An Efficient Intelligent System for Data Communication Using LIFI Technology

[1]Dr. Naveen Rathee, [2]Shreyaa Nagpal, [3]Abhinav Malik, [4]Charvi Khandelwal

[1]Department of Electronics and Communication, Bhagwan Parshuram Institute of Technology, Sector-17 Rohini, Delhi, India

[2, 3, 4]Bachelor of Technology, Bhagwan Parshuram Institute of Technology, Rohini, Delhi, India

ABSTRACT

The congestion of radio spectrum has led to the development of new wireless technology, Light Fidelity also referred as LIFI, which has a much broader spectrum. LIFI is a technology based on visible light communication (VLC) that makes use of LEDs as a source for data communication. The intensity of LED varies faster than a human eye can follow and helps to transmit the data. Our research deals with the usage of this technology for the future good of the world. A simple experiment to show the transmission of alphanumeric data using visible light communication is carried out. A Led light is the only source to transmit the data from the transmitter end to the receiver's. A keyboard is being employed as an input for the alphanumeric data and an LCD to display the inputted characters.

KEYWORDS

Light Fidelity; LIFI; Visible Light Communication; VLC; WIFI; Microcontroller; Keyboard; LCD.

INTRODUCTION

The mobile technology and communication system have been developed far ago when WIFI (wireless fidelity) came into picture .Introduced 30 years down the line , WIFI came as a medium replacing the wire line.[1] Involving the usage of the radio waves of the EM spectrum, WIFI turned out to be a necessity. With further introduction of 2G, 2.5 G, 3G and the latest 4G, the radio spectrum has been exploited. It is subjected to a spatial reuse and causes co-channel interference. Visible light communication has been introduced as an effective, efficient and an environment friendly technology that is capable of replacing WIFI and shortcomings of the RF spectrum.

Light is the fastest medium when used in vacuum and a lot cheaper than WIFI. With over a wavelength of 300nm to 700nm, the visible light spectrum proves to have a 10,000 times broader spectrum than the Radio wave spectrum [2]. Moreover, the need of the base stations, which are only 5% efficient as 95% of the energy is vitalized in cooling them, is eliminated .With 10 gbps and above speed, no licensing is required for the allocation of spectrum as in WIFI, no RF interference and prevention from harmful exposure to radio waves, LIFI stands out as a technology which has the potential to replace WIFI. [3]
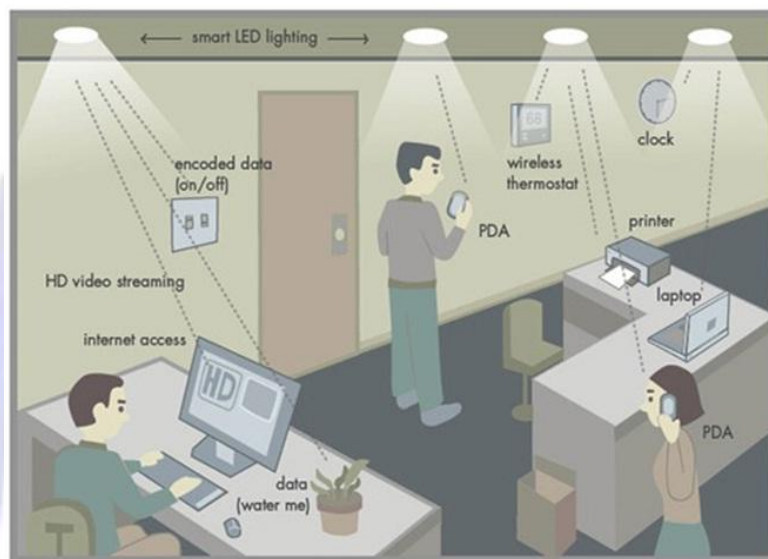

Figure 1: LIFI hotspots for data communication

PRINCIPLE OF LIFI TECHNOLOGY

LIFI is a technology in which the transmission of any data takes place through illumination .A process in which the LED light bulbs are incorporated for the transmission of data at a rapid rate incapable for a human eye to follow. [4]

An LED Light bulb follows a simple process of the digital data transmission. The data is converted into binary forms of '1' or '0' for an easy understanding. Whenever LED is on, the digital data '1' is transmitted and when LED is off,'0' is transmitted.[6] A led bulb is installed with microchip to manage the illumination, conversion of data into binary form and the high speed varying of the amplitude .A photo detector most likely a photodiode is used as a receiver of the binary data .The receiver circuit then decodes back the original data.[5]


Figure 2: Transmission of data in binary form

Figure 3: LCD display showing data transmission

An LED light bulb being the quintessential part of the visible light communication can serve a speed of 100 mbps and above. However, a reason that LED may replace the use of laser or the incandescent or fluorescent lamps is its credibility to rapidly transmit data at 10,000 to 20,000 bits per second.
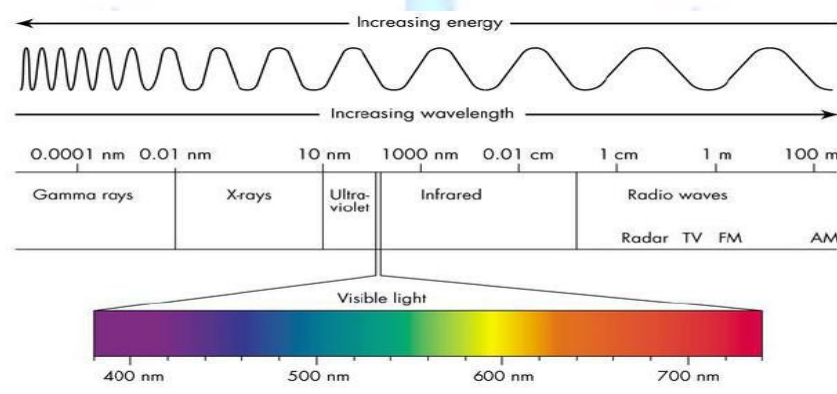
Figure 4: Visible light spectrum used for LIFI technology

LIFI COMMUNICATION

The LIFI technology given by Herald Hass, the German physicist, university of Edinburg in UK, is modeled by the IEEE 802 workgroup. This workgroup has suffice potential to transmit media, video, audio files. With the similar protocol as TCP/IP, LIFI defines the usage of two layers for its model, the physical layer (PHY) and the media access layer (MAC). MAC layer is used as a link to the other layers whereas the PHY layer is categorized into further 3 PHY layers based on their rates.

- PHY I- 11.67kbps to 267.6 kbps (for outdoor application)
- PHY II- 1.25 mbps to 96 mbps (reaching data)
- PHY III- 12 mbps to 96 mbps (emitting sources)

The modulation technique for the first two physical layers identifies the use of OOK (on –off keying) or BASK (base amplitude shift keying) and a variable pulse position modulation (VPPM). [9]

CIRCUIT DIAGRAM AND WORKING

Transmitter:

The transmitter section comprises of a keyboard connected with a PS2 connector and interfaced directly with microcontroller IC AT89S52. IC AT89S52 also referred as 8052, is a 40 pin IC, used to provide serial data communication. A crystal oscillator with a frequency of 11.0592 MHz is used to provide the desired clock frequency to the microcontroller for its working. Two paper capacitors of 27 pf are used to stabilize the clock frequency.

A 9v dc voltage is provided to the transmitter section with the help of a battery, which is step down to 5v using voltage regulator IC 7805. A capacitor of 10uf and a resistor of 10k ohms are connected with the microcontroller to provide the reset function. Two transistors, one NPN (IC TIP L6 122) and the other PNP (IC BC5578) are together used as a Darlington pair and are used to provide push pull amplification. The output of this transistor pair is connected to a led torch. A green led is used which glows if the caps lock key is on.

The keyboard can be used to send alphanumeric data. The spacebar, backspace, delete and enter commands can also be used. If the caps lock key is on then alphabets in the uppercase and special characters (! @, #, $, %,^,&,*,(,)) can also be transmitted. When a key is pressed on the keyboard, the ASCII code of that key is sent directly to the microcontroller.

The microcontroller converts the ASCII code into binary and sends this data to the transistor pair. The PNP transistor works at off state i.e. it reads zero in the binary code, while the NPN transistor works at on state i.e. it read one in the binary code. This transistor pair then sends the binary pulse containing zeros and ones to the led torch. The led torch is on when it reads a one and is off when it reads a zero. The blinking of led light is so fast that it cannot be detected by a human eye. A light channel (duct) is used through which this light is made to pass, so that it doesn't get scattered and thus help in efficient communication.
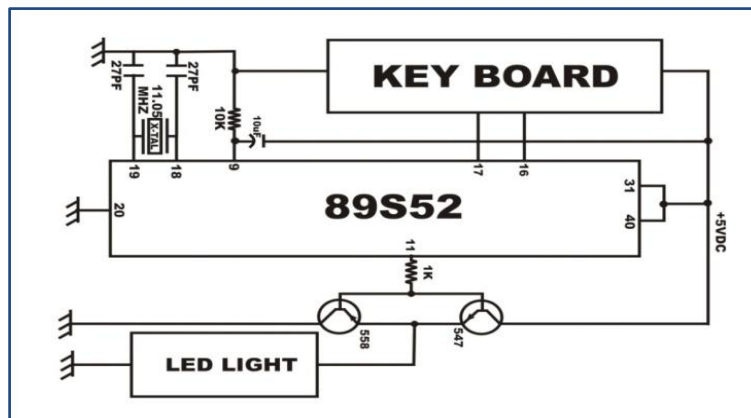

Figure 5: Circuit diagram of transmitter

Figure 6: Hardware design of transmitter

Receiver:

The receiver section comprises of a photodiode connected to the PNP transistor (IC BC 5578). A 9v battery is attached to the circuit to provide the power supply. A voltage regulator IC 7805 is used to step down the 9v dc supply to 5v dc supply for the working of the microcontroller AT89S52. The microcontroller is connected with a crystal oscillator of 11.0592 Mhz to provide the clock frequency, along with two paper capacitors of 27pf to stabilize this frequency. A 10 uf capacitor is also connected to the microcontroller to provide the reset function. A button switch is used to provide the manual reset function. The microcontroller is interfaced with the 16x2 LCD to display the data that is sent by the transmitter.

The light from the led torch is made to fall on the photodiode. The photodiode detects the blinking of the led, and transmits this train of ones and zeros to the transistor. The PNP transistor is in on state when a zero is detected by it and is in off state when a one is detected. This on and off state of transistor is read by the microcontroller and it converts this binary code so formed as a result of on and off , into an ASCII code. The microcontroller then sends this ASCII code to the 16x2 LCD for display, which is directly interfaced with microcontroller.
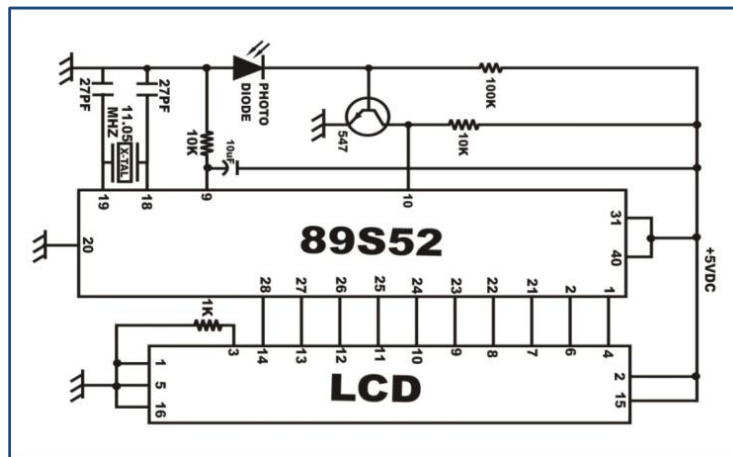
Figure 7: Circuit diagram of receiver

Figure 8: Hardware design of receiver

Complete Circuit:

Figure 9: Complete hardware implementation

HYPOTHESIS

Before conducting the experiment, our major objective was to transmit the data effectively and efficiently. Consequently, we formulated the following four hypotheses:

H1: Visible light is essential for the communication of data otherwise the data communication will be hampered.

H2: The rate of transmission of data depends on the intensity of light that is being provided.

H3: Since LEDs are used, the noise created in the environment will not affect the data transmission or reception.

H4: A perfect line of sight is required to transmit the data.

TESTING THE MAIN HYPOTHESIS

H1 is partially confirmed. Until and unless the light is visible to the human eye, no matter how dim it may be, the alphanumeric data is displayed on the 16x2 LCD used.

H2 is denied. The rate of transmission of data doesn't change when the intensity of light is reduced or increased. The data is transmitted and received at the same pace.

H3 is confirmed. Since the LED light flickers so fast that a normal human eye cannot even perceive, the noise also doesn't affect the data communication that is taking place.

H4 is partially confirmed. A perfect line of sight is not required but desired. When we transmit the alphanumeric data using a reflector in a duct, the data communication takes place perfectly. It's just that when reflected light is used the signal strength is less but the communication is still taking place.

OBSERVATIONS

Table 1: Observations of research

PARAMETERS	OBSERVATION
Height at which the source can be kept for LIFI communication to take place	Minimum height : 7 cm Maximum height : 75 cm
Light allowance	Data transmission occurs at every LED light that has a microcontroller operation attached with it.
Temperature range	0 - 70 Degree Celsius
Variation with Intensity	Intensity of light doesn't hamper the transmission of data. The data is transmitted even when the light is cold, dull and less intense.

RESULTS

This experiment provided an insight into the upcoming technology i.e. data communication using LED light. The communication of alphanumeric data in this experiment was done using a simple 8052 microcontroller and it enabled the data to be transmitted and received effectively. We also concluded that any LED light that has the microcontroller operation embedded with it can be used for the data transmission and reception. Moreover, the increase or decrease of intensity will not affect the communication between the transmitter and receiver if the light is visible. However, when there is an obstacle in between the light and the photodiode, the data transmission does not take place.

So, an unobstructed light is required for continuous communication. This technology cannot be used to transmit over solid materials or opaque structures but this can be advantageous in a way that it is more secure and safer in comparison to WIFI as data theft here will not be an issue.

APPLICATIONS

LIFI, with its manifested applications, is a safe and secure form of data transmission when a proper path is provided for its communication as compared to radio frequency transmission. LIFI technology finds its use in petrochemical industry, Airplanes, hospitals, military and navigation operations where radio frequencies cannot be used reliably as they create problems. Moreover, installation of microchips in street lights can also act as free access point for the purpose of data communication as it is mostly available everywhere.

CONCLUSION

Our experiment showed the alphanumeric data communication through a simple LED light. We can conclude that for a LIFI communication to take place we don't need a physical medium like wires, modem, or any other connection but a LED lamp or torch with a microchip. It can work efficiently in a place with no light obstruction. It's high speed and security has made it to be one of the safest technologies that can be used for communication. LIFI is a new technology and its growth is bound to occur. Its future applications can be extended to fields like education, medical, military, industry and many more.

REFERENCES

[1] Cisco Visual Networking Index, "Global Mobile Data Traffic Forecast Update, 2012-2017," White Paper, CISCO (Feb. 2013).

[2] en.wikipedia.org/wiki/visible_light_communication.

[3] http://computerinformationsite.com/2011/09/07/networking-through-lights-optical-data-transfer- using- li-fi, 7 September 2011.

[4] www.lificonsortium.org.

[5] http://heightech.blogspot.in/2012/10/lifi-latest-technology-in-wireless.html, October 2012.

[6] http://beyondweblogs.com/what-is-li-fi-is-this-replacing- Wi-Fi/

[7] seminarprojects.com/s/seminar-report-on-lifi.

[8]http://www.slideshare.net/niket7861/vlc-visible-light-communication-leaders-of-li-fi.

[9] M. Thanigavel M .Tech CSE DEPT, GKCE, Sullerpet, AP, India-IJERTV21S10048.