Using Li-Fi in Smart Sensors Integrated Chair for Medical Monitoring

K.Muthumeena[1],M.Brindha[2],R.Kayalvizhi[3],S.Sowmiya[4]
Final year ,EEE
A.Prabha[5] , Assistant Professor/EEE
Kings College of Engineering. E Mail Id: kmuthumeenakings97@gmail.com

ABSTRACT:
Constant monitoring of patient's health condition in hospital is either manual or wireless fidelity (Wi-Fi)-based system. Wi-Fi-based system becomes slow in speed due to exponentially increased scalability. In this scenario, light fidelity (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 patient's conditions without frequency interference with human body. This paper proposes an application of Li-Fi network in the hospital for monitoring the patient's conditions such as temperature, pressure, heartbeat, glucose level, and respiratory conditions 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.

Keywords: **Health-care monitoring, Light emitting diode light, Medical equipment, Patient condition, Visible light communications.**

I.INTRODUCTION:

Light fidelity (Li-Fi) is a revolutionary solution for the high speed data network, proposed by a German physicist Harold Haas. Li-Fi networks support the transmission of data through illumination of light emitting diode (LED) bulb, thereby it is also termed as visible light communications (VLC). In the epoch of internet, there is a continuous urge for faster, secure, and reliable wire-wireless connectivity in all fields, while wireless networks are more preferable in all domestic application in general and health-care application in particular. The reason for depending on wireless network in hospital is the cables which are running over the patient's body interconnecting the devices may cause contamination. Dependency on the wireless internet increases the burden on wireless fidelity (Wi-Fi) technology which, in turn, creates a huge demand for bandwidth and radio spectrum[1]. To reduce the load on Wi-Fi, an alternate mean of wireless internet is Li-Fi finds which find its applications in almost every field, even in vehicle technology[2].

For a long time, medical technology has lagged behind the rest. With more and more number of wireless medical devices coming up, utilizing the radio frequency (RF) spectrum increases which lead an electromagnetic interference (EMI) that results in potentially hazardous events related to medical equipment operations[3]. Apart from the interference with medical equipment, an EMI affects human body also in the form of diseases, immune dysfunction, electromagnetic hypersensitivity, etc., and in worst case, it may lead

to cancer. Another limitation of Wi-Fi in hospital system is its security issue. Patient information must be private and secure but remain accessible to authorized persons. Hospitals are places where both EMI sensitivity and security of medical details are issues with the uses of Wi-Fi. To combat the above limitations of Wi-Fi in health monitoring system, Li-Fi is used, which is a novel technology for high-density wireless data coverage relieving radio interferences in confined areas[4] .

Thus, a Li-Fi-based health-care monitoring hospital system secure patient's body from attack of many types of disease, as the resistance power of patients, is very low[5]. Not only improving the patient's health conditions but also communications among the physicians and clinicians. Wireless technology with Li-Fi system enables clinicians to monitor patients remotely and give them timely health information, reminders, and support[7] . Li-Fi technology ameliorates medical field to the next level and has a plethora of merits when installed and used beneficially.

Organization of this paper is as follows. The basic architecture of Li-Fi based monitoring system is presented in LI-FI framework. A brief discussion about the proposed prototype model is presented in the section prototype model which is followed by the description of various sensors under the heading of "role of sensors". Extended application of Li-Fi technology related to the proposed paper is highlighted in the following section. Conclusion is derived towards the end of the paper and references are listed.

II.MECHANISM OF LI-FI TECHNOLOGY:

The major components of this technology are LED light bulbs and a photo detector. LED bulbs are used to transmit data and the photo detector is used to detect the flash light from the LEDs in Fig.1. Initially the data that we want to transmit are encoded to binary 0's and 1's. The binary digits are then fed into LED bulbs. When LED light is switched ON, the binary 0's and 1's are transmitted via LED flash. These flashes are then detected by the photo detector. The photo detector transfers the binary data for further amplification in order to decode the binary digits. Finally the decoded data is transferred to destination computer device.

Li-Fi could lead to everything electronic being connected to the Internet with the lights on the electronics being used as Internet access points. This is why it embodies the future of connected objects and smart homes. Li-Fi is the technology that will enable this revolution to happen. The Li-Fi market is projected to be worth over $6 billion per year by 2018. And several companies are exploring the numerous opportunities Li-Fi offers. pureLi-Fi invests hefty sums to overcome some of the last hurdles for Li-Fi development, it has recently proved that a line-of-sight connection may not be necessary. Oledcomm develops Li-Fi solutions to provide more information for customers in shopping centres and museums. It is only the beginning of this revolution.

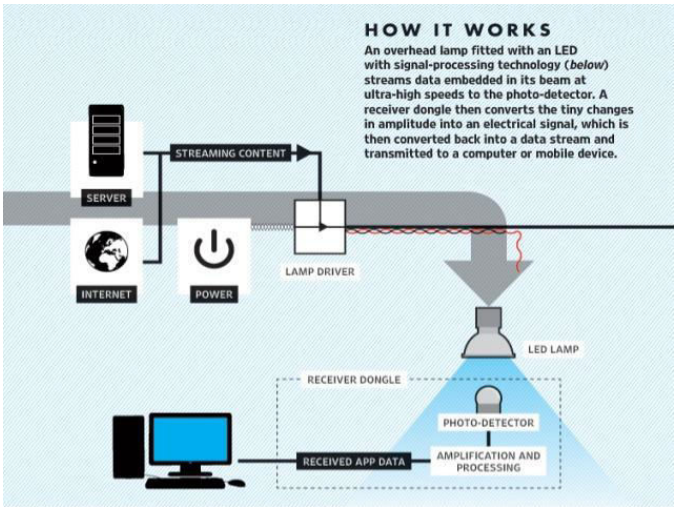


Fig. 1: Mechanism of Li-Fi Technology

ADVANTAGES OF LI-FI TECHNOLOGY:

HIGH SECURITY:

As visible light waves cannot penetrate through walls, the data cannot be intercepted, thus providing secured communication.

HIGH TRANSMISSION RATE:

As this technology uses LED light bulbs for data transmission, the speed of transmission rate takes place at the rate of 9 GBPS.

FREE TO USE:

Visible lights are safe to use from health point of view, rather than using RF that can lead to human disorders.

III.LI-FI FRAMEWORK:

The architecture of a Li-Fi-based health-care monitoring system (HMS) is depicted in Fig.2. The proposed system is highly beneficial but it requires an initial infrastructure, i.e., a built-in lightning infrastructures in hospitals. All the existing bulbs are to be replaced by Li-Fi compatible bulbs and the wires to transfer data, in the backbone local area network must be added inside the ceiling and/or wall. Latest smartphones are compatible for this technology usage. i-phone has high-resolution camera built in with external flash light. Furthermore, a Li-Fi supportable operating system (OS) is found in i-phone OS 9.1 firmware by Apple Inc. Hence, an i-phone can be included in basic infrastructure for Li-Fi networks[8].

Li-Fi networks can be used as fully automated system. Normally doctors and nurses should periodically keep an eye on patient's health condition by taking measurements of blood pressure, heart rate, temperate, respiration rate, etc. In this proposed method, the measurements are made without any human intervention and various patient statistics are also recorded (real-time health monitoring system). Each patient is provided with a tag for their identification and to study their previous medications which can be useful if they are moved to another hospital or medicated by some other technicians[9]. Based on the proposed architecture, a prototype model is built to test the concept of Li-Fi in the medical field..

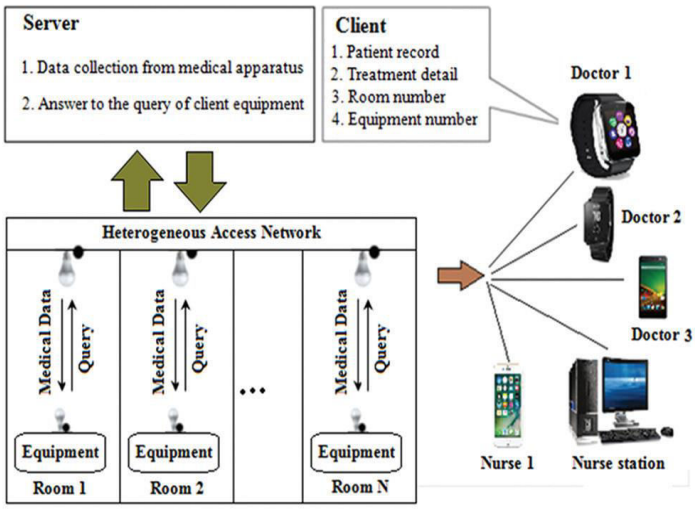


Fig. 2: The proposed system architecture of the health monitoring system using visible light communications transmission.

IV.PROTOTYPE:

Transmitter section

The transmitter section contains one direct current (DC) power supply to supply 5 V DC. DC power supply consists of a step-down transformer for converting 230 V-5V, a bridge rectifier; a voltage regulator LM7805, and a filter capacitor of 1000 mF. Each of the sensors is connected to PIC 16F877A. The PIC16F877A is low power high-performance microcontroller with 8KB in-system flash memory. The special feature of this microcontroller is the presence of in-built universal asynchronous receiver/transmitter, which is used for serial transmission. The signal is transmitted through the Li-Fi transmitter, and the source of transmission is LED Fig.3&Fig.4. The switching frequency of the LED must be high enough to avoid any flickering that might jeopardize the safety of the human eyes. The modulation scheme implemented in this system is the on-off keying (OOK) non-return-to-zero (NRZ) modulation scheme. OOK NRZ is a part of amplitude-shift keying modulation which represents the digital information through the presence and absence of the carrier wave

.

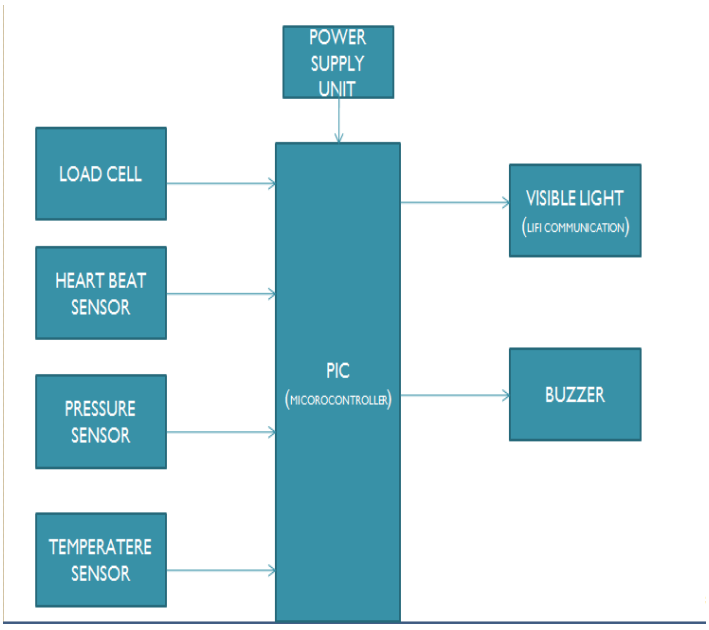


Fig.3: Block Diagram of Proposed System.

Circuit Diagram

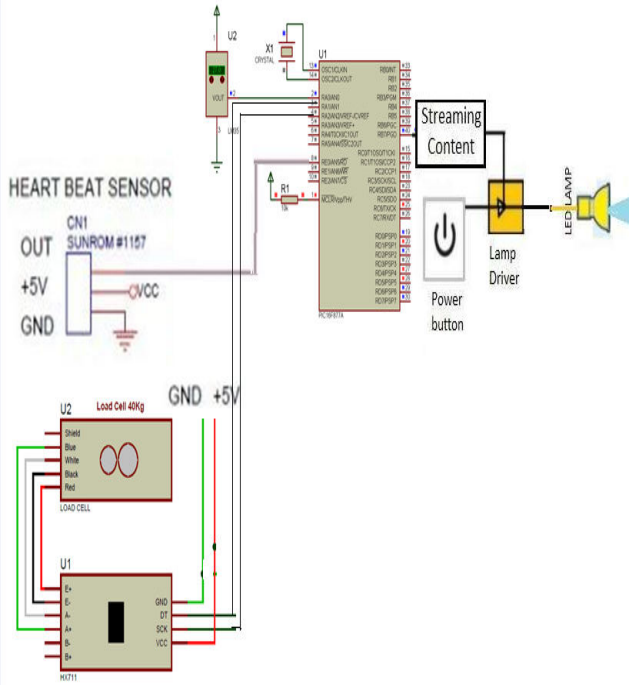
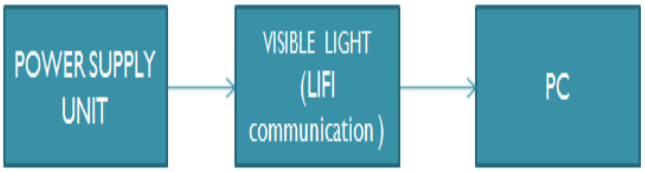


Fig.4: Circuit Diagram of Proposed System.

Receiver section:

A photodiode is used as a receiver in this section which works as a light to electricity converter. The resulting electric signal would be weak and noisy, hence, it passes through signal processing and amplifications units. An envelope detector and a low pass filter are further used to demodulate the signal from the carrier wave and to remove high-frequency noise respectively. Finally, a voltage comparator is used to transform the signal into digital format, before passing it to the microcontroller for further processing. The transmitter and the receiver section should be placed in line of sight position[10]. The received information can be depicted in the form of a graph to analyze the patient's health by connecting the receiver end to the computer. The health report of the patient can be mailed to the concerned person automatically without any human intervention through the internet.



V.ROLE OF SENSORS

The performance of the proposed system is highly dependent on the various sensors used in the system. A brief introduction of the sensors used is presented in this section.

Temperature sensor :

LM35 can be used to measure body temperature. It is an integrated circuit temperature sensor which converts temperature radiated by human body into voltage waveform. Fig. 4 shows LM35 DT temperature sensor with its pin detail. The output is voltage waveform which is linearly proportional to the temperature in Celsius.

Fig.5:Temperature Sensor.

Load cell:

A **load cell** is a transducer which converts force into a measurable electrical output. Although there are many varieties of load cells, strain gage based load cells are the most commonly used type. It is used to measure the weight of patients.

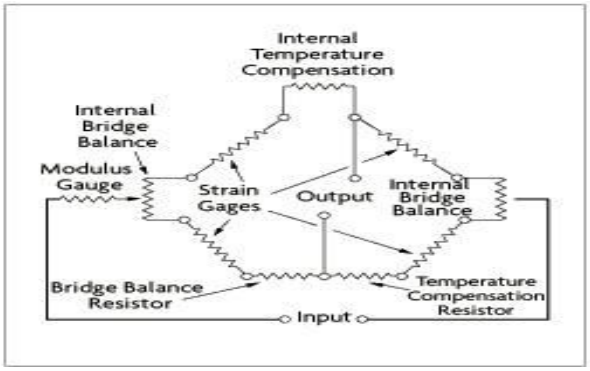


Fig.6: Circuit Diagram of Load cell.

Pressure sensor:

pressure sensor measuresbodypressure, typically o f gases or liquids. Pressure is an expression of the fo rce requiredto stop a fluid from expanding, and is us ually stated in terms of force per unit area. A pressur e sensor usually acts asa transducer; it generates a si gnal as a function of the pressure imposed. For the p urposes of this article, such asignal is electrical.it is Uesd to measure the blood preesor of patients.

Fig.7: Pressure Sensor

Heart beat sensor:

The heartbeat sensor is based on the principle of photo phlethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses[11].

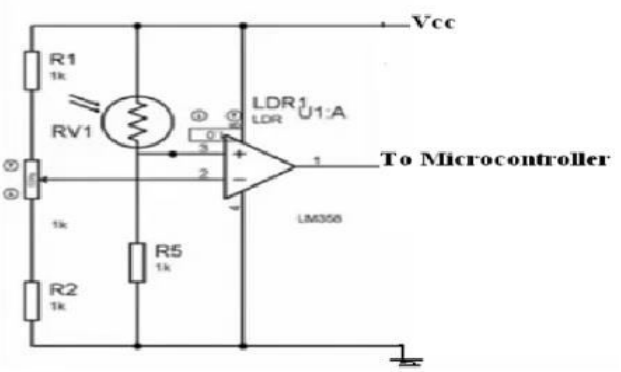


Fig.8: Circuit Diagram of Heart beat sensor.

VI.EXTENDED APPLICATION:

Apart from the routine normal monitoring of patients a very important services is emergency alert mediclaim .

Emergency alert:

Health-care professionals cannot be always readily available near the patient 24×7. In traditional methods, doctors have to be informed in person in case of any abnormality, under worst cases even first aid providence will not be possible. It is very time sensitive for a responsible personnel to react to the emergency calls. Therefore extra efficient high-speed timely alarm should be given to alert medical technicians through an effective HMS. This is made feasible via the proposed system. Patient is fitted with biomedical sensors, which captures the continuous physiological changes in real time and convert them into e-data, then compares it with predefined values or range of values if any discrepancies are noticed, notification will be communicated to the doctors or emergency medical technician staff (nurses and technicians) on their handheld devices. A screenshot of such, generating alert messages is shown in Fig. 6. This framework is independent of the device hardware, specially designed android application or compatible software can be developed and installed through which information could be transferred. The broadcasted information or data contains the room number, equipment id and patient id; these will be available to the client devices of the responsible personnel who is supposed to have the correct application and right authority for access.

VII.CONCLUSION:

Li-Fi is emerging as more suitable networks in next generation healthcare services in the hospital. In this paper, the application of VLC is demonstrated in HMS using one prototype model. It is shown that Li-Fi network is successfully can be used as a high-speed, secure and safe to human body data communication to provide real-time monitoring of heartbeats, blood pressure, temperature, and various other parameters. Using this technology in medical field makes diagnosis faster and allows to access the internet along with the radio waves based devices. The proposed system is fully automated and it could be a milestone in medical field if successfully implemented.

REFERENCES:

1. Shivaji K, Amogh D, Pavan J. A survey on Li-Fi technology. In: Proceeding of International Conference on Wireless Communication, Signal Processing and Networking (WiSPNET), March; 2016.

2. Pooja B, Ratul M, Balaji S. Smart vehicular communication system using Li Fi technology. In: Proceeding of International Conference on Computation of Power, Energy Information and Commuincation (ICCPEIC), April; 2016.

3. van der Togt R, van Lieshout EJ, Hensbroek R, Beinat E, Binnekade JM, Bakker PJ. Electromagnetic interference from radio frequency identification inducing potentially hazardous incidents in critical care medical equipment. JAMA 2008;299(24):2884-90.

4.Chang HJ. Framework for data communication in the hospital using Li-Fi technology. Int J Sci Eng Res2016;7(8):637-9.

5.Availablefrom:http://www.medgadget.com/2016/07/li-fi-market-increasing-demand-for-applications-in-medical-centers.html.

6. Aminian M, Naji HR. A hospital healthcare monitoring system using wireless sensor networks. J Health Med Inform 2013;4(2):1-6.

7. Rahane SL, Pawase RS. A healthcare monitoring system using wireless sensor network with GSM. Int J Adv Res Electr Electron Instrum Eng 2015;4(4):6330-5.

8.Availablefrom:http://www.9to5mac.com/2016/01/19/ios-9-code-li-fi-tech-no-headphone-jack.

9. Shobha G. Medical Applications of Wireless Networks. In: Proceeding of International Conference on System and Network Communication, 25-31 August; 2007.

10. Tan YY, Chung WY. Mobile health-monitoring system through visible light communication. Biomed Mater Eng 2014;24(6):3529-38.

11.Availablefrom:https://www.elprocus.com/heartbeat-sensor-working-application.