Real Time Embedded Health Monitoring System using Li-Fi

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***Abstract*: LiFi is a wireless optical networking technology that uses light-emitting diodes (LEDs) for data transmission. LiFi is designed to use LED light bulbs similar to those currently in use in many energy-conscious homes and offices. However, LiFi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. LiFi data is transmitted by the LED bulbs and received by photoreceptorsIn today's world, technology plays an important role in every industry as well as in our personal lives. Out of all of the industries that technology plays a crucial role in, healthcare is definitely one of the most important. This merger is responsible for improving and saving countless lives all around the world.Medical technology is a broad field where innovation plays a crucial role in sustaining health. Areas like biotechnology, pharmaceuticals, information technology, the development of medical devices and equipment, and more have all made significant contributions to improving the health of people all around the world.**

Keywords: Health Monitoring, Light Fidelity(Li-Fi),ARM7,ECG, Accelerometer.

I. INTRODUCTION

Constant monitoring of patient's health condition in hospital is either manual or Wi Fi based system. Wi-Fi based system is became slow in speed due to exponentially increased scalability. In this scenario, Li-Fi finds the places wherever Wi-Fi is applicable with additional features of high speed data network. Apart from the speed factor, Li-Fi is more suitable in hospital application for monitoring the patents' conditions without frequency interference with human body. This paper proposes an application of Li-Fi network in hospital for monitoring the patients' conditions such as temperature, pressure, heartbeat, glucose level and respiratory conditions by using respective sensors. The collected data from the sensors is transmitted to the sink and further these data are processed using microcontroller and sent to display unit in the form of graphs or charts. Based on the concept of visible light communication, a prototype model is built with the PIC microcontroller and basic sensors as peripherals and tested it's working. Thus the application of Li-Fi as a health monitoring system demonstrated experimentally.

Embedded technology can be found inside everything from computerized fitness equipment to lifesaving medical monitoring devices. These systems used in medical care increasingly help to improve the quality ofdiagnostic tools available to physicians and treatment available to patients. With the help of heart beat sensor we can monitor the rates of the heart every second. To measure the low &high blood pressure we using blood pressure sensor. As well as we collect temperature variations and body moments sudden changes or motions in the patient's body .These data's can be transmitted through the Bluetooth, which is received by the smart phone. So these mobile communications to portable to be used everywhere.

II. BLOCK DIAGRAM

This system can be represented by the block diagram shown in fig.1. This work is aimed at producing a cost effective, smart, secured and safe health monitoring system. We have built a prototype model which as shown in above block diagram. Following is the hardware description.

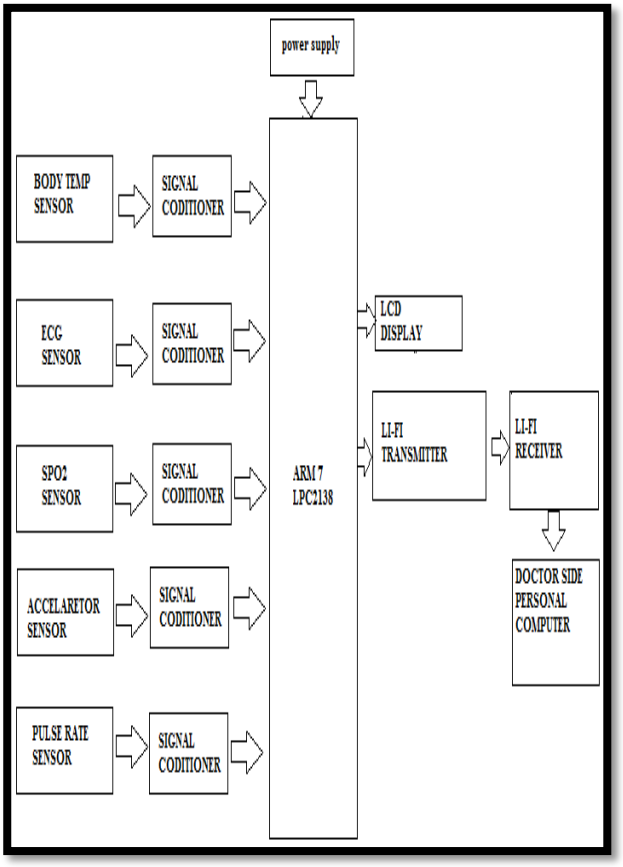

Fig.1. Block Diagram of whole system

III.COMPONENTDESCRIPTION

1.ARM7module: ARM7 LPC2138controller is used in this project with interfacing of sensors and LCD along with Bluetooth. Controller is configured with 64 pins in QFP (Quad Flat Package) with 512k Flash memory and 32KB RAM 2 I/O ports of 32 bit wideIt is also used to get input from various sensors and

then uses it to process for monitoring system and gives processed digital signal to life transmitter . It needs 3.3V to drive the module.

2. Power supply unit:It requires 3.3 V for ARM 7 module and for other sensors like ECG, LM35, SpO2, Accelerometer and pulse rate etc requires 5V. So to do this we will have to build variable power supply unit using voltage divider circuit and regulator ICs like regulator IC 7805 and amplifier 317.

3. ECG sensor:ECG records the electrical activity generated by heart muscle depolarization, which propagate in pulsating electrical waves towards the skin. ECG electrodes are typically wet sensors, requiring the use of a conductive gel to increase conductivity between skin and electrodes.

4. Sp02 sensor:The pulse oximeter **works** out the oxygen saturation by comparing how much red light and infra red light is absorbed by the blood. Depending on the amounts of oxy Hb and deoxy Hb present, the ratio of the amount of red light absorbed compared to the amount of infrared light absorbed .

5. Accelerometer:It is actively used recording such as walking and running are detected from the body movements are recorded by the accelerometer sensor. ADXL335 is used for wireless communication between sensor and base station. If any abnormality occurs at server
then the alarm condition sends to the doctor' Personal Digital Assistant (PDA).

6. LM35 Temperature sensor:The LM35 sensor series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.
The LM35 series are precision integrated- circuit LM35 temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 sensor thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling.

7. LED:Information such as biomedical signals and patient information are transmitted via the LED lighting. A small and portable receiver module is designed and developed to be attached to the device, providing a seamless monitoring environment.

8. Pulse rate sensor:This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at eachpulse.This pulse sensor fits over a fingertip and uses the amount of infrared light reflected by the blood circulating inside to do just that. ... When the heart pumps, blood pressure rises sharply, and so does the amount of infrared light from the emitter that gets reflected back to the detector.

9. LM35 Heart beat sensor: A pair of LED and LDR is used to calculate the heart beat rate of a human body depending on the blood pumping and circulation motions and gives information in terms of voltage signal. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. sensor will identifies the changes in environment temperature and gives information in terms of voltage signal.

10. Liquid Crystal Display:LCD (liquid crystal display) is the technology used for displays in notebook and other smaller computers. Like light-emitting diode and gas-plasma technologies, LCDs allow displays to be much thinner than cathode ray tube technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it.

11. Li-Fi :Li-Fi is a technology for wireless communication between devices using light to transmit data and position. In its present state only LED lamps can be used for the transmission of visible light.In technical terms,Li-Fi is a visible light communications system that is capable of transmitting data at high speeds over the visible light spectrum, ultraviolet and infrared radiation.The receiver converts the incoming light into current using a photodiode.

Components List :

- ARM7 LPC2138 controller
- LCD
- Power LEDS
- Temperature sensor LM35
- ECG sensor
- RS-232
- Spo2 sensor
- Pulse rate sensor
- Li fi transmitter and receiver
- Amplifier 317
- Regulator IC 7805

Software's used:

- Proteus 7
- Keil Micro vision 4
- Visual studio

IV. WORKING

The Module-wise working is explained below;

1. Biomedical Sensors:

Temperature Sensor – The temperature sensor here is LM 35 . It can be seen as below.It converts the temperature of human body radiated into the voltage

waveform.We can derive the temperature by manupulating the voltage output level when it is given to ARM processor.

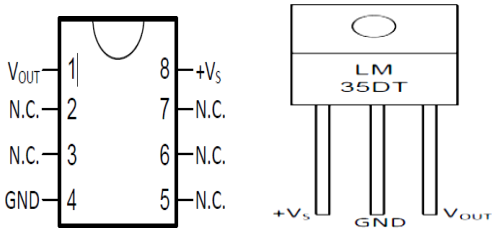

Fig 2. Temperature sensor lm35

a)ECG sensor- Sample high-resolution ECG trace taken from the electrodes directly on top of the skin over the chest. The entire sequence of PQRST waves can be clearly seen and the signal is comparable to that obtained through adhesive contact sensors.

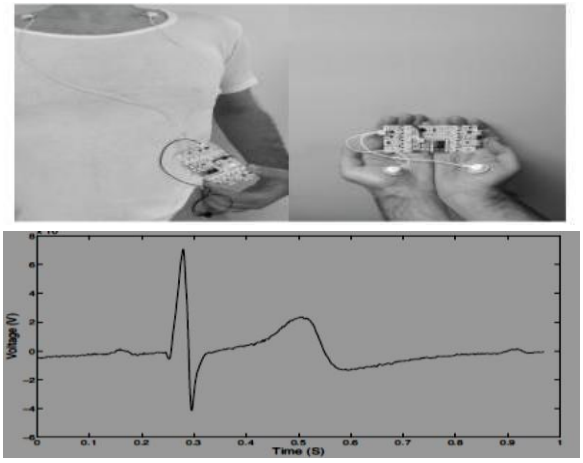

Fig 3. ECG Sensor

We present a wireless body sensor network for high quality EEG/ECG recordings utilizing non-contact electrodes. The full schematics for building the simple, low noise capacitive electrode are presented. Future work will focus on miniaturizing and better packaging the electrode as well as reducing the power consumption of the digital and wireless transmitter components.

b)*SpO2 Sensor*- SpO2 stands of Saturation of Peripheral Oxygen. Pulse oximeters measure oxygen saturation.The pulse oximeter works out the oxygen saturation by comparing how much red light and infra red light is absorbed by the blood. Depending on the amounts of oxy Hb and deoxy Hb present, the ratio of the amount of red light absorbed compared to the amount of infrared light absorbed changes.

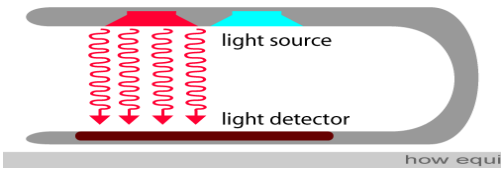

Fig. 4. SpO2 sensor working

The main way oxygen is carried in our blood is by means of haemoglobin. If a finger is placed in between the light source and the light detector, the light will now have to pass through the finger to reach the detector. Part of the light will be absorbed by the finger and the part not absorbed reaches the light detector. The amount of light that is absorbed by the finger depends on many physical properties and these properties are used by the pulse oximeter to calculate the oxygen saturation. The amount of light absorbed depends on the concentration of the light absorbing substance, Length of the light path in the absorbing substance, oxyhaemoglobin and deoxyhemoglobin absorbs red and infrared light differently.

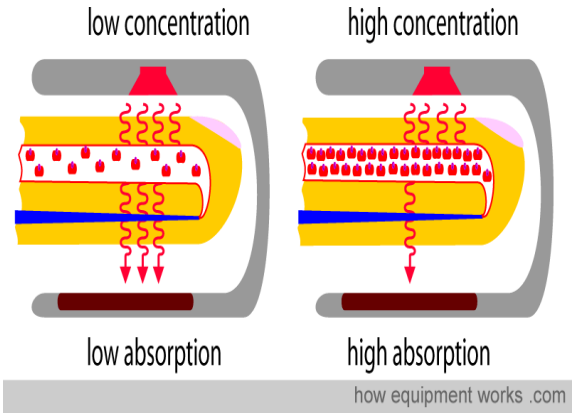

Fig. 5.Different concentration

c) *Pulse Rate Sensor*- When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

d)*Accelerometer* –The ADXL335 is a complete 3-axis acceleration measurement system.

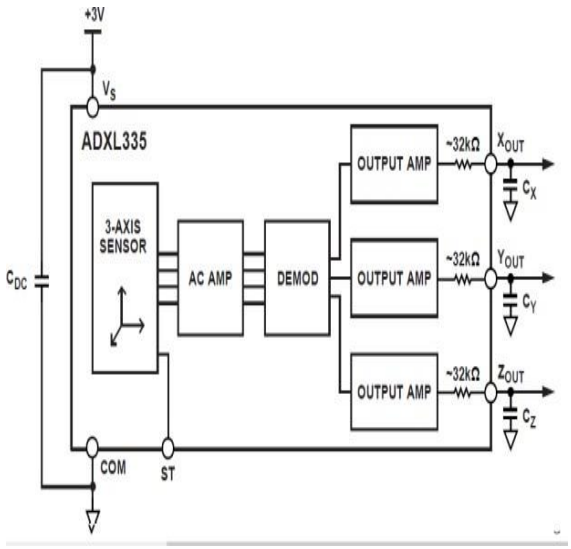

Fig.6.Functional block diagram of Accelerometer

The ADXL335 has a measurement range of ±3 *g* mini-mum. It contains a polysilicon surface-micro machined sensor and signal conditioning circuitry to implement an open- loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration.

2. *ARM 7:*

The µC is the final decision making body on the system. The logic is developed and then the program is burned inside the microcontroller and the other peripherals are accessed via microcontroller only. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. The ARM7TDMI-S processor also employs a unique architectural strategy known as Thumb, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue.

3. *Li-Fi transmitter and Receiver:*

– The working of Li-Fi is very simple. There is a light emitter on one end, for example, an LED, and a photo detector (light sensor) on the other. The photo detector registers a binary one when the LED is on; and a binary zero if the LED is off. To build up a message, flash the LED numerous times or use an array of LEDs of perhaps a few different colours, to obtain data rates in the range of hundreds of megabits per second. The block diagram of Li-Fi system is shown in fig below.The working of Li-Fi is based on VLC, which uses visible light for data transmission. The visible light spectrum has wider range of hundreds of THz of free bandwidth, which is 10,000 times more than RF spectrum up to 30GHz. It uses LED to generate data stream which is connected to the internet or cellular system. As per the data stream the LED flickers at high rate which is not recognized by human eye.

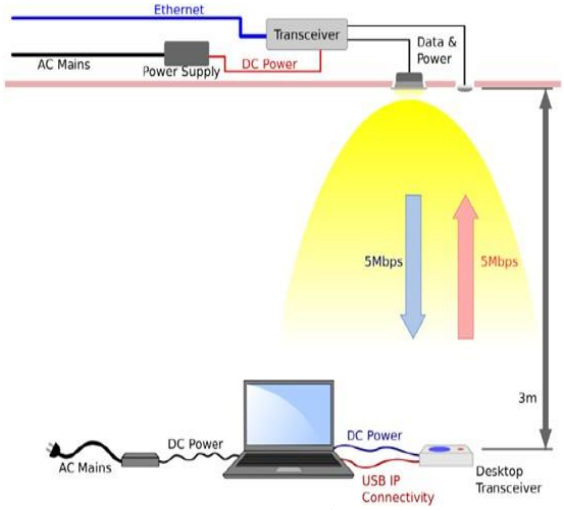

Fig 7.working principle of LiFi technology

V. ADVANTAGES

- Speed of the Li-Fi communication is high, hence it reduces the time.
- Due to high speed of the system we can send more accurate and less noise signal compared to the previously existing system.
- *Capacity:* Visible light spectrum is 10000 times bigger than RF spectrum. It is predicted that will we run out of the RF spectrum by 2020.
- High security.
- higher efficiency.
- *Transmission of data:* Wi-Fi transmits data serially and Li-Fi transmits thousands of data streams parallely thus offering higher speed
- *Infrastructure:* It is already existing. Inexpensive devices, mostly powered by LED, so it is cost effective, compared to base stations

VI. APPLICATIONS

- In the hospitals where the RF waves is not used.
- In the home resided patient monitoring.
- In the Wearable devices like wrist watches.

VII. CONCLUSION

The electromagnetic spectrum shrinking continuously the Li-Fi system will going to provide a greener, safer, better and healthier future for communication system. When this system will be developed each light source can be used as a Li-Fi application means where is a light there is a internet. Also it will shapes the better future for human kind by reducing the energy consumption, data as well as light at low cost, minimal cellula infrastructure and creating the employments opportunities at large scale. In short the Li- Fi system will be going to change the scenario of wireless communication in many greener ways.

VIII. REFERENCES

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