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Internet of Things applications in Healthcare

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Abstract— The Internet of Things (IoT) is fundamentally a system which contains smart objects with different sensors, networks, and processing technologies. IoT is regarded as to change the way internet works and carries altogether the areas like machine-to-machine communication, artificial intelligence, big data etc. to work underneath the same umbrella such that cyber space and human (physical systems) are more entangled and hence offers ubiquitous computing giving rise to cyber physical systems. Hence IoT is an integrated system working collectively to provide smart services to the end-users. IoT offers great benefits to us. It provides an environment where smart services are provided to use any activity anytime & anywhere. These smart services are provided through different applications running in the IoT environment. IoT applications examine & consequently help in quick decision-making process for client management. In the present work, application of IoT in the field of healthcare systems is discussed. In any healthcare system, the use of IoT technologies brings convenience to both physicians as well as patients. IoT applications assist in various medical areas like continuous real-time monitoring, management of patient information, management of blood banks etc.

Keywords**—**IoT, Quality of Service (QoS), Sensor, Arduino.

1. INTRODUCTION

Big data technologies like IoT and machine learning [14, 15, 16, 17, 18, 19] are important & recent research domains in modern times. The IoT can be defined as a technology that is a combination of human beings, physical objects such as sensors, actuators, controllers, computing, devices, storages and internet. Now days IoT technology is prevalent in all fields including home, schools, universities, precision agriculture, healthcare systems [20], industries and different factories, smart cities etc [1]. Many smart features like generation and consumption of big data, various online services, improve our day today life and different activities all over the world with the help of IoT [2]. Various facilities and smart services execute with the help of several applications executing in the IoT environment [3]. With increasing user requests, advanced applications for examining, managing, and powering human activities are provided [4, 5]. IoT applications also use cloud computing services to achieve appropriate composite services by the composition of present simple services for service-based applications [6, 7]. IoT setups are applied to applications through smart devices and users apply them to regular activities in different places. IoT applications also have the advantage of choosing the best chance for the users, irrespective of whether they agree, manage, or control environmental cloud resources[8]. IoT is all about improving the quality of our life by offering smart services [9, 10]. One of the important objectives of IoT applications is fulfilling QoS metrics. All essential user requirements which envelop QoS metrics like cost-effectiveness, good service time, security, low energy consumption, reliability & availability must be offered through IoT applications [13]. But till date there are very less technical research & review articles that focus on IoT applications systematically [11,12]. In the present work we suggest use of IoT in healthcare systems. A simple healthcare system consists of health sensing parameter which is used to converse with a portable computer such as tab or a smart phone which has the basic capability of communicating with the cloud (hospital database). Nowadays people have access to handy communication devices, and these devices have become quite affordable. Any healthcare system can thus be made IoT enabled and machine to machine compatible.

In the same way a reliable healthcare system can be developed with the help of sensors. Each sensor should timely access the data following the recommended sampling rate of the parameter, and the data should be sent to the data processor without any overlap. Each sensor has changing requirements in terms of data length or size.

Nowadays monitoring our family becomes a tedious task in our day to day life. Keeping track of the health status of the patient at home is also a time consuming task. Particularly elderly family members should be occasionally monitored and their family members need to be timely updated about their health status while at work.

2. IoT BASED HEALTHCARE SYSTEM COMPONENTS

The proposed IoT Based Patient Health Monitoring System using Arduino is shown in Fig. 1. The system employs sensors to monitor patient's health. Blood pressure, PIR and heart beat sensors measure respective parameters of the patient. These sensors are attached to Arduino to monitor the patient's health status. It uses internet to update patient's family members in case of any critical condition. If the system notices any abrupt change in patient's heartbeat or body temperature, the system automatically aware the user about the patient's status through IoT. The Arduino processes and executes the code and displays it to 16*2 LCD Display. The WiFi module connects to the WiFi and transmits the data to IoT device server. Consequently, the data can be examined from any part of the world by logging into the IoT server channel. The system presented also demonstrates the patterns of heartbeats and details of temperature of patient live over the internet.

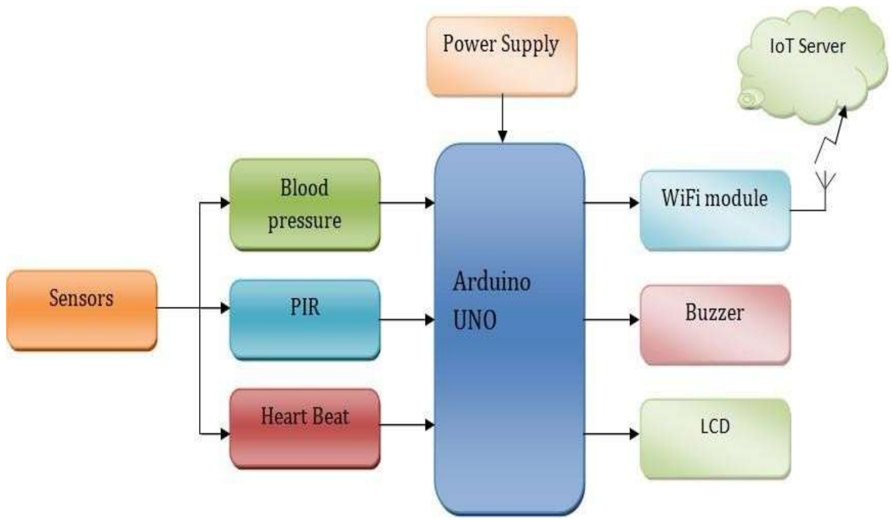

Fig.1 – Block diagram of healthcare system using IoT.

Thus IoT based Healthcare Monitoring system efficiently uses the internet to examine patient health status and save lives on time. The components of proposed healthcare system include -

A. Arduino

It is a microcontroller board based on the ATmega328P. It consists of 14 digital input/output pins (out of which 6 can be employed as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It consists of everything needed to assist the microcontroller. One simply needs to connect it to a computer through a USB cable or power it by a AC-to-DC adapter or battery to get started.

B. Blood Pressure Sensor

It is based on the oscillometric method. This method takes the benefit of the pressure pulsations taken at the time of measurements. The principle is that cuff is inflated till a pressure larger than the typical systolic value is reached, then the cuff is slowly deflated.

C. Heart Beat Sensor

It is sensed by using a large intensity type LED and LDR. The finger is placed sandwiched between the LED and LDR. Here as a sensor photo diode or a photo transistor may be employed. The detectors photo current (AC Part) is changed to voltage and intensified via an operational amplifier (LM358). The output is sent to a different non inverting input of the same LM358. This time the second amplification is done. The value is preset in the inverting input. Thereafter a comparison is performed between the amplified value and the preset value. In case of any abnormal condition, it will generate an interrupt to the controller.

D. Passive Infra-Red Sensor

A Passive Infra Red sensor (PIR sensor) is shown in Fig 2. an electronic device that is used to measure Infra Red (IR) light radiating from objects in its field of view. PIR sensors are frequently used in the construction of PIR-based motion detectors.

Fig.2 – A PIR sensor.

A. Power supply

The Arduino Uno board can be powered through the USB connection or by an external power supply. The power source is chosen mechanically. External (non-USB) power may come either from an AC-to- DC adapter (wall-wart) or battery.

The ATmega328 contains 32 KB (with 0.5 KB occupied by the boot loader). It also consists of 2 KB of SRAM and 1 KB of EEPROM (which can be read and written through the EEPROM library.)

C. Buzzer

Additional parameters can be sensed as per the availability of sensors or recent development in biomedical trend. A graphical LCD may be employed to represent a graph of rate of change of health parameters over a time period. The entire health monitoring system proposed may be integrated into a little compact unit as minute as a cell phone or a wrist watch. This will assist the patients to easily hold this device with them wherever they move. In addition to medical application, the proposed system can be used in industrial and agricultural applications by using sensors like humidity sensors, fertility check sensors, etc.

Buzzers such as TMB-series are magnetic audible signal devices using built-in oscillating circuits. The construction joins an oscillation circuit unit by a detection coil, a magnetic transducer and a drive coil. Transistors, resistors, diodes and other little devices act as circuit devices for driving sound generator.

D. Liquid Crystal Display

The Arduino used in the system processes the code and displays it to 16*2 LCD Display.

3. CONCLUSIONS

The healthcare services are vital part of our society. The transparency of proposed healthcare system assists day today patients to trust it [20]. The present work presented a system consisting of proposed method consists of sensors for PIR, heart beat and blood pressure to evaluate the condition of the patient under observation. The presented system addresses the patient monitoring through sensors. The IoT based system presented is generalized so far, and it is probable to customize it for more critical circumstances like operation theatre, intensive care unit patients, newborn babies, and more complex patients. The presented system is cost effective also as it reduces the healthcare costs by reducing the physician(s).

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