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Experimental Biomedical Data Transmission Using VLC

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Abstract:

In biomedical or healthcare application, the implementation of radio communication technologies is frequently flustered by the electromagnetic wave radiations and interference which are harmful to the humanbeings.Hence the transmission of low power (10 to 100µv) Biomedical signals with high degree of accuracy and at very high transmission rate is a challenging job. Thereby we go for a new novel method of transmission of these Biomedical signals using VLC (Visible light communication) technology. White beam light emitting diodes are used as a optical information emitter for efficiently transmitting biomedical data such as patient EEG,CT scan,MRI etc., information. ON/OFF keying modulation is used to modulate the data on to the visible light beam only at the Line of Sight condition. This amplified signal is fed into controller and the Biomedical signal is simulated by interfacing the kit with softwares (Embedded c coded in keil uvision 2.0 and visual basic 6.0).This proposed system has achieved a maximum distance as 10m and the resultant Biomedical signal has SNR greater than 7db with BER of 4.74X10-6.These results proves the excellent reliability and accuracy of proposed system.

Keywords: Biomedical signal,RF radiation,VLC,accuracy,high transmission rate.

1. INTRODUCTION

Biomedical data are the obervations of physiological activities of the humans . An Biomedical data can be used to detect potential problem associated with the activity. Because of their low amplitude of biomedical signal,it is more difficult to detect than the other signal . Visible light communication using white light emitting diode is a promising technology for the next generation communication for high speed data transmission. The usage of RF based device in the healthcare have a dangerous impact on the health of the patient, especially for those person with seizure attacks, infants in incubators, heart attack patient, possibility of brain death patient and head surgery patients. Taking into these considerations, we are using, a harmless effective high speed visible light communication system is used to transmit the Biomedical signal. **T**HE vast usage of radio frequency (RF) in healthcare would, however, have a profound impact on the health of the patients. Also, the electromagnetic interference (EMI)would be threatening to the expensive medical instruments since RF devices such as mobile phones are restricted to use near emergency room and intensive care unit (ICU) [1]. Due to the harmful impact of EMI radiation by RF systems, we are in need for an alternate ecofriendly source of communication in healthcare. Conventional RF communication suffers from scarce spectrum for high data rate communication. In view of these shortcomings of RF based healthcare technologies, visible light communication (VLC) could be a solution to such problems [2], [3].VLC is an evolving technology that uses light in the visible region (400nm-780nm) as a medium for data transmission.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 WiMAX [4]. Therefore, the VLC technology would be a strong candidate for clinical data transmission in

healthcare. Moreover, hospitals are indoors Fig. 1. Block diagram of the proposed system. where VLC would be best suited for efficient wireless data services with no RF radiation.

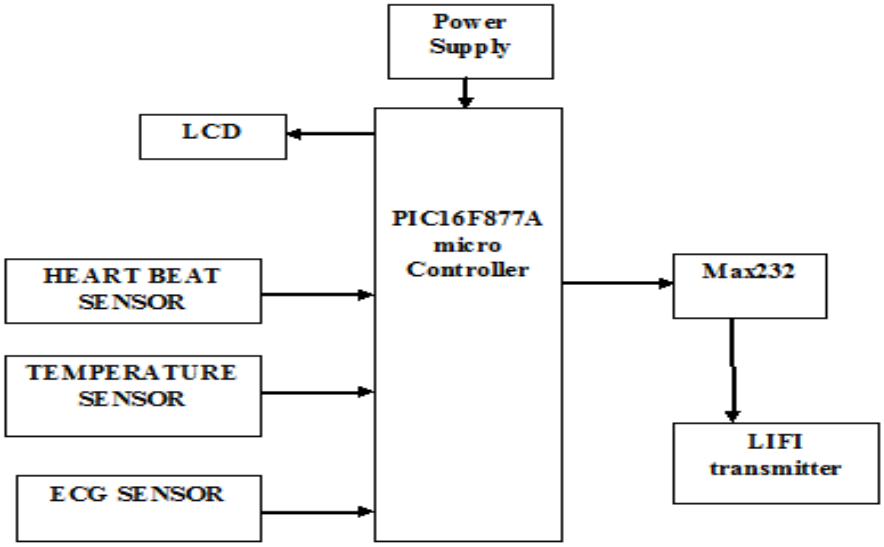

Fig. 1. Block diagram of the proposed system for Transmitter side.

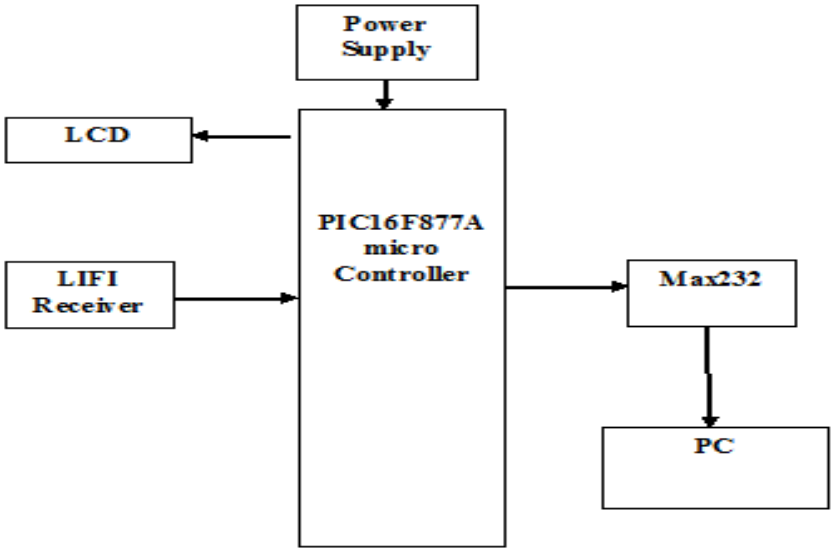

Fig. 2. Block diagram of the proposed system for Receiver side.

To address the critical issues associated with EEG signal transmission using RF, we propose a VLC based EEG signal transmission using selection combining scheme. In the proposed VLC based system, captured EEG signal is processed and transmitted via parallel data streams of red, blue and green colors from RGB LEDs. The VLC transmission technology using color clusters has already been demonstrated by many researchers, confirming its efficiency and reliability [7]. To transmit healthcare data that requires high precision, we utilize all three components of a RGB LED simultaneously for data transmission.

2. LITERATURE REVIEW

In[2]At some hospitals and nursing homes, people have already thought about improving healthcare quality, efficiency and accuracy by bring in the technology of wireless local area network (WLAN), which possesses the advantage of high mobility, flexibility and high speed. However, this idea always takes the risk that medical equipment may get disturbed by the invisible electro magnetic interference (EMI). It has been proved by many cases that some precision medical instruments could not work properly when they are under radiofrequency radiation. In this paper we will describe a new wireless communication system with no RF radiation, no EMI but safety and convenience. This design takes the advantage of optical modulation based on hospital illuminating network. High brightness light-emitting diodes (HB-LED) are used in this system as illuminating source which take priority over conventional gas discharge fluorescent lamp or other low luminous efficient lamps. The information is modulated on the visible light emitted by HB-LED lighting source. A portable device is also designed to receive and demodulate the information, offering mobile data service. In[3]Visible light communication refers to shortrange optical wireless communication using visible light spectrum from 380 to 780 nm. Enabled by recent advances in LED technology, IEEE 802.15.7 supports high-data-rate visible light communication up to 96 Mb/s by fast modulation of optical light sources which may be dimmed during their operation. IEEE 802.15.7 provides dimming adaptable mechanisms for flicker-free high-data-rate visible light communication.
In[4] Visible Light Communication (VLC) is a short range wireless transmission of visible light through free space. The light source can be based on Light-Emitting Diodes (LEDs), that are becoming common use in our future connected home where they can be simultaneously used for both illumination (i.e. LED TVs, Light bulbs, etc.) and communication with appropriate photodiodes in the receiver side. VLC can be adapted to mobile devices enabling new types of short range applications such as HD video streaming. However, many of the new emerging mobile applications require increasingly high data rates; some can even exceed 1 Gbps. In this paper, we propose new optical/electrical front-end and baseband systems that achieve the required bit rate of 1 Gbps over free space. We also detail the implementation challenges of the low power VLC communication system for a mobile device. Specifically we focus on the new VLC baseband system and propose new baseband scheme with state-of-the-art LDPC channel coder. Finally, we will present the results of the new proposed gigabit baseband system as well as lab test results of a single channel VLC front-end running at 540 Mbps and 1080 Mbps.

In[5]The utilization of radio-frequency (RF) communication technology in healthcare application, especially in the transmission of health-related data such as biomedical signal and patient information is often perturbed by electromagnetic interference (EMI). This will not only significantly reduce the accuracy and reliability of the data transmitted, but could also compromise the safety of the patients due to radio frequency (RF) radiation. In this paper, we propose a method which utilizes visible light communication technology as a platform for transmission and to provide real-time monitoring of heart rate and patient information. White LED beam is used as the illuminating source to simultaneously transmit biomedical signal as well as patient record. On-off Keying (OOK) modulation technique is used to modulate all the data onto the visible light beam. Both types of data will be transmitted using a single data packet. At the receiving end, a receiver circuit consisting of a high-speed PIN photodetector and a demodulation circuit is employed to demodulate the data from the visible light beam. The demodulated data is then serially

transmitted to a personal computer where the biomedical signal, patient information and heart rate can be monitored in real-time.

3. SYSTEM MODEL

In our proposed system we need to use PIC16F877A micro controller, ECG sensor, LIFI transmitter, LIFI receiver. ECG sensor is used to get the heart signal of the human and it is readily transmitted by using the LIFI transmitter. The value is modulated with the light frequency and transmitted to the desired destination. On the other side LIFI receiver is ready to receive ECG values from the transmitter. Pc is used to store the information from the LIFI receiver. All the actions are performed with help of pic Microcontroller. Every actionis going to displayed on the LCD. The captured EEG signal is modulated using OOK-NRZ and transmitted through red, green and blue color of a RGB LED. At the receiver, three photodiodes are installed, each being equipped with an individual color filter as shown in Fig. 2.Each color filter receives the modulated data from the specified color only. After demodulation, the received signal from each photodiode is then compared with the signals received from the other photodiodes. Finally, selection combining [7] is performed to detect the most probable bits.

4. EXPRIMENT

Fig. 3 shows the experimental setup of the proposed scheme. The experiment is carried out under VLC condition. The distance between the transmitter and the receiver is 50cm. The transmitter is employed with HL022 RGB LED. OOK-NRZ modulation is utilized to modulate the data on visible light beam. The microcontroller Atmega 2560 acts as an interface between the PC and the transmitter module at the transmitter side, and also between the receiver module and the PC at the receiver side. The receiver part is modeled with three TSL252R photodiodes and each photodiode is provided with an individual color filter (BP635, BP525 and BP470 (MIDOPT)) to demodulate the received signal. The color filters detect the data modulated from the specified color only. Using the experimental setup, we transmitted the single channel EEG data obtained from the EEG toolbox [8] using OOK-NRZ and observed the received signal. Evidently, it exhibits significant distortions at certain points due to errors in the received data. The error in most significant bits (MSB) is of much concern and thus for a reliable and accurate communication of the EEG data, the distortion in MSB should be effectively eliminated. Meanwhile, the error in other bits does not cause much distortion, but this should also be reduced or eliminated. To verify a reliable and accurate transmission of the EEG biomedical data, we analyzed the transmission of EEG signal in the experimental setup. Fig. 3(b) shows the experimental result of the proposed system that employs a RGB LED and selection combining with color filters. It is clear that the transmitted signal is accurately received with very high reliability. As part of further evaluation of the effectiveness of the proposed system, we continued to perform simulations under additive white Gaussian noise (AWGN) and computed the bit-error rate (BER) at various levels of signal-to-noise ratio (SNR).

5. REQUIREMENTS

These are the requirements for doing the project. Without using these tools and software's we can't do the project. So we have two requirements to do the project.
They are

1. Hardware Requirements.
2. Software Requirements.

A. HARDWARE REQUIREMENTS

The hardware requirements may serve as the basis for a contract for the implementation of the system and should therefore be a complete and consistent specification of the whole system. They are used by software engineers as the starting point for the system design. It shows what the system does and not how it should be implemented.

- Pic16f877a microcontroller – 2 no's
- LIFI transmitter
- LIFI receiver
- LCD-2 no's
- ECG sensor
- Heart Beat Sensor
- Temperature Sensor

B. SOFTWARE REQUIREMENTS

The software requirements document is the specification of the system. It should include both a definition and a specification of requirements. It is a set of what the system should do rather than how it should do it. The software requirements provide a basis for creating the software requirements specification.

- MP lab
- Embedded c

CONCLUSION

An experimental data transmission scheme for EEG signal using VLC is proposed. Using this scheme, the system achieves a BER of 4.74 × 10−6 at low SNR values and shows excellent reliability of the critical biomedical EEG data without causing any RF radiation in hospital areas. In addition, the proposed system can transmit not only the EEG data but also other biomedical data simultaneously. This system would ideally be suited to a VLC-based healthcare environment. Nonetheless, it is envisioned that the proposed system can also technically be incorporated in existing instruments of EEG with practical and suitable LEDs and receivers fitted.

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