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Efficient Transmission Using a Visible Light Technology for Data Communication- A LIFI Approach

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Abstract

It is a new technique to transmit secure data using light energy, for sending and receiving the data using light, LED (Light Emitting Diode) from one node to another node. In the decade research, the sender's node light will blink continuously blink when the data is transferred to the receiver node. this might look awkward like a remote control. And moreover, there are drawbacks in the wireless network which used as Wi-Fi for node and there might be speed difference in the nodes when using the network like some node get the high speed of data transfer and remaining nodes suffer at very low speed. This problem will overcome in the Li-Fi approach since the light radiation received on the receiver side is similar and the receiver node will able to transfer data at high speed even the device is far away from the sender. The data transfer rate will be 9600 bits per second, it means the speed is sufficient to transfer without lagging. Li-Fi System is mostly applicable for the mobile nodes and IoT devices with embedded software, color sensor, and a microcontroller. The light source from the mobile node communicates with the color sensor on the receiver node which further covert the light data into digital information. These applications are mainly used in consumer product IoT devices.

Keywords: Visible Light Communication, Max 232 IC, Photo-phone, photodetector, data interpreting, GUI,IoT.

Introduction

The purpose of LEDs to transmit the signals between the node with the data transfer rate of 10kbit/s to up to 500 Mbit/s in the range of 1 to 2 kilometres ie 0.6m to 1.2 miles. As the distance between the nodes increased larger and powerful optical LEDs are used for data transfer. In general, these electronic

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devices are designed such that they have a photovoltaic receiver to receive the signals from the light sources from the mobile nodes or other IoT devices. In simples' devices that are like communication between two nodes, the single light source and receiver are used. In some sensor nodes, the sensor can provide multiple channels for optical communication and spatial awareness of more light sources. Visible Light Communication (VLC) can be used as a communication channel for unique devices because it generates light communication devices such as televisions. traffic signals etc. This visible-light is less dangerous for humans and it can be used for high power applications as a data transmission channel[23][24]. This idea originates from the development of Li-Fi, the history of this dates back to the year 1880s, the United States of America where the Scottish born scientist Graham bell discovered a photo-phone[25][26], it transmits the speech as a modulated sunlight over several hundred of meters. This led to the path of the transmission of voice over the radio. In 2003, at Nakagawa Laboratory at Keio University[27], Japan the research over the transmission of data using LEDs starts and a prototype is designed by three Undergraduate students at the University of Buenos Aires, they transfer the data using amplitude modulation of 532nm laser diode with 5mW photodiode detector at the receiver end. Since then many research activities focussed on VLC, notably such as smart lighting engineering centre, project omega.

Working Model

The main objective of this paper to perform the data transmission in an efficient manner over a maximum distance, and transmit the data in highspeed with a reliable format. To carry out this process, a LED of 650nM 5V with a red dot and a silicon photodiode is used as a sender and receiver. In this study, the communication is made in serial way to perform the data transmission between the two nodes. The transceiver mainly consists of Max 2312 IC for sending the data in the format of light and in the receiver side DB9 pin is used for receiving the data. The Light is made such a way that it on and off simultaneously as per the data received. It is received as a binary format if the receiver gets to zero the output of MAX 232 will be 0V or else it will be 5V.

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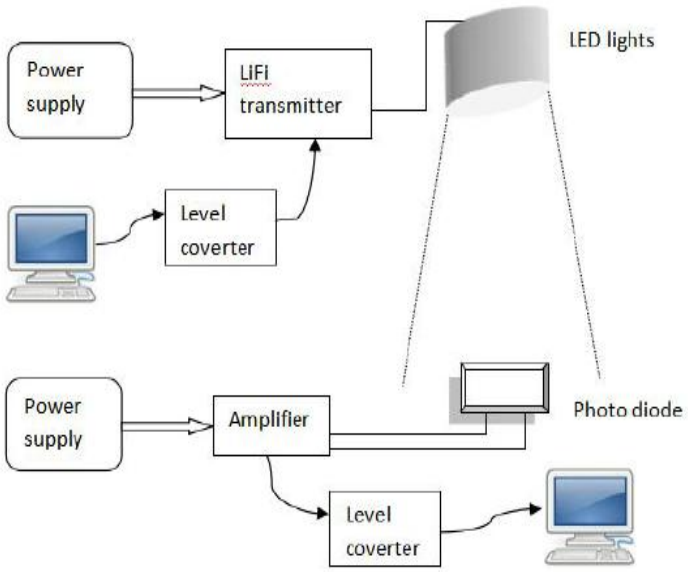

Fig 1. Block diagram of LIFI

The Li-Fi circuit consists of three major sections which are used to transfer the data using VLC and they are,

1. Energy Impart section
2.Sender Section
3.Receiver Section

Energy Impart Section

The Sender and Receiver are worked with the power of 5V DC. It is designed in such a way using the regulating IC 7805. The bridge rectifier is achieved by using the IN4007 diode. For wide range applications, the 780x serious of constant voltage integrated circuit voltages regulators are designed. These regulators are single-point regulation and each of these regulators can provide up to 1.5 A of current. The internal power limiting and thermal shutdown properties of these regulators make them unique to overload. In additional, fixed voltage regulators are used along with the external components to get the regulated output voltages and current.

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Transmission Section:

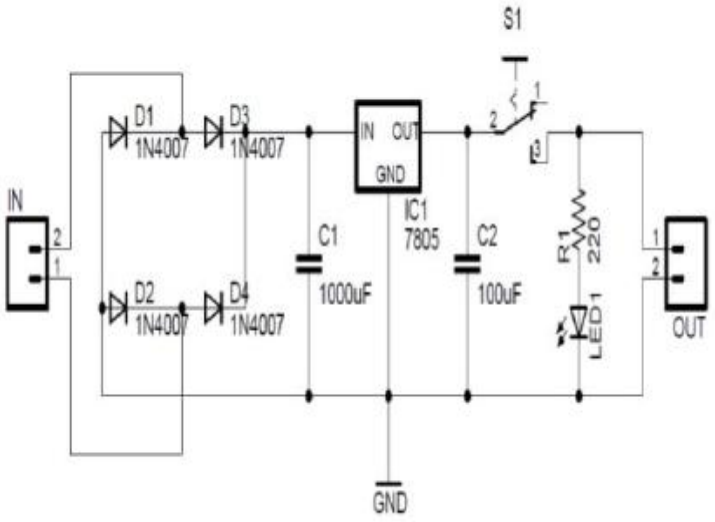

Fig 2. Transmission Unit

The Sender Section processes the data and transmits to the receiver in the form of VLC. There are several components in the sender section which encode the data into the light source, they are

a) node with the HyperTerminal program
b) Max 232 IC
c)Switching Circuit
d)Diode-Laser

One of the main Components in the sender section is the VLC source. For transmitting the data from sender to receiver the LASER is used to perform serial communication. The serial communication is performed between the nodes using the RS 22 pin. For the efficient and high-level analysis, the image is transmitted from one pc to another pc for experiment purpose and the result is evaluated by the program called hyper terminal program. In this Sender side, the data which is to be transmitted is converted to binary format using the MATLAB software and further its inputted into hardware section, then the binary data is processed by Max 232 IC's and given as input to the LASER light with the configuration of 650nm 5V red dot laser diode. Thus, the binary data is processed into a light source and transmitted as serial communication. The binary file is encoded as, like when the LASER is on its considered as 1 and if it's off it would be 0.

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Fig 3. Transmitter

Receiver Section

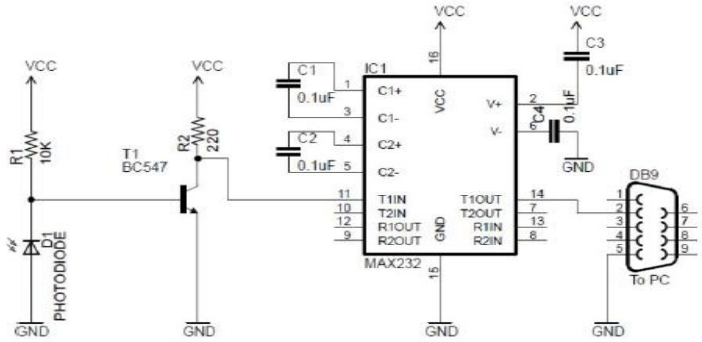

Fig 4 Receiver Unit

In the receiver section, the laser light is received using the silicon photodiode. The silicon photodiode captures the VLC and transmits it to the Max 232 IC, here it performed the decoding operation by converting the light source into binary data. Once the binary data is identified it is processed using MATLAB software by recovering the original image from the binary data and the nodes can finally view the data transmitted by the sender.

Implementation

Li-Fi technology works based on communication between one node to another using visible. The proposed system consists of Li-Fi sender and receiver circuits with powerful LEDs and photodetector, Max 232 IC, and serial communication port. The sender node will select the data to be transmitted and it is processed and it's transferred as a light source. In the receiver end, the light source is processed and its original data is recovered from the light source.

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The proposed Li-Fi working system consists of following units.

a) GUI Unit
b) Date analysing unit
c) Data conversion unit
d) Transmitting unit
e) Receiving unit
f) Data interpreting unit

The data analysing unit senses the data from the sender node and sends the data to the data conversion unit to process the data. The data is thus processed into a suitable format for transmission i.e. binary format. The binary format is widely used in all communications since it can be easily represented as a digital signal. Before transmitting the data can be processed using a few cryptography techniques to ensure the data is transferred in a secure manner. Then the data is given as input for the transmitter unit, the transmitting unit converts this binary data into an electric source and makes the LED on-off pattern based on the binary data. Thus, the data is transferred from the sender. In the receiver unit, the light source is captured using the photodiode. and it processes the light signal and converts that light source to the binary file. Then the binary file is decrypted using the cryptography techniques. Thus, the original data is recovered at the receiver end. The data interpreted unit is applied in both sender and receiver side so that it can convert the data into binary format.

Results and Discussion

This Li-Fi System is capable of transferring any format of data such as text, image, and multimedia data between the two nodes at high speed. The main requirement for this Li-Fi is the line of sight between the sender and receiver. This makes the Li-Fi limitation used to within a small geographical area as a LAN. But the speed and accuracy of this technology is faster and more reliable than wireless signal transmission. Here the VLC acts as the main source for the data transfer and receiver. The visible light region of 375nm-780nm is used as the medium of data transmission. With continuous research and the speed is now achieved about 800Mbps speed. Many companies and their research development unit invested in Li-Fi research in order to implement full-fledged on their network.

Conclusion

In this paper, the VLC is processed and analyzed under all real transmission criteria. To maintain the efficiency communication under drastic situations the data transfer bits are transmitted and BER of less than the range of 10-3. The data rate must be increased when the LED light is in dimmed condition. To achieve this a variable M-QAM OFDM is applied along with the VLC devices,

where M is modified at first according to the duty cycle, by adjusted the symbol rate. The results have explicitly shown that the symbol rate are not always larger than the original rate which guarantees that the communication also be made in best in the dimming light control scheme.

Future Work

Li-Fi works efficiently in the LAN area networks without any need for modulation technique. As this technology is improving a lot in upcoming years in the future these technologies are widely used to data communication in space shuttles, satellites, and space technologies. This is method is wireless communication so that data transmission is accurate and faster in an efficient way.

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