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Continuous Assessment of Critical Parameters in A Secluded Intensive Unit for A Patient

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***Abstract*— In recent times, with the tremendously increasing technology, communication has become easier & smarter. But however, healthcare sector doesn't possibly implement these advancements because of radiation being the major hindrance. This proposed project is being developed with a novel idea to use ambient light as a means of communication to continuously assess critical parameters of a patient without human intervention, especially when the intensive unit is cloistered. Another predominance of this concept is, using the blue-tooth low energy to retrieve the data from the ambient light communication to any preferred device getting itself automatically paired in the user end. This system is being exclusively made for monitoring the health parameters that are critical which has to be monitored on a regular basis for a patient to know his wellness level when he/she has to be secluded due to various reasons.**

Index Terms*— *Bluetooth , Healthcare , Li-Fi , Monitoring , Transmission , Receiving.

I. INTRODUCTION

With the advent of the information communication technology, world have become a town, the demand of the technology is uprising vertically and horizontally in terms of development of the nation and its economy. Li-Fi is one of the pioneer technology which is clean and green. Microwaves have several advantages on other type of communication mode but due to increasing demand of data the spectral becomes so dense that if it will continue for some more year there is a chance of such Electro Magnetic Interference that all communication system will crashed. Furthermore, electromagnetic waves have hazardous effect on human body. By taking all these issues in account we are trying to use this new mode of communication called Li-Fi.

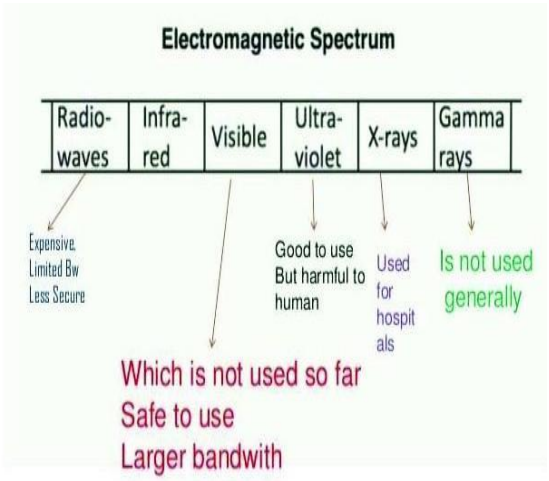

Fig. 1 Electro-Magnetic Spectrum

Li-Fi which is a wireless communication same as present with only difference of wavelength, here we are using visible light spectrum in place of microwave.

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.

Electromagnetic interference test with medical equipment, about 20% of the incidents was classified as hazardous or

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significant If this happens in intensive care room with critical care medical equipment, it may jeopardize some patient's lives from equipment malfunctioning. Due to this reason, the usage of Wi-Fi connection is limited (even prohibited completely) in the part of the hospital building, in this case, only wired communication channels are used. To overcome such limitations from using Wi-Fi in the hospital we use Li-Fi instead. Li-Fi is a new technology that can transmit (exchange) data at high speed using visible light communication (VLC). The prototype of first wireless communication was proposed by Alexander Graham Bell back in 1880 for transmitting sound and human voice over a beam of optical light. Since then, VLC did not get much attention for a while. LED (Light Emitting Diodes) off-the-shelf product, it regained an interest from research community. The electromagnetic spectrum is shown clearly in Fig 1 that explains the significance of each region.

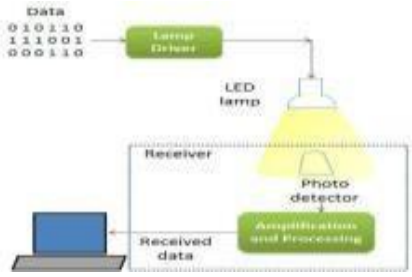

Fig 2 Li-Fi working Process

II. LITERATURE REVIEW

The usage of RF in health care world, would have a profound impact on the health of the patients[1][2]. 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[3]. 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[4]. 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)[1][2].

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[5]. 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. 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)[6]. But, Wi-Fi is not advisable to use in ICU[6][7]. 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 .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).[6][8] 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. When the doctor enters the ICU, he can able to access every patient's details through his mobile phone[7]. 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

III. EXISTING SYSTEM

As with all the discussions and the surveys made almost all the existing system are under the development or prototype stage. Either the communication is using RF transmission and reception or the controller used is being a choice of PIC or

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raspberry pi. Also, the retrieval of data in the system is being a wired medium that's after the communication through visible light. If it is not being wired then directly internet is coming into paly which proportionally increases the cost of the system developed, also decreasing the safety considerations. There is not any vitally stabilised system proposed for the continuous assessment taking in account the end user's reliability, cost, security and the narrowed down application lane. Currently the system with Zigbee is one intact which there is the minimal interference of the radiation but even that is not being permitted in the hospital or intensive units or the health care zones.

IV. PROPOSED SYSTEM

The proposed ideology targets a narrowed down application for the assessment of critical parameters continuously for a patient who is majorly been secluded for any cause. This combines two of the safest form of wireless communication, one the targeted end is the mobile / tablet. The transmitting part that's meant to collect data from the patient, process it and get it displayed in the LCD while transmitting it using the ambient light. So, here the main part is collecting proper and exact data from the sensor. The receiver part gets the data from the transmitter module, the photo detector does the work of getting the encrypted data from the light source then it processes back in the controller that's is the Arduino. Once the data is processed there, it checks the threshold set, if they obtained value is lesser or above the value set, it switches on the emergency alarm so that it acts as a alert. Simultaneously the values are sent to the Bluetooth low energy module from where the data go to the pre-paired Bluetooth aided device such as phone or tablet. The Fig 3 shows the complete blocks that is present in the continuous assessment model.

communication through the visible light being referred as Li-Fi and the other Bluetooth – BLE communication. The sensor senses the data, gets itself processed through the controller and then through the transmitter the data travels at the same time it displays in the LCD. The Li-Fi receiver, receives the data, processes it and sends to the Bluetooth module which from there sends the data to the app that's been paired to. Also alerts through the buzzers are given according to the required threshold set .These are highly useful to identify the patient's abnormalities. Thus, the nurse, caretaker or person deputed to monitor over the health of the patient will get to know the condition of the patient secluded. The Fig 2 shows working of the Li-Fi process.

V. CONTINUOUS ASSESSMENT MODEL

The model actually has two major groups, one the transmitter and the other receiver. The receiver is again made up of two parts, where one part is just a hop between the Li-Fi Transmitter and the Bluetooth receiver. The middle set up has the Li-Fi receiver and the Bluetooth Transmitter, when the

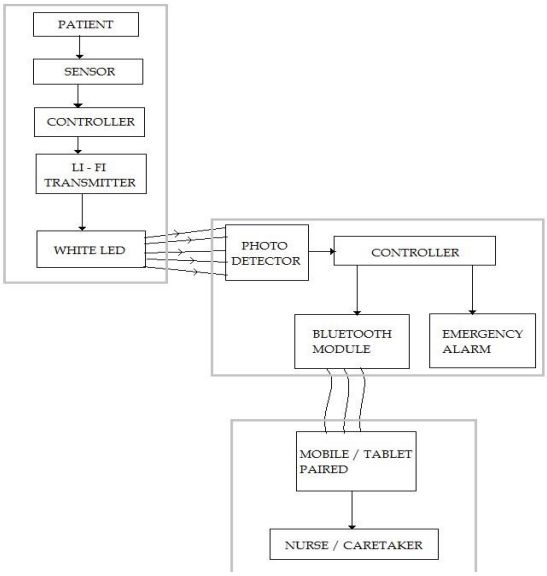

Fig 3 Block Diagram of the Continuous Assessment Model

VI. FLOWCHARTS & BLOCKDIAGRAMS

The flow of the functional operations is explained below in Fig 4 for the transmitting section and Fig 5 for the receiving side. Both the diagrams show the significant function in each of the sections on how the operations occur. The conditions that's to be satisfied at each and every portion so that the looping.,continues and the system continues to function yielding the expected values.

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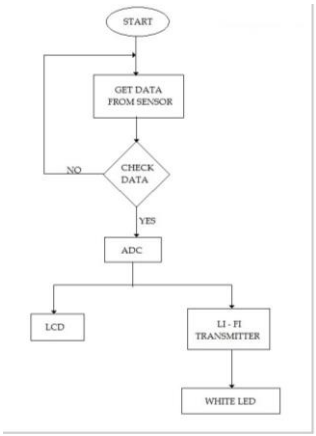

Fig 4 Flowchart of the Transmitter

There are two sections one the transmitting section – Tx and the other receiving section – Rx . The first the transmitting section that contains the controller and the Li Fi transmission module being the major components along with the sensor to measure the heartbeat.

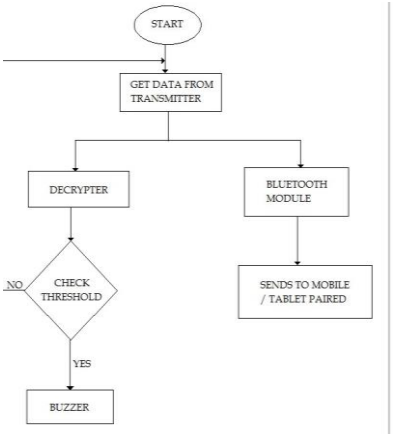

Fig 5 Flowchart of the Receiver

The controller here being Arduino UNO process the data from the sensor and then passes on to the Tx module where the circuit encodes in its own format and sends through the visible light being its medium of communication. The block diagram of the transmitter section is shown in Fig 6.

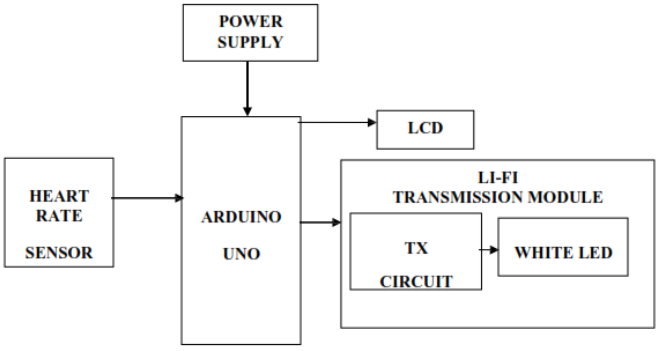

Fig 6 Block Diagram of the Transmitter

The second section is the receiving section that comprises of the Li-Fi receiver module that sends in the received data to the controller for the further processing. The receiver section is shown below in Fig 7. The controller from there on it send to the Bluetooth Tx module which auto pairs itself with the connected device to pass on the data to the other end.

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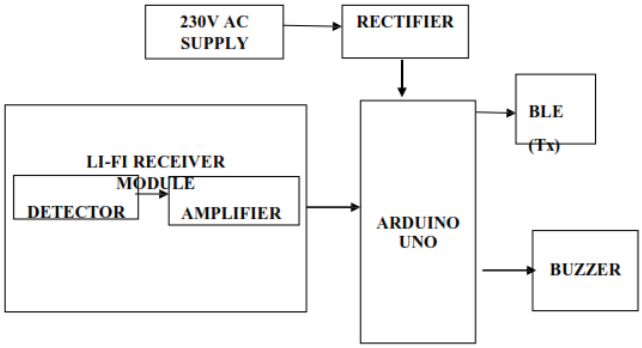

Fig 7 Block Diagram of the Receiver

Meanwhile, there is also a buzzer connected for the purpose of an indicative alarm which will beep if the sensor values go lesser or above than the set threshold value.

VII. SOFTWARE CODING

The transmitting part that's meant to collect data from the patient, process it and get it displayed in the LCD while transmitting it using the ambient light. So, here the main part is collecting proper.So here , the 7^{th} pin of the controller is connected to the sensor and hence the input should be taken from that. Then the variables are initialised. As the number of pulses is obtained also the time instant is needed to be known so as to predict the number of heartbeat per minute at every instant of time. The baud rate is set to be 9600. The looping is done to get 5 consecutive pulses and from there on it gets time taken for each pulse and to show the estimated whole pulse rate for the entire minute. The obtained value from there is displayed in the LCD and also given to the Tx pin and goes to the Li-Fi module , where the values are encrypted in zeros and ones and it gets transmitted in zeros and ones. The following code is being written to mainly get the data from the heartbeat and segregate it accordingly to be the lead for the reception to take place.

The receiver part in here mainly collects the data from the transmitter module, the photo detector does the work of getting the encrypted data from the light source then it processes back in the controller that's is the Arduino. Once the data is processed there, it checks the threshold set, if they obtained value is lesser or above the value set ,it switches on the emergency alarm so that it acts as a alert. Simultaneously the values are sent to the Bluetooth low energy module from where the data go to the pre-paired Bluetooth aided device such as phone or tablet. The pins are initialised thus the Arduino board acts here as a decrypter. The photodetector gets the light flickers and thus retrieves the data that is transmitted. Delay is induced for about 1000 milliseconds for about the transmission to happen and the values to get processed. Looping is done to obtain the values that come serially. The trigger for the buzzer that acts as an emergency alarm is also initialised under certain minimal conditions.
The following code is being written to receive the data from the transmitter and then pass on to the Bluetooth low energy module.

A. Tx ALGORITHM

Step 1: The system is started so that it is ready to do the desired functionalities.

Step 2: The system triggers its receiver function to get data from the sensor.

Step 3: The system checks if it has received any data from the sensor, if yes it proceeds to next step else to step 2.

Step 4: The obtained continuous data from the sensor is processed through the analogue to digital converter.

Step 5: Then from there it splits itself to two operation, one it displays the value in the LCD and other it goes to the Li-Fi transmitting module.

Step 6: From the Li-Fi Transmitting module to goes to the White LED where the signals are sent.

B. Rx ALGORITHM

Step 1: The system is started so that it is ready to do the desired functionalities.
Step 2: The photodetector is enabled so that it gets the data from the transmitter.
Step 3: From there it does two simultaneous operation, one to the alarm and other to the Bluetooth module.
Step 4: For the buzzer it , checks the threshold value beyond which it varies then the emergency alar is triggered .

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Step 5: From the Bluetooth transmitter module, the data gets auto paired with the device connected automatically so that the end user being the nurse or caretaker gets it displayed in their mobiles or tablets

VIII. CONCLUSION

The possibilities are numerous and can be explored further because the concept of Li-Fi is currently attracting a lot of eye-balls because it offers a genuine and very efficient alternative to radio based wireless. It has a good chance to replace the traditional Wi-Fi because as an ever-increasing population is using wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. In the future, data for laptops, smart phones and tablets can be transmitted through light in the room by using Li- Fi. Researchers are developing micron sized LED which are able to flicker on and off around 1000 times quicker than larger LED. If this technology can be put into practical use, every bulb can be used as a Wi- Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. This concept promises to solve issues such as the shortage of radio- frequency bandwidth and boot out the disadvantages of Wi-Fi. Li-Fi is the upcoming and on growing technology acting as competent for various other developing and already invented technologies. Hence the future applications of the Li-Fi can be predicted and extended to different platforms and various walks of human life. And as this proposed project focus on transmitting and receiving data , for the purpose of critical assessment is done for a patient is done successfully there by both the Li-Fi and Bluetooth are coupled conceptually to get the best suitable solution for the monitoring in a secluded area.The final prototype of the proposed project is showed in Fig 8 that is made into two parts, one is the transmitting side which is with the light source, sensor and the controller.

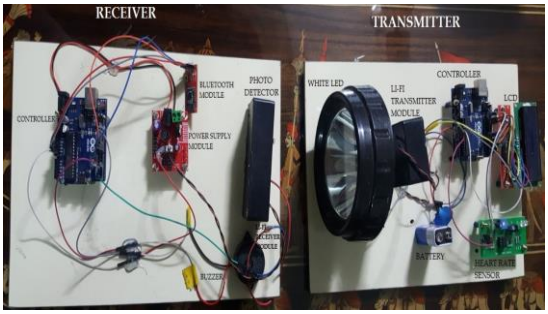

Fig 8 Final Prototype

Also, the receiving part consists of the detector, controller, buzzer and the Bluetooth module. Thus, herewith the concluding statement is made as far as medical field is concerned the radiations and interference has to be completely avoided for the concept to be implemented in the health care sector and also even though there are other limitations that happen due to the combining of Li-Fi and Bluetooth Low Energy this may be the solution for the narrowed down approach for the case where there is communication needed with zero interference.

IX. RESULT

This project mainly focus on the communication between both the modules through the Li-Fi communication and Bluetooth communication. Here in the prototype heart rate sensor is implemented , so the patients finger is intercepted to the sensor so that the continuous readings are taken. Thus that's displayed in the LCD available there also. This is clearly shown in the Fig 9 with a finger kept in the sensor and the data taken.

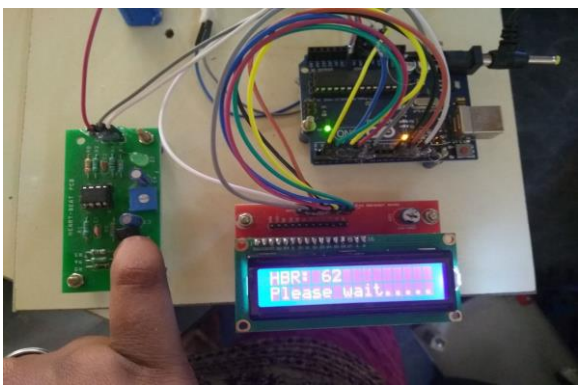

Fig 9 Heartrate measurement

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Also, next after the data have been collected , then it communicates through light, which is shown in the Fig 10therby the photodetector is used to obtain the light and retrieve the data from it.

Fig 10 Light Transmission & Detection

Followed by which , the data are sent to a Bluetooth module where it transmits the data to the auto paired mobile / tablet. The snapshot of the interface is shown in Fig 11.

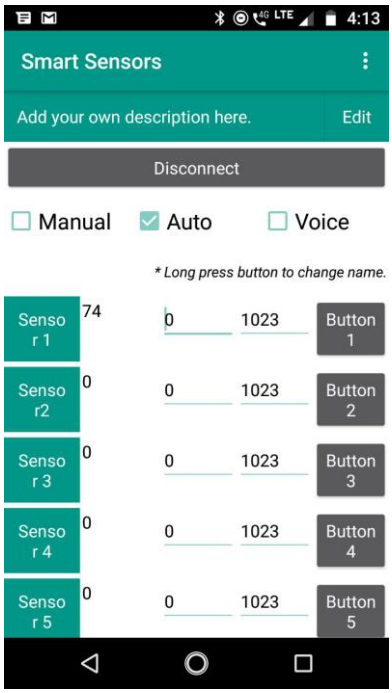

Fig 11 Snap Shot of the Bluetooth Receiver Interface in a mobile.

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