A HOME HEALTH CARE MONITORING SERVICES FOR CARDIAC PATIENTS USING IOT

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***Abstract* - Now a days most of the senior citizens are affected by heart attack. Heart diseases are one typical kind of chronic illnesses with rather high recurrence rate. What's worse, in most cases heart attacks occur suddenly without obvious omens. However, these patients usually live at home rather than stay in hospitals, which makes them far away from medical resources when emergencies happen, as well as leads to a great difficulty for physicians to know the patients' status in time. Consequently, heart diseases have become one of the leading cause of death in china . Mobile and Internet of Things (IoT) technologies have overwhelming superiority in solving the problem of heart diseases patients care as they can expand the availability of medical resources greatly. With wireless sensors and mobile device or laptops, the real-time physical status of patients can be known by the remote physicians no matter where they are or what they are doing. By doing so, not only can the precious rescue time be saved, but also will an opportunity of giving early warnings to heart attacks be provided. Therefore, mobile monitoring systems really do good to life saving of heart diseases patients. In this paper, we propose a mobile monitoring system based on the IoT technology that can send patients' physical signs to remote medical applications in real time.**

***Keywords:* Home healthcare, Internet of Things, Monitoring system, data transmission, Heart diseases**

I. INTRODUCTION

The quality of life of residents is an important objective of smart cities [1], and the daily mobile health-care service becomes more and more important for the solitary people, such as the disabled and elderly people [2]. Chronic diseases such as cardiovascular and cerebrovascular diseases [3] Influence the health of the people living alone in daily life, such as cardiovascular and cerebrovascular diseases affect [4], so that the corresponding motor, sensory and cognitive functions have been lost or compromised, and real-time remote monitoring service is required.

The cardiovascular disease is the foremost cause of death in the United States (US) and Europe since 1900. More than ten million people are affected in Europe, one million in the US, and twenty two million people in the world [5]-[7]. The number is expected to be triple by 2020. The ratio is 17% in South Korea and 39% in United Kingdom (UK) [8]-[9]. The healthcare expenditure in the US is expected to increase from $2.9 trillion in 2009 to $4 trillion in 2015 [10]. The future health crisis attracts the researchers, industrialists, and economists towards optimal and rapid health solutions.

The need for home health care is being driven by several factors [11] including demographic trends; the needs of patient in-home health-care, and changes in health care towards the more cost–effective approaches, such as managed care and other risk sharing systems. Chronic heart disease patients who are in stable condition, belonging to one of four specific risk groups: Arterial hypertensions, malignant arrhythmias, heart failure and post infarction rehabilitation Cardiac disease patient compulsory require their continuous health monitoring. One method to provide home health-care is to use communication technology, *e.g.*, providing an emergency care and health monitoring at home.

Internet of Things (IoT) [12] will be the most sought soon after enabling technology from the domain of Intelligent City. Therefore, distant health-care monitoring services, aided with IoT, tend to be valuable. A remote health monitoring system mainly is made up of portable, wearable and battery pack powered sensing unit that's assigned with the task of sensing a variety of physical parameters of the human body. This unit boasts the responsibility regarding transmit the sensed data for the remote environment with regard to storage and diagnosis in the patient.

II. RELATED WORK

There are various researched works that give attention to providing remote health services by using portable sensors along with communication technologies. A remote health monitoring system using a physician apparatus that interactively monitors the patient's health by asking the sufferer questions and getting answers to those people question, is displayed . A technique of monitoring patients within their own homes using electronic devices and wireless technological is discussed inside.

A centralized checking station that receives a data from remote patients using mobile phone lines and allows medical procedures to be administered and remotely identified. A research in targets optimizing battery inside remote health checking system that works by using smartphone

Our proposed system mainly focuses on the patients with chronic heart disease who are in stable conditions. The major objective of the system is to provide the 24/7 health monitoring. We design the model that efficiently utilized the wearable battery powered sensors unit and fuzzy scheme to diagnosis the health parameter for the chronic cardiac diseases.

Reminder of the paper is organized as follows, it explains the Internet of Things for Healthcare, data collections from the sensors, Model of Fuzzy Expert System, fuzzy scheme for the proposed system, implementation, Inference mechanism and system output.

III. INTERNET OF THINGS FOR HEALTHCARE

The Internet of things (IoT) is the internetworking of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "The infrastructure of the information society". The IoT allows objects to be sense and control remotely existing network infrastructure, creating opportunities for more direct integration of the physical world into computer based systems, resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but it is able to interoperate within the existing internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020. Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications and covers a variety of protocols, domains and applications. The interconnection of these embedded devices is expected in automation of all fields, while also enabling advanced applications like a smart grid and expanding to the areas such as smart cities.

Things in the IoT refers a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, the analyzation devices for environment monitoring or field operation devices that assist fire fighters in search and rescue operations. These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include home automation also known as smart home devices such as the control and automation of lighting, heating like smart thermostat, ventilation, air conditioning systems and appliances such as robotic vacuums, air purifiers, ovens that use Wi-Fi for remote monitoring.

We have proposed a sensor-cloud framework in and some of the challenges are discussed with particular focus on health-care application. This framework lays the foundation of the IoT enabled health-care monitoring system. Here, a system design is presented in that is used for the healthcare management. Our system comprises two part are local and remote. Firstly, the local part deals with collection of information from the sensors connected to a patient, and the remote part enables storing and distributing the data to remote service seekers like emergency service providers, doctors, and insurance providers. Arduino-based data aggregator, Arduino is an open source electronics prototyping platform, is used to collect the sensor-data before sending to the data processing unit.

IV. BLOCK DIAGRAM

Health-care applications need to acquire different types of sensor-data. The sensors-data need to be collected in precise and timely manner. When health sensor-data are forwarded to the data aggregator node, more sensing data may be accumulated along the route. Thus, a huge traffic may be generated during data collection. Handling such a large amount of data while and minimum data loss is challenging. Improper handling may result in unbalanced and inefficient energy dissipation. In most cases, the data is forwarded or collected through multiple hops either in a request-reply manner or in continuous streams.

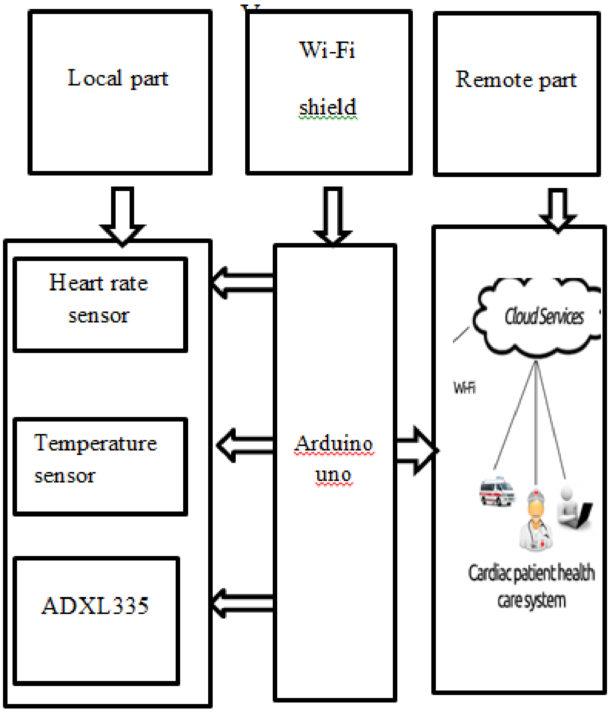

Fig.1.Block diagram of event – driven approach

Furthermore, it has also been observed in the back-end system [21]. Huge amount of data may lead to burdened payload which results in packet fragmentations and due to packet fragmentation, the latency for data collection becomes longer to tackle the above issues, an event driven knowledge collection technique is proposed.

Continuous data collection from the sensors is not required in event-driven approach [23]. Usually, data gathered on occurred fusion center makes the decision. In this scheme, instead of implementing fusion centers, case detection and choice mechanisms are executed by the sensor nodes. Events are defined by means of some threshold values of the parameters.

V. HEART RATE SENSOR

A person's heartbeat is the sound of the valves in his/her heart contracting or expelling activity as they force blood from one region to another. The number of times the heart beats is the heart beat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse.

VI. WAYS TO MEASURE HEARTBEAT

Manual Way: Heart beat can be checked manually by checking one's pulses at two locations wrist (the radial pulse) and the neck (carotid pulse). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiplying that number by 2 to get the heart beat rate. However pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt.

Using a sensor: Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heart beat changes.

An electrocardiograph is a machine that is used to perform electrocardiography, and produces the electrocardiogram. The first electrocardiographs are discussed above and are electrically primitive compared to today's machines. Some indications for performing electrocardiography includes,

- Suspected myocardial infarction (heart attack)
- Suspected pulmonary embolism
- A third heart sound, fourth heart sound, a cardiac murmur or other findings to suggest structural heart disease
- Perceived cardiac dysrhythmias
- Fainting or collapse
- Seizures
- Monitoring the effects of a heart medication (e.g. drug-induced QT prolongation)
- Assessing severity of electrolyte abnormalities, such as hyperkalemia

- Hypertrophic cardiomyopathy screening in adolescents as part of a sports physical out of concern for sudden cardiac death. Pre-operative monitoring is the method in which any form of anesthesia is involved (e.g. monitored anesthesia care, general anesthesia) typically both intraoperative and postoperative. As a part of a pre-operative assessment some time before a surgical procedure , especially for those with known cardiovascular disease or who are undergoing invasive or cardiac, vascular or pulmonary procedures

1.Cardiac stress testing

Computed tomography angiography (CTA) and Magnetic resonance angiography (MRA) of the heart (ECG is used to "gate" the scanning so that the anatomical position of the heart is steady)

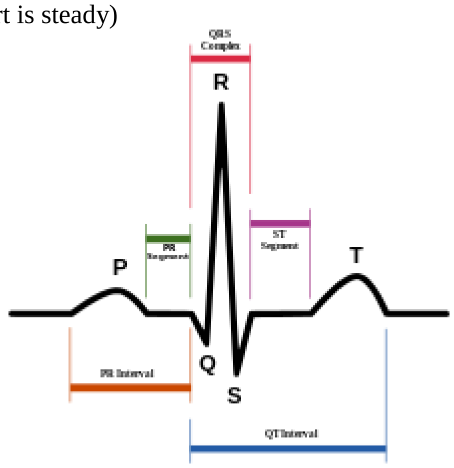

Fig. 2. ECG Waveform

2.Temperature Sensor

LM35 is an analog, linear temperature sensor whose output voltage varies linearly with change in temperature. LM35 is three terminal linear temperature sensor from National semiconductors. It can measure temperature from-55 degree Celsius to +150 degree Celsius. The voltage output of the LM35 increases 10milli-volt per degree Celsius rise in temperature. LM35 can be operated from a 5 volt supply and the stand by current is less than 60uA.

3.Body Position Temperature

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3g. It can measure the static acceleration of gravity in tilt sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

VII. MODEL OF FUZZY EXPERT SYSTEM FOR THE CARDIAC MEDICAL DIAGNOSIS

The modeling of any fuzzy expert system normally contains the following steps: (i) selection of relevant input and output parameters, (ii) selection of proper membership functions, fuzzy operators, reasoning mechanisms, (iii) choosing of specific type of fuzzy inference system, and (iv) formulation of rule base. The Fig. 3 signifies the model of a proposed generic fuzzy expert system and showing the flow of data through the system. Primarily it consists of GUI, knowledge acquisition, knowledge base and inference engine modules.

User can refer and select the relevant clinical parameters and symptoms from the knowledge base to converge to the inference. The knowledge acquisition module allows user to seek the inputs as well as to build the new domain knowledge. The input variables are fuzzified whereby the membership functions defined on the input variables are applied to their actual values, to determine the degree of truth for each rule antecedent. Finally, defuzzification is applied to convert the fuzzy output set to a crisp output. The basic fuzzy inference system can take either fuzzy inputs or crisp inputs, but the outputs it produces are always fuzzy sets.

The defuzzification task extracts the crisp output that best represents the fuzzy set. With crisp inputs and outputs, a fuzzy inference system implements a nonlinear mapping from its input space to output space through a number of fuzzy 'if-then' rules. The average heart rate ranges from 60 to 100 beats per minute. Here, the heart rate parameter range is divided into three fuzzy sets, namely, 'low', 'medium' and 'high'. Range of value and fuzzy sets of heart rate & Body Temperature is shown below.

Input	Range	Fuzzy Sets	Diagnosis
Heart rate	< 100	Low	Bradycardia
	90 – 150	Medium	Normal
	140 >	High	Tachycardia

Input	Range	Fuzzy Sets	Diagnosis
Body Temperature	<35.0˚C (95˚F)	Below Normal	Hypothermia
	36.0 -37.5˚C (97.7-99.5˚F)	Normal	Normal
	>37.5 -38.3˚C (99.5-100.5˚F)	High	Fever or Hyperthermia
	>40.0 -41.5˚C (104.5-106.7˚F)	Very High	Hyperpyrexia

Fig.3. Fuzzy sets of heart rate & Body Temperature

VIII. CONCLUSION

Given the nature of Cardiac patient's disease, the physical conditions information is necessary for determine the required actions to be taken by the health practioners's. Upon timely and accurate information availability can ensure efficient intervention. Benefiting from using of fuzzy techniques such health monitoring system can be used to overcome the traditional limitations of ambiguity and less efficient monitoring system. In our proposed healthcare model, we have attempted to fulfill the gap. Proposed system model is a fuzzy logic based home healthcare system for cardiac patients. Step by step diagnosis and detection of physiological stages of patient body is promising way to avoid unnecessary data collection. This way saving valuable energy of a portable monitoring device can be achieved. The generation of accuracy of knowledge can enhance performance of whole system. The proposed system constitutes an effort toward the design of an intelligent, flexible and integrated fuzzy logic based home healthcare system.

Our hypothesized system can be augmented further practical research and possible better enhancements could be introduced when applied in adopted in real world situation.

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