service by individual from their location itself. The health of individual has mainly focuses on number of projects and different case studies whose goal is to improve the present healthcare system status. A closer look on recent report which is given by United Nations (World Population Ageing, 2013) predicted there will be 22% of world population (approx. 2 billion) older by 2050 and also their research shows that about 89% of aged people are going to live independently and survey on medical research indicates about 80% of aged people older than the age 65 are suffer from at least one of the disease (Weinstein, 2005). Thus the main objective in this health care system case study is to minimize the percentage of people who suffer from any of the disease by navigating people in a proper way by using the concept of internet and its standards the health care system is globally designed in such a way that the system is monitored and controlled from their location (Niewolny, 2013) called e-health care system. The e-health which drives better outcomes and it increases the efficient and by making health care more affordable. Now a days there are many technologies gets evolving day by day and the big data is the technology comes from the concept of managing the huge amount of data which is obtained from different applications in our surroundings ie, e-health system is one among them. The huge amount of data or information which is collected by implanting the different devices into the system such as some sensory devices etc. The huge collect data from the e-health system is going to analyse properly by using different data analytic tools such as Weka, Tableau, KNIME, RapidMiner etc., The analysis results to take future decision about individual health by keep tracking theirs health record which is stored in the cloud. IoT has spreading in many applications and their impact predicted at 2025 by McKinsey Global Institute analysis by considering health care, manufacturing, electricity, urban infrastructure, security, resource extraction, agriculture, retail and vehicle etc. the real time impact of applications (Shown in Fig. 1) from the below report it observes that the impact of IoT in health care application has more among remaining applications (Keat *et*

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al., 2005). And it is predicted that health care application has an impact of $1.1 trillion to $2.5 trillion annual impact on the environment. Thus it is intended to provide the rich platform for the health care by which each normal people can get the treatment easily by communicating with theirs doctor or with physician by keep tracking their previous medical health record. And also corresponding stake holders are gets notified when the patient's health gets upset.

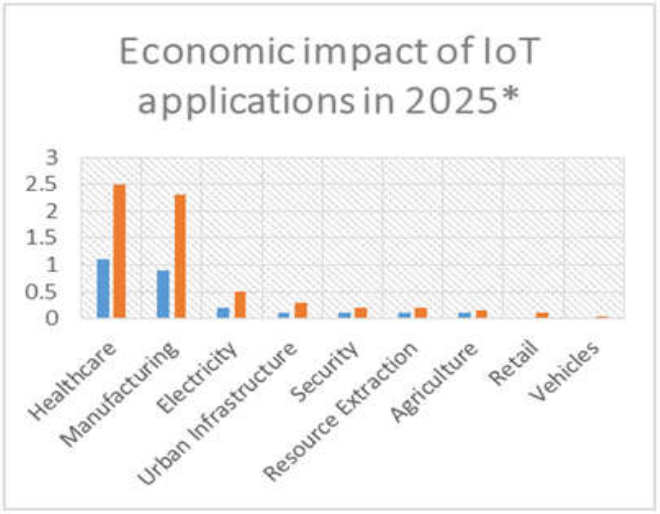

Fig. 1. Economic impact of Internet of Things (IoT) applications. ($ trillion annually)

By considering the people and devices in mind the IoT has given light changes to the current health care system that as shown in below Fig. 2. The patient or patient relatives will get the notification about the health status if any variation found with their health and also they can view theirs own health report and it is possible to communicate with doctors using their smartphones or with computer. And the each patient data is transformed through secured gateways to store in the cloud called IoT cloud thus the stored data is accessed by the desired doctors or by physicians for to give proper services to theirs patients and also cloud data is linked to insurance company and if any sudden death happens to the patient due to uncontrollable high variations in health parameters thus server is going to automatically informs to the registered insurance company to claim the compensation amount.

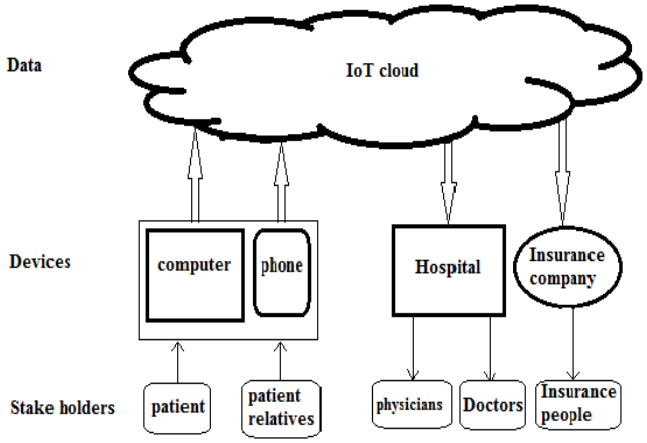

Fig. 2. Internet of Things (IoT) Confluences.

The main functions that e-health includes are (Pang, 2013):

- Monitoring and tracking of individual patient record for their disease.
- Managing of each patient's information.
- Provides the remote services to all desired stake holders.
- Proper data analysis to individual patient information.

The basic elements which IoT consider as the architecture for e-health system are (Tianhe Gong *et al*., 2015; Mukherjee *et al*., 2014; Salvi *et al*., 2007):

- The different sensors which are connected to the sensor shield which collect the e-health data.
- The wearable devices such as Raspberri pi microcontroller which process the collected data and analyse it and allows communicating wirelessly.
- Also microcontroller which provides the rich GUI for each stake holders.
- The e-health specific data which will be sent to the cloud through gateways.
- The huge stored e-health data is analysed properly by using some data analytic tools.
- Proper actions are taken place depending the data stored in the cloud and instantly corresponding stake holders are get notified.

MATERIALS AND METHODS

The main application of e-health system that contains the domain of sensors that attached to the human body (Shown in Fig. 3) that capable of monitoring the patient health parameters continuously. In other words the wearable devices such as sensors and Raspberri pi will continuously monitor the patient's physical and physiological conditions and send the real time sensed data to the cloud via wired or wireless devices ad it is also responsible to protect the stored e-health data of individual (Tianhe Gong *et al*., 2015).

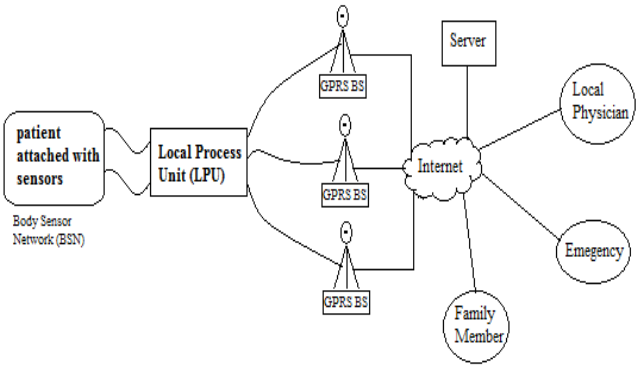

Fig. 3. Secured Modern IoT e-health care system.

In order to build the portable e-health monitoring system by make use of some portable, small, low-powered and light weight IoT devices. Thus Raspberri pi is the perfect platform for to interfacing with many different devices such as sensor shield, display devices etc. The sensor shield is attached to Raspberri pi board and the different sensors that reads the people health parameters like blood pressure (BP), Heartbeat, Electromyography (EMG), Electroencephalography (EEG), Electrocardiogram (ECG) etc., the sensors attached to human

Table. I. Action and Response table using Blood Pressure data

BSN BP Data	Action	Response
BP≤120 and BP≥80	No Action	Null
BP>120	Inform Family Members	FR:T/F
BP>160 and FR:F	Inform Physician	PR:T/F
BP>160 FR:F and PR:F	Inform Emergency	ER:T/F
FR: Family Response	PR: Physician Response	ER: Emergency Response

Fig. 4. Real time Patient Monitoring system

body are called Body Sensor Network (BSN) (Prosanta Gope and Tzonelih Hwang, 2016) (Shown in Fig. 4). The stored e-health data is keep monitoring continuously thus if any variations found in the sensed data then the immediate action will takes place by sending notifications to the patient relatives or by calling ambulance and also immediately notifies the registered doctor. Then the doctors or physicians are allowed to proceed to take care their patient by contacting them.

Sensor shield (Version 2.0)

The shield V2.0 (SSV2.0) provides the capability to connect ten different sensors (e-Health Sensor Platform, 2015) and it performs some biometric and medical applications by monitoring the body parameters through sensors.

- Pulse
- Oxygen in blood (SPO2)
- Airflow (breathing)
- Body temperature
- Electrocardiogram (ECG)
- Glucometer
- Galvanic skin response (GSR- sweating)
- Blood pressure (sphygmomanometer)
- Patient position (accelerometer) and
- Muscle/electromyography sensor (EMG) (Fig. 5)

Raspberri pi (Version 2)

The light weight microcontroller which has a support of 40 General Purpose Input and Output pins (GPIO) used to connect other electronic devices and digital I/O signals.

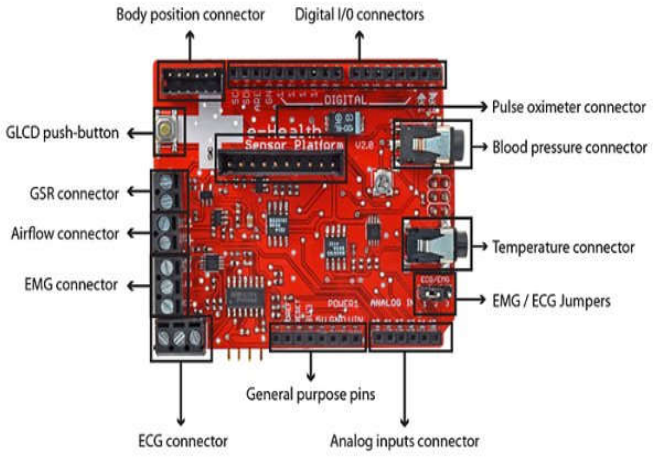

Fig. 5. Internet of Things (IoT) e-health Sensor Shield

The GPIO pins are programmed directly on Raspberri pi using high level programming languages and some other GPIO pins are used as interfaces for embedded protocols for to handle a sensors, relays, status buttons, Analog to Digital converter

(ADC) etc. and Raspberri pi consists of port to connect audio and video jack and as well as it contains the port to insert the SD card to store the data locally. It provides a port to connect some visual displays such as monitor etc. Here Raspberri pi is attached to the sensor shield and display device so that it is capable of reading the health parameters of patient. And has an access to store the sensed data in IoT cloud through secured gteways.

Data Analysis

Each human measure their health status by using e-health system thus each can live happily without any tension. As from the statistics of United Nations there will be 22% of world population older people by 2050 and also it shows that 80% of the aged people whose age is more than 65 are suffer from at least one of the chronic dieses. Thus it's our job to minimize this statistics and the proper precautions needs to be advised to individual human before they affect by any of the dieses. Thus e-health system describes a proper analysis to the stored data (Wullianallur Raghupathi and Viju Raghupathi, 2014). In real time there are many analytics tools present namely RapidMiner, KNIME, Orange, Weka, Tableau etc. the analysis includes analysing of individual collected data in such a way that each stake holder has to get the notifications if any variations found against the standard data and also the doctors can able to predict that till how many days can patient will be remain in hospital by referring the stored e-health parameter values. The analysing of measured data will play a vital role and it must be perfect because the each sensed data from the human body is going to compare with the standard data and it helps to take the further decision about shall himself to concern the doctor are not depending on their health severity level.

Weka Tool

It has an acronym of Waikato Environment for Knowledge Analysis and is one of the data analytic software tool which written in java and it is developed by University of Waikato, New Zealand. It is a workbench it mainly for future data prediction. Weka supports some standard data mining tasks such as classification, data processing, regression, clustering, visualization and future selection. The future prediction is predicted based on the data which is present in the file or cloud. It provides an access to Structure Query Language (SQL) database using java DB connectivity and it process the data which is returned by the SQL query. The user interface of weka is an internet explorer and it fetches the data from the file and it performs some actions and provides a good interface to the user so that it helps for to take the future decision. Weka contains the different panel namely cluster panel, regression panel, classification panel, associate panel etc. the cluster panel provides user interface by grouping of similar data. The regression and classification algorithms provides an estimation of accuracy of results and associate panel allows to access to an association rule learners to identify important interrelationships between data attributes. The sample analysis made by the Weka tool for the given sensed data (shown in Table I). The given data set gives the action table based on the data received from BP sensor. We all knows that healthy human can have normal blood pressure range of 80 to 120. Thus from the table if the blood pressure is in between 80 and 120 it looks to be normal thus there is no action will takes place. Here responses like FR indicates Family Response, PR indicates Physician Response and ER indicates Emergency response. If blood pressure found 120 then the server will automatically call to the family member and infirms about the patient situation and if family member fails to pic the server's call then it return family response false (FR:F) and still the blood pressure is raises to 160 and above then server will proceeds to call to a local physician automatically and still condition of the patient found to be critical and mean while server will repeatedly calls to both physician and as well as family member till to get the positive response from them and if the blood pressure rises to 160 and above server will calls to emergency unit of nearest health care center. Thus the human that is in danger will be cared by at least any of the stake holders. Similarly each sensors which are attached to patient's body are going to collect the data and corresponding actions will be taken care depending the data which sensed from each sensor.

Conclussion

Health is the important issue that everyone has to be taken care. The e-health system will provides a capability of collects the health data from the sensors which are attached to the patient's body and process it and performs appropriate analysis to the stored e-health data and data is protected it has only an access to authorised concern people. The proper analysis is done by using data analytic tool Weka. This analysis enables to take the future decisions about individual patient by tracking and monitoring theirs previous health record. And it gives an idea about to predict the number of days a patient will spend in a hospital for future days.

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