IoT BASED SMART HEALTH MONITORING SYSTEM: A RECENT APPROACH AND ANALYSIS

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ABSTRACT

In India, near about 20% of the total population loses their lives due to interrupted health monitoring system i.e., in most of the hospitals doctor visits patient either in morning shift or in evening shift or in both shifts. What happens if patient's health becomes critical in between that interval or when a doctor is not available with a patient? The answer is; a patient may lose his/her life. So to avoid this critical situation; A patient monitoring system is proposed by using IoT that monitors the patient using the sensor data and triggers a notification to the corresponding doctor in case of a emergency situation. The data of each patient is collected and stored for prediction purpose. This helps in increasing the health care of the individual. The patient's caregivers and family members can ubiquitously monitor the videos and physiological records of the patient's rehabilitation situation via the handheld mobile devices via the internet or wireless communication networks. This system is efficient with low power consumption capability, easy setup, high performance and time to time response. The security issue has been addressed by transmitting the data through password protected with GPRS and the users/doctor can access the data by logging to the web page.

KEYWORDS: *Internet of things (IoT), sensors, patient monitoring, prediction, diagnosis, health care.*

1. INTRODUCTION

In our day-to-day life we are always busy with some responsibilities. It is tough to watch a person who is unhealthy. In order to overcome this problem an IoT is adopted. Internet of things (IoT) is an advanced area which includes embedded technology, wireless sensor network, artificial intelligent and machine learning etc. to intercommunicate things. Today internet has become one of the important parts of our daily life. It has changed how people live, work, play and learn. Internet serves for many purpose like education, finance, business, industries, entertainment, social networking, shopping, E-commerce etc. The next new trend of internet is internet of things (IoT). IoT improves user convenience and also enhances data collection. To improve existing medical systems IoT is applicable. In WN, deployed wearable sensors senses health conditions like pulse rate as well as heart rate, respiration level and temperature using IoT exploited devices circuits. The information is send to the cloud. As a result, patient's doctor can see his current health condition irrespective of the time and place. In case of any abnormality or critical condition in the patient's data an emergency alert of the patient's health condition is automatically send to the doctor through an email notification. The doctor can thus monitor his patient from anywhere without the need to visit him and also help the patient to view his health condition without visiting the doctor each time. Hence the time of the doctor and the patient is saved and thereby greatly improving the health care process.

2. METHODOLOGY

2.1. HEALTH MONITORING SECTION

This module comprises the hardware component of the system that makes it IoT enabled and is used to record the health parameters of the patient using various sensors. The following sensors are temperature sensor, heartbeat sensor and respiratory sensor. Here, PIC microcontroller acts as a central server to which all the sensors are connected.

2.2. EMERGENCY ALERT SECTION

This module particularly deals with the steps to be taken after an abnormality is detected in the health of patient such as notifying his/her family members as well as hospital. The following values in our program which if crossed will trigger an alert in the form of email to the patient family/doctor. The following alert messages in the form of buzzer, information stored in the cloud.

2.3. HEALTH STATUS PREDICTION SECTION

This is one of the most promising modules of our system. In this module, we use the patient health data as recorded by our system along with any symptoms they may be feeling by asking a few simple questions and compare it with the existing knowledge based to predict if any disease/disorder the patient may have making it an efficient expert system with proper data mining techniques**.**

2.4. BLOCK DIAGRAM

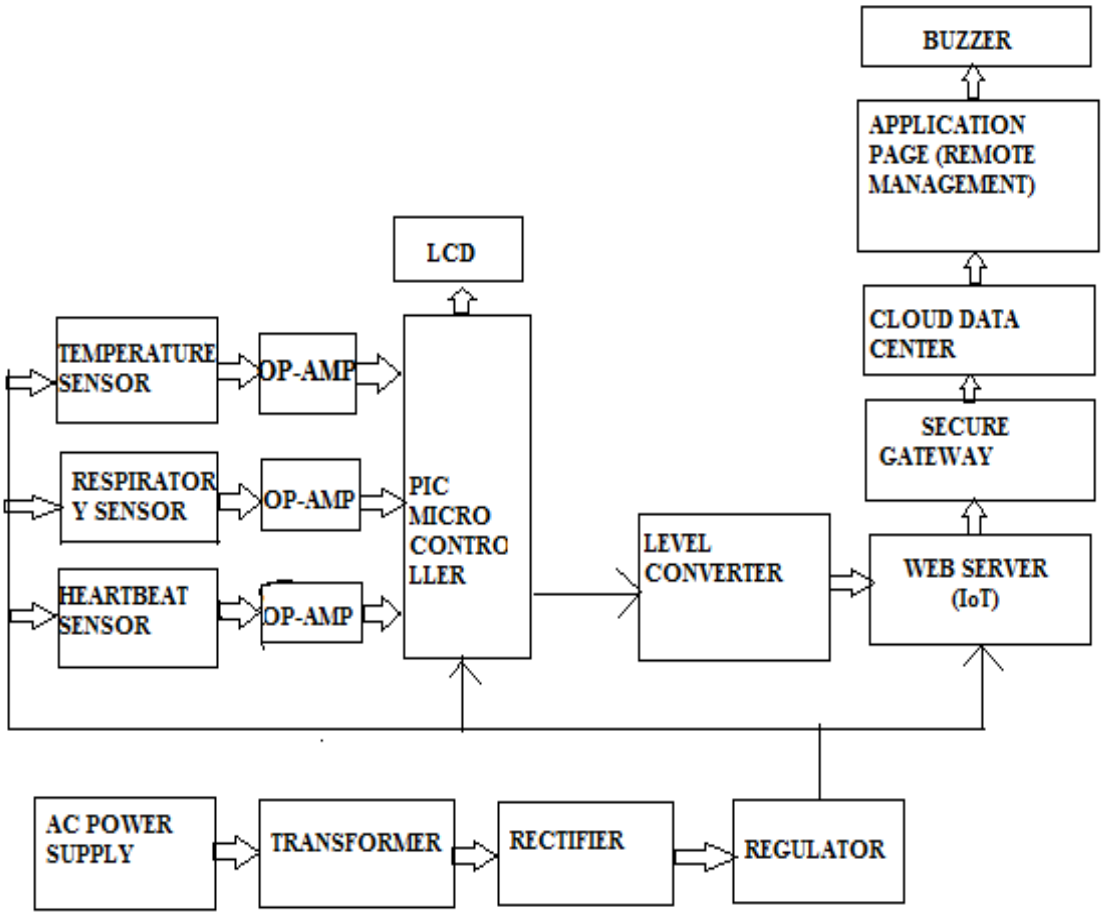

Fig.1.Block Diagram

3. BLOCK DIAGRAM COMPONENTS

3.1. AC POWER SUPPLY

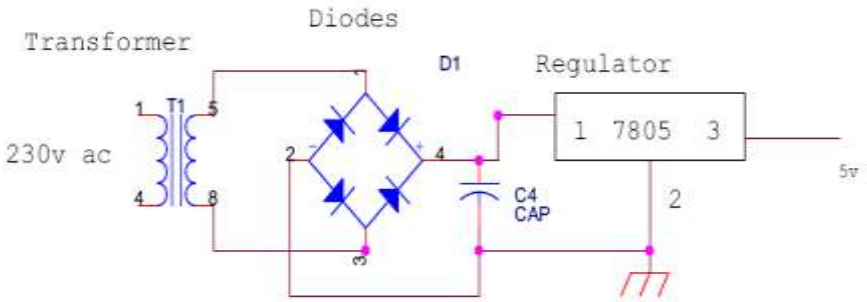

Fig.2 AC power Supply

The power supply will employ a transformer to convert the input voltage to a higher or lower AC voltage. Hence, it required stepping down the high AC voltage around 230V to 5V for measuring voltage using microcontroller's .The difference amplifier or potential transformer is used to step down the voltage and then by using analog to digital converter or rectifier the voltage reading is displayed on LCD display.

3.2 TRANSFORMER

Transformers are devices used in electrical circuits to change the voltage of electricity flowing in the circuit. A step down current transformer is used to convert high current into low current for the use of different electrical circuits. The step down transformer is used to step down the main supply voltage from 230V AC to lower value.

For example: if our equipment has been specified for input voltage of 5volts and the main power supply is 230volts,we will need a step down transformer, which decreases the incoming electrical voltage to be compatible with your 5V equipment.

3.3. RECTIFIER

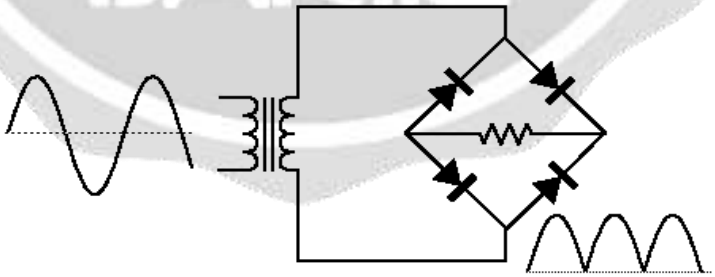

Fig.3. Bridge Rectifier

A Bridge rectifier is an Alternating Current (AC) to Direct Current (DC) converter that rectifies mains AC input to DC output. Bridge Rectifiers are widely used in power supplies that provide necessary DC voltage or the electronic components or devices. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a center-tapped transformer design.

3.3.1. Input Filter

Capacitors are used as filters. The ripples from the DC voltage are removed and pure DC voltage is obtained. And also these capacitors are used to reduce the harmonics of the input voltage. The primary action performed by capacitor is charging and discharging. It charges in positive half cycle of AC

voltage and it will discharge in negative half cycle. So it allows only AC voltage and does not allow the DC voltage. This filter is fixed before the regulator. Thus the output is free from ripples.

There are two types of filters. They are

1. Low Pass Filter(LPF)
2. High Pass Filter(HPF)

1. LOW PASS FILTER

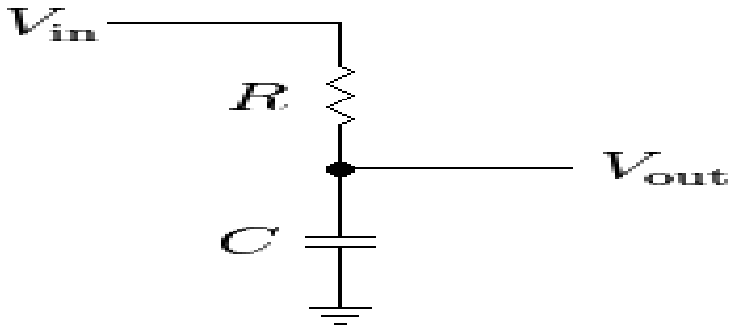

Fig.4.LPF

One simple electrical circuit that will serve as a low pass filter consists of a resistor in series with a load, and a capacitor in parallel with the load. The capacitor exhibits reactance, and blocks low-frequency signals, causing them to go through the load instead. At higher frequency the reactance drops, and the capacitor effectively functions as a short circuit. The combination of reactance and capacitance gives you the time constant of the filter $\tau = RC$.

2. HIGH PASS FILTER

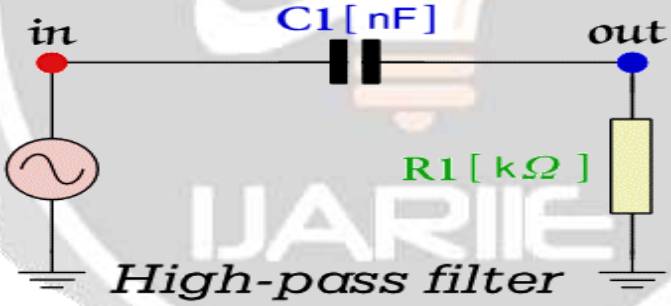

Fig.5.HPF

The above circuit diagram illustrates a simple 'RC' high-pass filter. We should find that the circuit passes 'high' frequencies fairly well, but attenuates 'low' frequencies. Hence it is useful as a filter to block any unwanted low frequency components of a complex signal while passing high frequencies.

3.4. REGULATOR

Fig.6.7805 Regulator

Regulator regulates the output voltage to be always constant. The output voltage is maintained irrespective of the fluctuations in the input AC voltage. As the AC voltage changes, the DC voltage also changes. Thus to avoid this regulators are used.

3.4.1. Output Filter

The Output filter is often fixed after the regulator circuit. The capacitor is often used as a filter. The principle of the capacitor is charge and discharge. It changes during the positive half cycle of the AC voltage and discharges during the negative half cycle. So it allows only AC voltage and does not allow the DC voltage.

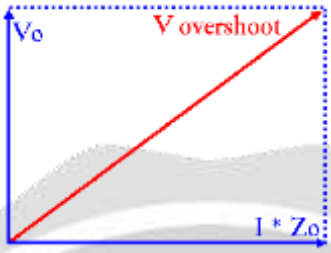

Fig.7. Output Filter

This filter is fixed after the Regulator circuit to filter any of the possibly found ripples in the output received finally. Here we used 0.1micro farad capacitor. The output at this stage is 5V and is given to the microcontroller.

3.5. TEMPERATURE SENSOR

Fig.8.LM35 Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius temperature. The LM35 has an advantage over linear temperature sensors calibrated in degree Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling. The LM35's low output impedance, linear output and precise inherent calibration make interfacing to read out or control circuitry especially easy.

3.6. RESPIRATORY SENSOR

Fig.9.Respiratory Sensor

The Respiratory sensor is used to monitor the abdominal or thoracial breathing in bio feedback applications such as stress management and relaxation training. Besides measuring breathing frequency, this sensor also gives you an indication of the relative depth of breathing. The Respiration sensor is usually placed in the abdominal area, with the central part of the sensor just above the navel. The sensor should be placed tight enough to prevent loss of tension. The respiratory sensor process consists of inhalation and exhalation process. The oxygen is diffused into the blood and carbon dioxide is diffused out of blood.

3.7. HEARTBEAT SENSOR

Fig.10. Heartbeat Sensor

A person's heartbeat is the sound of the valves in his/her's heart contracting or expanding as they force blood from one region to another. The number of times the heart beat per minute (BPM), is the heartbeat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse. The following heart rate can be measured by two ways as manual way and using a Sensor. In manual reading the heart rate is calculated by radial pulse and carotid pulse. By using 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.

3.8. OP-AMP

The operational amplifier consists of two inputs and two outputs namely, inverting and non-inverting terminals. This IC741 is most commonly used in various electrical and electronic circuits. The main intention of this 741 op-amp is to strengthen AC and DC signals and for mathematical operations. It is used to amplify and sense the low values.

3.9. PIC MICROCONTROLLER

Pic microcontroller was developed in the year 1993 by microchip technology. It is defined as Peripheral Interface Controller (PIC).Initially it was developed for supporting PDP computers to control its peripheral devices, and therefore, named as a peripheral interface device. These microcontrollers are very fast and easy to execute a program compared with other microcontrollers. The PIC microcontroller is the smallest programmed device to carry out a vast range of tasks. It can serve as a central server by connecting all sensors. It is found in many electronic devices like phone, alarm system, embedded system. PIC microcontroller architecture is based on Harvard architecture. PIC microcontrollers are very popular due to their ease of program, wide availability, easy to interfacing with other peripherals, low cost, large user base and serial programming capability (reprogramming with flash memory).

We know that the microcontroller is the integrated chip which consists of CPU, RAM, ROM, Timers and counters etc. In the same way, PIC microcontroller architecture consists of RAM, ROM, CPU, timers, counters and supports the protocols such as SPI, CAN and UART for interfacing with other peripherals. At present PIC microcontrollers are extensively used for industrial purpose due to low power consumption, high performance.

3.10. LIQUID CRYSTAL DISPLAY

Fig.11.16X2 LCD

A Liquid Crystal Display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amount of electric power. It consists of two electrodes and two polarizing filters.

Before applying an electric field, the orientation of the liquid crystal molecules is determined by the alignment at the surfaces. In a twisted pneumatic device, the surface alignment directions at the two electrodes are perpendicular to each other, and so the molecules arrange themselves in a helical structure.

When a voltage is applied across the electrodes, a torque acts to align the liquid crystal molecules parallel to electric field, distorting the helical structure.

3.11. LEVEL CONVERTER

UART stands for Universal Asynchronous Receiver/Transmitter.

It is a very popular serial communication interface which provides full duplex communication between two devices. UART uses two data lines for sending and receiving data. Some of the microchips PIC microcontroller has built in USART module.

3.12. WEB SERVER

The aim of HTTP protocol is to allow the transfer of HTML files between a browser in the client and a web server where the data is locate. In this case server will be the microcontroller. IoT is used as a web server.

3.13. SECURE GATEWAY

A secure web gateway is primarily used to monitor and prevent malicious traffic and data from entering, leaving on organization's network. Typically, it is implemented to secure an organization against threats originating from the internet, websites and other web 2.0 products/services.

3.14. CLOUD DATA CENTER

The following data can be stored in cloud network to monitor the health condition of the patient. If any abnormality is detected the following information can be stored in cloud

3.15. APPLICATION PAGE

The following user name and password of the patient can be given by the hospital, which is used to monitor the health condition. It can be applicable for n number of patients. Those following information can be known by patient's family, doctor and hospital in charge

3.16. BUZZER

Buzzer is also known as beeper. There are many kinds of buzzer are available to alert the patient's health, they are electrical, electromechanical, piezoelectric. Among these piezoelectric buzzer is used.

4. FUTURE SCOPE

Monitoring the patient's condition can be done by using biomedical telemetry method where there is a mobile communication between microcontrollers. The temperature, heart beat and respiration are all sensed by using the appropriate sensors which are placed near the patient's body that is under investigation. The biomedical telemetry system consists of temperature sensor, heart beat sensor, pressure sensor, A/D converter, signal conditioning circuit, microcontroller, data cable, mobile phone, LCD display. This unit delivers a train of pulses to microcontroller and the value gets displayed using LCD display.

5.CONCLUSION

This indeed is an easy, practical, inexpensive and yet very effective way. The proposed Remote patient monitoring system is integration of embedded and web application, provides a platform in cost efficient manner, solution for patient and doctor located at a remote location. The doctor can come up to a conclusion by examining and monitoring the health parameters of the patients at remote locations .The abnormal change in values of patients health parameters can alert the doctor and help in taking the necessary actions that are possible . A Remote health care provides real-time reading of vital parameters of patients along with its demographics, which will help in patient health diagnosis and in critical health conditions.

6. ACKNOLEDGEMENT

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