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A System for Patient Status updating in mobile phones and patient monitoring using Li-Fi

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ABSTRACT

The present scenario of monitoring patients manually in ICU is where, a lot of paper work and a labour is needed for careful observation. It also has the possibility of losing the data. Now, the technology is faster and accurate than the human eye can follow. Although, Wi-Fi is introduced in Bio-medical applications, it cannot be used in Intensive care units because of RF radiations impact on patient's health and medical instruments. The purpose of the paper is to explain a modern approach to monitor patients in ICU and update their details digitally. Li-Fi is a useful technology with high speed, better bandwidth, high efficiency, availability and is more secure. Our proposed work minimises paper work, saves time and maintains the records of patients with high security. The regular examinations status by doctors and periodic assessment details by nurses are updated digitally. It includes the facility of viewing the patient's results and status by the patient's family in their own mobile phones. Hence, Li-Fi based patient monitoring system is highly compatible and has better scope and benefits in future.

Index terms- Patient monitoring, Li-Fi, Bluetooth, Android application, Status update**.**

1. INTRODUCTION

The usage of RF in health care world, would have a profound impact on the health of the patients. Also, Electromagnetic Interference (EMI) would be threatening to the expensive medical instruments since RF devices such as mobile phones are restricted to use near emergency rooms and Intensive Care Unit (ICU) (Durai Rajan Dhatchayney, 2015). Due to the harmful impact of EMI radiation by RF systems, we are in need for an alternate eco-friendly source of communication in Health care. Conventional RF communication suffers from scarce spectrum for high data rate communication. At present, the health care units are using a lot of paperwork for maintaining patient's records regarding patient's health condition, their details medicine prescriptions, etc. But, if the paper is lost, it is very difficult to gather all these information from the scratch. In view of these short comings, Li-Fi could be a solution to such problems. Li-Fi uses transceiver fitted LED lamps that can be used as a light or for transmission of data communication at a speed of 800Mbps, with larger frequency band of 300THz (Durai Rajan Dhatchayney, 2015; Pathak, 2015). VLC is less hazardous to human health and is more secure against hacking, as transmitted light is confined within the system's coverage area. It also offers high data rates, compared with the conventional RF based wireless technologies such as Wi-Fi, Bluetooth and Wi-MAX. Therefore, the VLC technology would be a strong candidate for clinical data transmission in healthcare. Moreover, hospitals are usually indoors where VLC would be best suited for efficient wireless data services with no RF radiation. An application is developed in Android which can be installed in mobile phones, such that the doctors, nurses and patient relatives can view the patient's current status in it.

Existing model: In general, the Temperature, Pressure and Heart Beat of the patients in ICU are sensed by sensors and monitored by computer or the readings are taken manually. As the technology grows, these are performed using Wi-Fi (Hazim and Sizali, 2013). But, Wi-Fi is not advisable to use in ICU. Hence, the eco-friendly technology called Li-Fi has bloomed into existence, where many devices in a room can exchange data using light (Pathak, 2015). This is called as Visible Light Communication (VLC). In Bio-medical field, the usage of Li-Fi has extended in transmitting the Electroencephalography (EEG) signal via VLC link (Durai Rajan Dhatchayney, 2015).

Proposed model: The patient in ICU needs ultimate care and continuous monitoring. The Temperature, Pressure and Heart beat of each patient are sensed by corresponding sensors. These analog signals are converted into Digital form and are stored in a Microcontroller (Manisha Shelar, 2013; Hazim and Sizali, 2013). From the microcontroller the data is transmitted through the light and received by a Photo detector. The receiver which is placed in the room, containing Universal Asynchronous Receiver Transmitter (UART) can be connected with a mobile phone or a computer. In this proposed model, when the doctor enters the ICU, he can able to access every patient's details through his mobile phone. An application can be developed in android such that the Doctor, Nurse and Patient's relatives can view the details in their mobile phones. Hence, the Patient can be monitored 24*7 and their details are updated easily.

	Data Rate	No of Channels	Interference avoidance method	Minimum quiet Bandwidth required
Li-Fi	10Gbps	Depends on the light rays reached at the receiver	Optical filtering or equalization techniques can be used	400THz
Wi-Fi	11Mbps	13	Fixed channel collision avoidance	22MHz(Static)
Bluetooth	723Kbps	79	Adaptive Frequency hopping	15MHz(Dynamic)
Wireless USB	62.5Kbps	79	Frequency agility	1 MHz(Dynamic)
Zigbee	128Kbps	16	Fixed Channel collision avoidance	3MHz(Static)

Figure.1. A Tabulation showing features of wireless connections

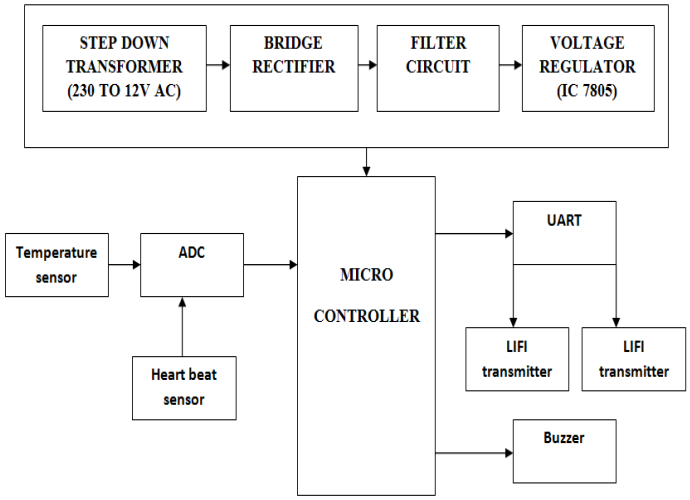


Figure.2.Block Diagram of Transmitter

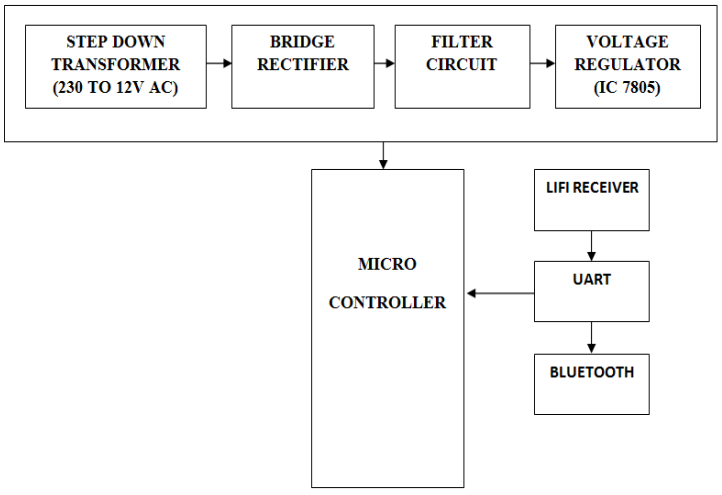


Figure.3.Block Diagram of Receiver

Working model: The proposed system consists of 2 sections. They are, Transmitter Section and Receiver Section.

Transmitter Section:

Sensors: The temperature of the patient is measured using temperature sensor LM35 and the heartbeat is measured using heart beat sensor. The output obtained is in analog form.

Buzzer: The obtained sensor values are compared with the reference value. If any mismatch occurs, then the buzzer will blow.

ADC: The objective of an A/D converter is to determine the output signal in digital corresponding to an analog signal. The output of the sensors are converted into digital data using Analog to Digital Convertor. ADC0808 is a

converter which has 8 analog inputs and 8 digital outputs. ADC0808 allows us to monitor up to 8 different transducers using only a single chip. This eliminates the need for external zero and full scale adjustments. The digital output varies from 0-255. ADC needs a clock to operate. The time taken to convert the analog to digital value depends on the clock source.

Microcontroller: The AT89c51 is a low-power, highly flexible, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The on-chip Flash allows the program memory to be reprogrammed in system or by a conventional non-volatile memory programmer. The program for a microcontroller is generally written in C or assembly language. This program helps in guiding the microcontroller in transferring data to the required destination. The keil compiler generates a hex file which contains the machine language instruction understandable by a microcontroller. It is the content of this hex file which is transferred to the memory of the microcontroller. The Doctor's comments, his prescription and the sensors output are stored in the microcontroller.

LED: The LED lights in the patient's room can be used as the LED transmitter. It serves dual purpose for the transmission of data communication at a speed of 800Mbps with the larger frequency band of 300THz (Grobe, 2013). The data stored in microcontroller is in binary form. The LED lights are made ON and OFF according to the binary data within few nanoseconds (Pathak, 2015).

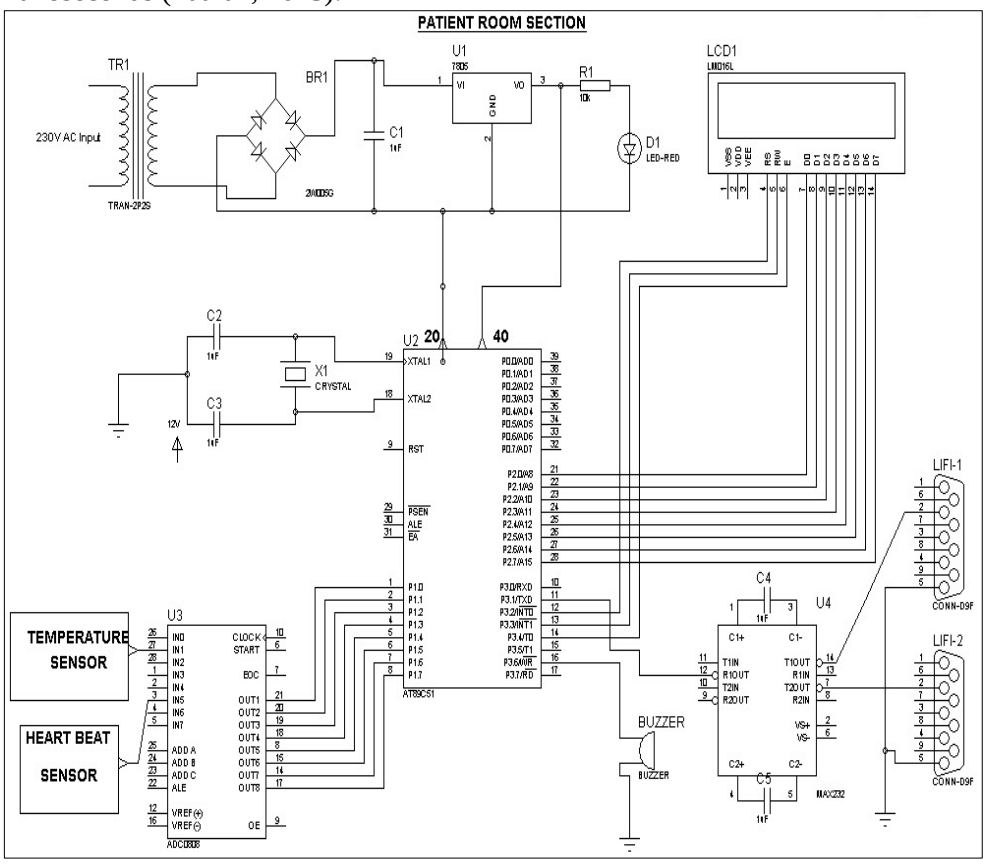


Figure.4.Circuit Diagram of Patient room section

Receiver Section: Photodiode: The transmitted light is detected using photodiode and it produces analog voltage with respect to the data received. The analog voltage corresponds to the binary data 0's and 1's when passed through ADC. A photodiode can measure very small changes in light intensity. It can even be used to detect different colors of light. It works on the foundation of reflection.

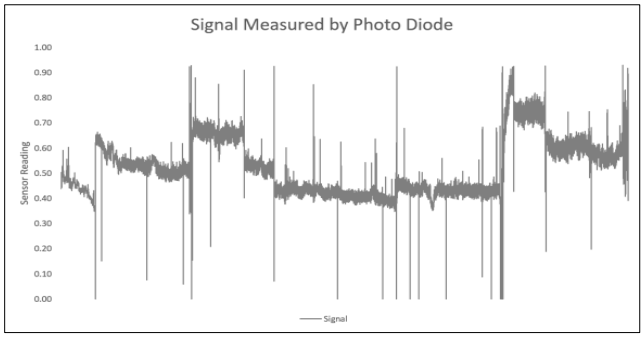


Figure.5.Output obtained from Photo Diode

Bluetooth: Bluetooth operates at frequencies between 2402 and 2480 MHz, or 2400 and 2483.5 MHz including guard bands 2 MHz wide at the bottom end and 3.5 MHz wide at the top. Bluetooth divides transmitted data into packets, and transmits each packet on one of 79 designated Bluetooth channels. Each channel has a bandwidth of 1MHz. Through Bluetooth, the data is sent to the Android mobile phones.

Android application: The Android is a platform where an application is developed in a java language environment (Zarka, 2004). The proposed work has android application designed as follows.

- The first page contains the login details where, the user can enter as a Doctor or a nurse or a family member.
- When the user enters with doctors ID and password, he can view the patient's current status. Also, he can add suggestions and prescriptions if necessary.
- If the user login with nurse ID and password, she can view the patient's current status and can edit the comments space. But, she cannot have the facility of altering the prescriptions.
- When the user is a relative, he can only view the patient's current status.
- By selecting the logout button, the users can come back to the first page.

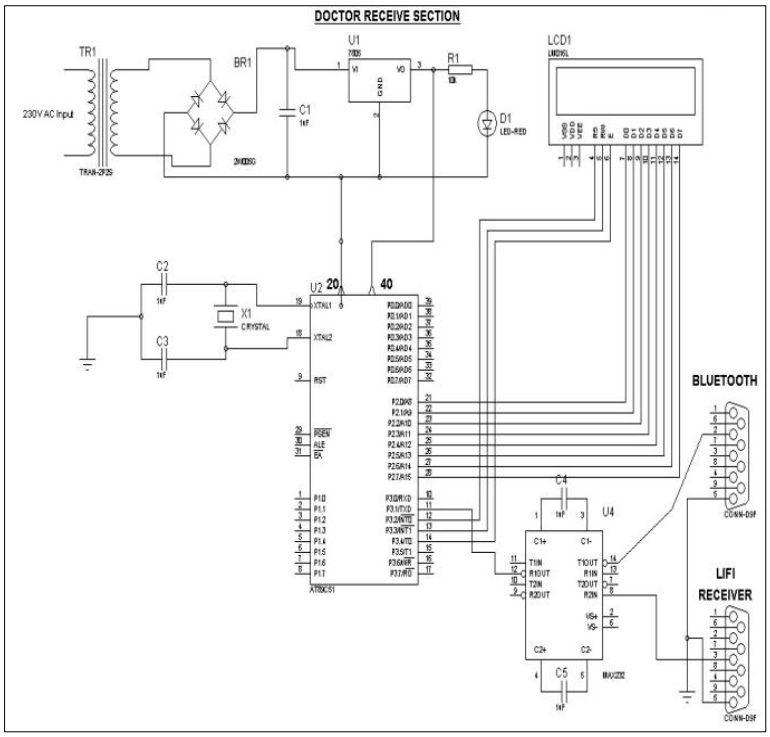


Figure.6.Circuit Diagram of Doctor Receive Section

2. RESULTS

Using this setup, the patient's temperature, Heart beat are measured and displayed in LCD display at the Transmitter side shown in fig 7

Figure.7.Heart beat Sensor measuring Heart Beat of a Patient and transmitting through Li-Fi

The transmitter side consists of two Light transmitter. ICU patient 1 who needs continuous temperature monitoring is monitored here with the help of temperature sensor and the data is transmitted through Light 1 in ICU room1. Similarly, ICU patient 2 who needs continuous monitoring of heart beat alone is achieved with the help of heart beat sensors. The heart beat sensors are designed in the form of a Clib. The patient when fixes his finger in clib as shown in fig 7, his heart beat will be displayed in the LCD display. Heartbeat rate (displayed in LCD in fig

8.), patient status and patient records is transmitted through Light 2 which is fixed in ICU room2. The receiver circuit detects data with the help of Photo Detector as shown in fig 9.

Figure.8.Displayed Heart beat value

Figure.9.Receiver side

This data is transmitted through Bluetooth to the Doctor's mobile phone. (Shown in fig 10)

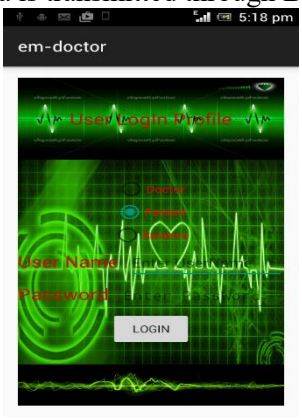


Figure.10.User Id and Password login page in mobile phone

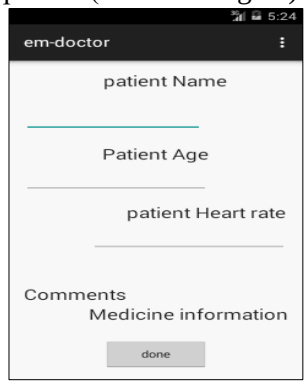
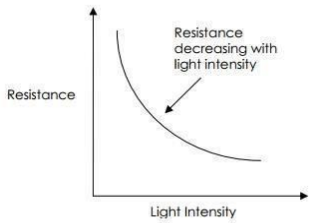


Figure.11.Patient Details Page after Login is successful

Comparison of LDR and Photodiode outputs:



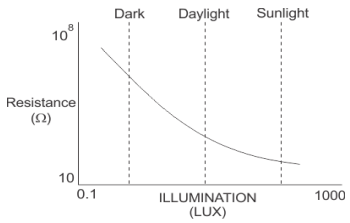


Figure.12.Resistance Vs Light intensity of LDR **Figure.13.Resistance Vs Illumination of Photo Diode**

Advantages:

- Highly cost effective as it uses only LED lights. When the light becomes defective, they can be replaced by new lights.
- More secure than Wi-Fi, as Li-Fi is used within a room and no hacking of data is possible (Pathak, 2015; Elgala, 2011).
- Unlike RF signals, it does not affect patient's health or the medical equipments in the room (Durai Rajan Dhatchayney, 2015).
- It has high data rate of 10Gbps.
- Li-Fi has low implementation and maintenance costs.

Challenges:

- In case of Power failure, this system may not be used, as power supply is a necessary source.
- During night times, the data is stored in microcontroller, but to retrieve the data one should switch on the lights.
- Each light fixture in the application environment becomes a separate data channel. These channels can supply different data into each separate pool of light, delivered at the full rated download speed for that channel

Future Work: The proposed work can be improved in such a way that, the details of all the patients in General Wards, can be updated using a Single Light placed in the room. Hence, we can make the record updating system for patients, digital.

3. CONCLUSION

In this paper, the patient details like temperature, pressure and heartbeat are monitored continuously and transmitted wirelessly through visible light. Also, now the doctor's mobile phones contains the status of the patients. This eco-friendly technology is a productive step towards "Digital India". When everything turns digital, man can access the whole world with his fingers.

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