Non Invasive Remote Health Monitoring Using Li-Fi Communication System

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Abstract: **Recent advancements in the field of light emitting diode (LED) has spurred the interest to use LED for illumination and data transmission. This has resulted in the growth of visible light communication (VLC) system, with ongoing research to utilize VLC in a variety of applications. This paper presents a non-invasive remote health monitoring system, where biomedical signals are transmitted via the Li-Fi communication system. A heart rate sensor and temperature sensor are used to obtain ECG signal and temperature from our body respectively, which are boot into Arduino board. Li-Fi module is used to transmit these signals wirelessly to computer. Li-Fi is a part of the Visible Light Communications (VLC) PAN IEEE 802.15.7 standard. Li-Fi module, which uses visible light of range 350nm to 800nm for data transmission, is usually implemented using white LED light bulbs. These devices are commonly used for illumination by applying a constant current through the LED. on the other hand, by high-speed and slight variations of the current, the optical output can be made to vary at extremely high speeds. Invisible by the human eye, this dissimilarity is used to carry speedy data. This allows for a more precise and exact monitoring and diagnosis. The data packet size is carefully designed in such a way to transmit data in a minimal packet error rate.**

Key words: **Visible Light Communication, Li-Fi, ECG, Temperature.**

INTRODUCTION

One of the main concerns nowadays are regarding the compatibility of medical equipment in healthcare field with the incorporation of wireless technology. Wireless technology such as radio frequency (RF) technology has always been resulted in the emission of electromagnetic interference (EMI).The emission of the EMI threaten the quality of medical monitoring ,as the accuracy of data transmission is vital for the medical field to give corresponding measures or treatment, based on the real–time information obtained. In addition to that, the prolonged usage of RF wireless technology in the health care has been in debate due to the intrusion of RF radiation that would be harmful for the health of the patient.

Visible light communication (VLC) system involves the usage of visually–perceived electromagnetic wave to transmit data. It is a type of optical wireless communication which uses the visible light spectrum from 380 to 780nm.The fast switching property of the LED allows the data transmission using visible light, by controlling the intensity of the optical sources in such a fast manner. Another advantage of VLC is its unregulated bandwidth which provides free domain research and implementation without any restriction. The advantages of the VLC make it's a potential candidate as an alternative wireless technology. It possesses the same characteristics as the convention a lRF technology, while eliminating any disadvantages held by the RF technology in the health-care industry.

Furthermore on-body devices make it possible to change healthcare from snapshot measurements of physiological parameters to continuous monitoring allowing clinicians to give guidance on a daily basis, without affecting patient's daily routine by avoiding the complex and bulky wired connections. By considering the increasing popularity of on body devices, this project proposes the development of a non-invasive wireless remote health monitoring system that can monitor vital signals such as ECG. One of the main aim of the project is to help to support the vision of the internet which is important to the goals of Qatar National Vision 2030. This proposed design can be used by the elderly and disabled people with no assistance, to measure and send results to their doctors' immediately. The inspiration for the project came from the necessity of a safer communications system for health care field nowadays. Some of the medical devices that are being used in hospitals give inaccurate reading and so there is a demand for a better communications system for the replacements of Radio Frequency (RF) signals which causes interference of data.

The non-invasive remote health monitoring system consists of a wireless ECG kit coupled with AT89S52 board and a temperature sensor, which is used to obtain temperature from the body. The ECG kit measures the heart activity and sends it to AT89S52 board, which sends the ECG signal along with the temperature to the PC via Li-Fi communication, which is an advanced version of Visible Light Communication. This system will help to reduce the cost and complications associated with data transmission and will introduce ease in healthcare monitoring and well-being, which is seen as a global challenge nowadays. In this project, the main aim is to develop a remote–health monitoring system using VLC for the transmission of data. This system consists of following aspects:

(1) Transmission of data via Li-Fi.
(2) real–time monitoring of the data
(3) Analysis of the data received

MEASUREMENT SETUP

ECG leads will be attached to a human body to get the heart rate readings. A temperature sensor is used to obtain the temperature from the body. LM35 sensor is used to measure the temperature.

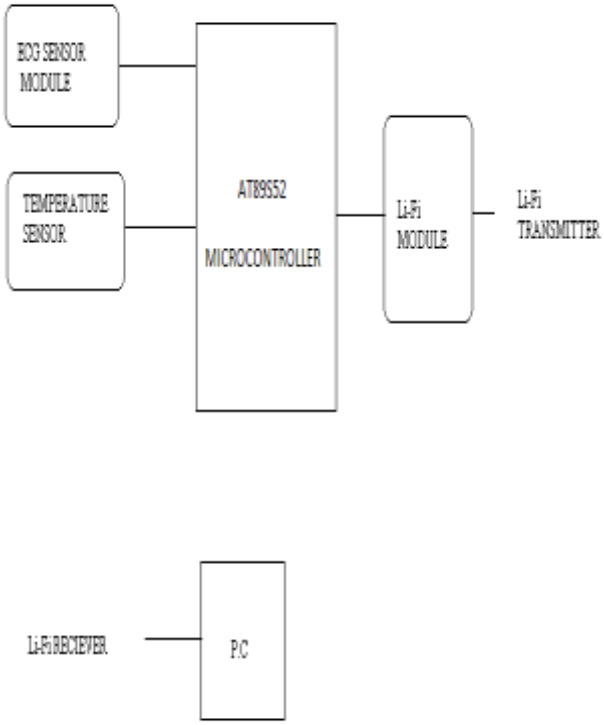

Fig1: Block diagram of the proposed design

The main advantage of using this sensor is that the voltage is linearly proportional to temperature, so that we can easily analyze the temperature variations in the body. The AT89S52 board was programmed to send a command to the wireless ECG kit to have it to send the readings that were from the human body and then send the readings through the Li-Fi Module which is attached to the AT89S52 board. The Li-Fi transmitting module is used to send there was saved on the Arduino MEGA board to Li-Fi receiving module, where the result is displayed on computer screen. In addition the results can be displayed on mobile phone as well.

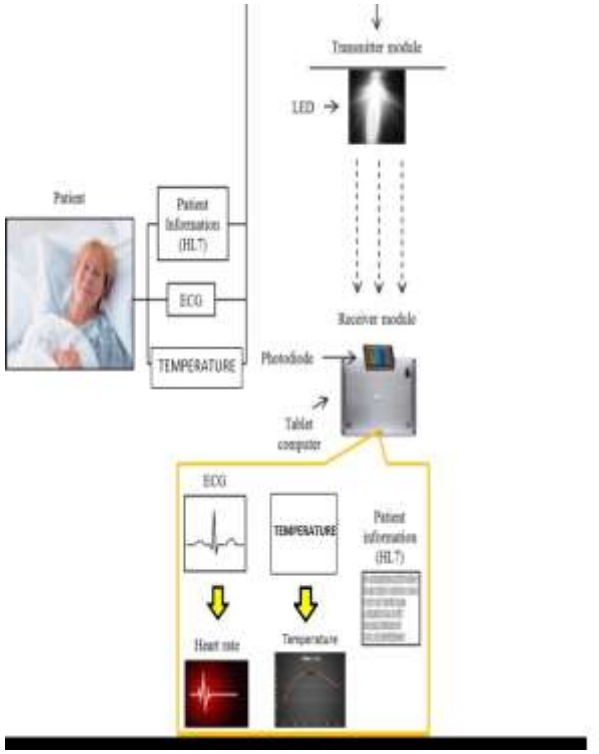

Fig 2 The architecture of the health–monitoring system using Li-Fi

LI-FI TRANSMITTER MODULE

The Li-Fi transmitter modules have mainly two components, a modulation circuit and a LED. The LED works as both an illuminator and transmitter. It is used to transmit data by switching between the on–and–off states in a very fast manner. In addition to that, the switching frequency of the LED should be high enough to avoid any flickering that might cause damage to the human eyes. A microcontroller, At mega 128, is used to interface the data to be transmitted with the transmitter module. The modulation process is carried out using a NAND gate. A transistor is installed as an optical driver for the LED which is used to limit the current that flows through the LED.

LI_FI RECEIVER MODULE

The receive r module consist of a demodulation circuit and a microcontroller. As both the demodulation circuit and the microcontroller needs a different amount of voltages to function, a single battery unit along with two voltage boosters is commonly used. The demodulation circuit uses various components to operate. The photo detector used in the receive r module has high sensitivity and wide spectral response ranging from 320nm to 1100nm.The photo diode is used to convert the incident light into an electrical signal and microcontroller works as an intermediate device to serially transmit the data under the RS–232 standard protocol, to another device such as a personal computer (PC).

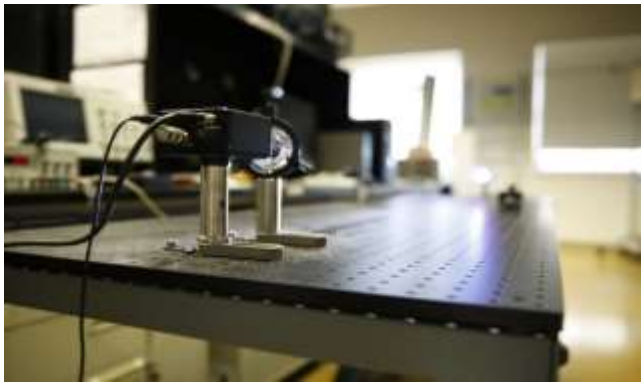

Figure 3: Transmitter, receiver and LED driver

RESULT

The temperature and ECG signals are received by the Li-Fi receiving module. It is connected directly to a computer using a USB port. The corresponding data are displayed on the computer screen which enables accurate and precise diagnosis of the bio signals. This result can be also displayed on mobile phones.

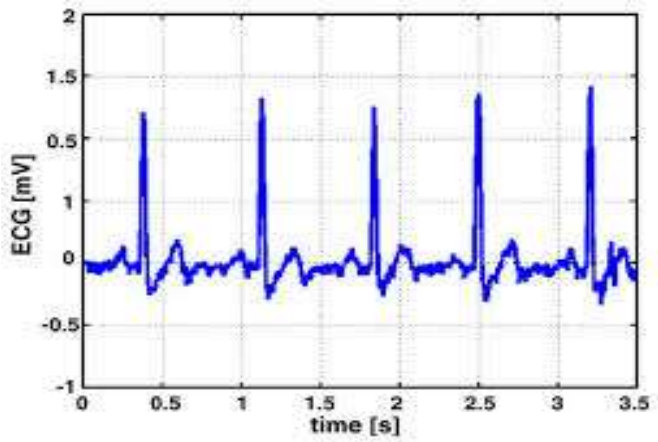

Figure 4 :Graphical display of ECG signals

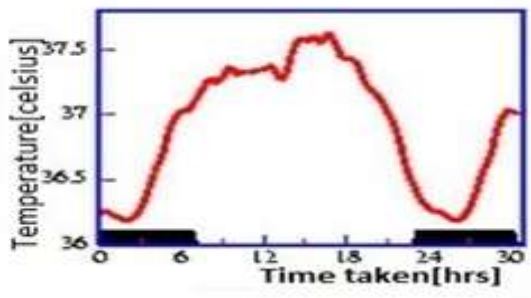

Fig 5:Graphical display of temperature

CONCLUSION

A non-invasive remote health monitoring system using VLC is designed for the advantages and convenience of the visible light to transmit healthcare information. The transmission of bio signals can be used for further evaluation which is crucial for the diagnosis of a patient. Furthermore, elderly and disabled people with no assistance can use this proposed design to determine and send results to their doctors instantly which helps in faster diagnosing by the doctors. The idea of Li-Fi is attract a great deal of importance as it offers a very efficient alternative to radio-based wireless .It also helps in solving issue such as the absence of radio-frequency bandwidth and allow internet where traditional radio based wireless isn't allowed such as in hospitals. Finally, the current prototype can transmit ECG signals and temperature only, while future work involves measuring and transmitting other vital signal like breathing rate, blood pressure etc., in addition to the enhancement in VLC link and the mobile application for a complete diagnosis system.

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