ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 7, Issue 8, August 2018

Wireless Data Transfer using Solar Panel in Li-Fi Technology

Aayush Gupta[1], Syed Adeebul Hafiz[2], Iltesha[3]

Students, Department of Electronics and Communication, Jamia Millia Islamia, New Delhi, India[1,2,3]

Abstract: This paper attempts to showcase the accessibility and availability of a simple Li-Fi system to be used in our everyday life, made from basic equipment at home. It also discusses various parameters such as distance, visibility and angle that affects the Li-Fi communication using a solar panel array. The use of solar cell allows the system to harvest energy along with receiving signal simultaneously. It also highlights the uses of this technology in the future that makes it an exceptional candidate to dominate in the coming era.

Keywords: Solar Panel, Li-Fi, Wireless, LED, Security

I. INTRODUCTION

Today, the need to provide higher speeds and secure communications for smartphones, tablets and portable computers and other devices has dramatically increased in all related sectors [1]. This voracious demand of high speed and secure communication can no longer be fulfilled by antiquated wireless technology, which gave rise to the Li-Fi (Light Fidelity) technology. Instead of using the conventional radio frequency signal, this technology uses the signal in the frequency range of visible light (300nm to 700nm). The use of visible light spectrum allows the use of additional 400THz frequency band as compared to the 300GHz band of radio waves [2].

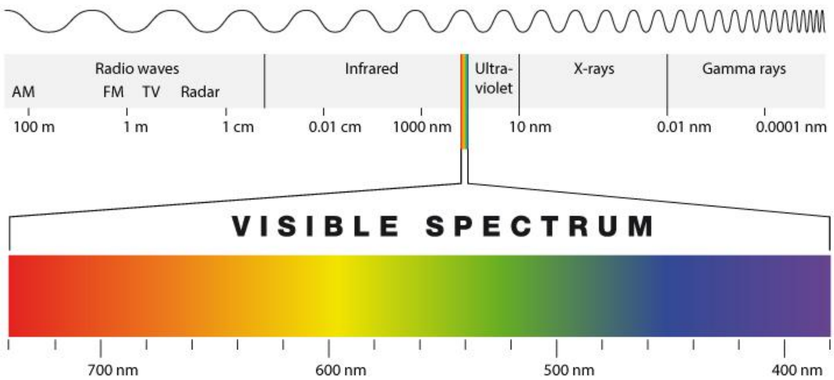

Fig 1. Photo of the spectrum

Li-Fi offers a major advantage over RF communication as the light waves cannot penetrate through the walls and cannot be intercepted by anyone outside whereas, due to the high penetrating power of the RF signals they can travel through the walls and can be received by anyone. Such systems can be used in a military area, banking, and offices where privacy and security are critical. The RF signal-based communication can have a maximum transmission speed of 600Mbps whereas Li-Fi offers speeds well over 10 Gbps from a single LED [3]. The signal to noise ratio is directly proportional to the frequency and bandwidth of the signal therefore Li-Fi technology provides a means of communication which is far less affected by the noise than Wi-fi Technology [4].

In this paper, we present the general model of Li-Fi based system and how the use of Solar Panel as a receiver will enhance the efficiency of the system. And parallelly contrast the advantages of Li-Fi based communication system for secure areas.

The paper is divided into 6 sections. Section II will focus on explaining the proposed model of Li-Fi technology system along with its components. An efficient receiver for a Li-Fi technology that makes it an exceptional candidate to dominate is future along with the performance of Li-Fi are discussed. Section III describes the experimental setup and the following Section IV explaining the working of experiment and discussing its findings. Section V lists various application of Li-Fi in current and future world. And Finally, the Conclusion is given in section VI.

DOI 10.17148/IJARCCE.2018.7816

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 7, Issue 8, August 2018

II. ARCHITECTURE OF LI-FI SYSTEM

Li-Fi is essentially a fast and cheap version of Wi-Fi. It uses visible light of the electromagnetic spectrum which ranges between 400THz to 800THz. This paper proposes the model of a system which uses fast pulses of light to transmit information wirelessly and received by a highly efficient PV solar cell, which can be used parallelly for energy generation [5]. The components of the proposed system include:

1. Transmitter (An LED bulb with modulator)
2. Channel (Air)
3. Receiver (A PV Solar cell/ Solar panel)

A. TRANSMITTER

The transmitter of the proposed model consists of an LED, a PCB (Printed Circuit Board) to control the electrical signals of the inputs and outputs of the bulb along with a microcontroller to manage the function of lamp, an RF (Radio Frequency) signal generated by the Amplifier is aimed towards the LED. The transmitter operates by switching it on and off at a speed faster than human perception is used to generate a sequence of 0s' and 1s' [6]. Fig 2 shows the transmitter of a general Li-Fi system. The whole setup is enclosed with the LED protruding out of the enclosure to send the Li-Fi signal into the medium.

Fig. 2. Li-Fi Transmitter/LED

B. CHANNEL

The channel through which the signal will prorogate is primarily taken as air. However, any medium that allows the light to pass through can be taken as the channel. Since the visible light cannot pass through opaque objects such as walls, trees, etc. The signal is confined to a local area and cannot be intercepted by any unwanted receiver, thus providing a secured connection [7].

C. RECEIVER

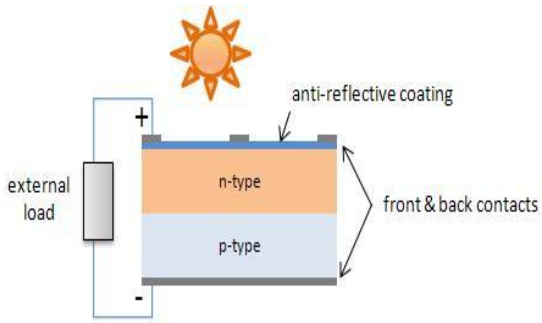

Fig 3. Photo of PV cell

The receiver of the model consists of a photovoltaic solar cell as shown in Fig. 3. The intensity of signal falling on the solar cell is dependent upon the distance between the light source and the solar cell and on the orientation of the solar cell with respect to the source given by the eqn. 1[8].

$$P = (k * \cos(\theta))/l^2 \quad (1)$$

Where P is the Power received, l is the distance between transmitter and receiver, k is a constant that depends on the environmental factors and theta is the angle between normal of solar plate and source.

The specification of the receiver such as number, type of solar cells used, and signal amplifier are dependent upon the type of data being transmitted, the speed with which it is to be transmitted and the distance from which it is being transmitted [9]. For e.g. many solar cells are required if the distance between the solar cell and light source is large. Fig. 4 shows a solar panel used in the setup. The solar cell used in the receiver can also simultaneously serve the purpose of the generation of energy which can be used for the regeneration of signal by the amplifier or can simply be stored for future use [10].

Fig 4. Receiver

III. EXPERIMENTAL SETUP

A rudimentary setup as shown in Fig. 5 was constructed to provide the verification of the concept. The setup consists of a laptop as a source of signal with three 5V LEDs connected through Arduino for amplification and processing. This acts as a transmitter. The receiver is a 36-polycrystalline cell based solar panel with a max output of 6V whose signal was given to a loudspeaker with inbuilt amplifier via aux cable.

Fig 5. Experimental Setup

IV. EXPERIMENT AND RESULTS

In this section, the principle used for the proposed model and the working of the setup has been described. Along with this, the experiments performed, and its results have also been summarized. In the model, data transfer is accomplished by standardized and well-defined amplitude modulation techniques. Due to the high switching speed of LED, the variation is not perceived by the human eye but can be detected through the solar cell receiver i.e. the changes in the intensity causes a fluctuation in voltage of the solar cell. As the intensity of light increases the voltage across the cell increases [11]. The air act as channel to the light just as any EM wave, and hence making the system wireless.

The paper is supported by the model by sending an audio signal to a loud speaker over Li-Fi. An MP3 audio file is converted to MIDI format and sent to Arduino through serial communication for amplification and processing [12]. This signal is sent as PWM signal to an LED transmitter that varies the intensity of light as per the variations in the input signals. The LED transmitter is facing towards the solar cells which detect the variation of intensity as variance in the output voltage of the array. The detected voltage signal is sent to an amplifier via aux cable which then is connected to an audio device that decodes the signal and produces the sound wave corresponding to the signal received by the solar array.

The transmitter and receiver initially kept at 25 cm apart successfully transmitted complete audio signal without any delay or noise. Communication at different distances have also been performed and the setup was successfully able to communicate the audio signal.

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 7, Issue 8, August 2018

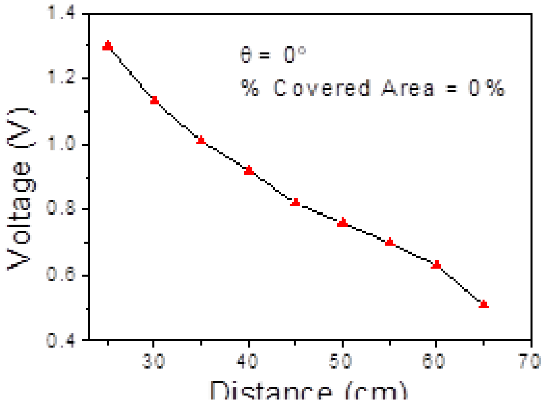

Fig 6. Voltage across the solar panel output vs distance between the solar panel and LED transmitter.

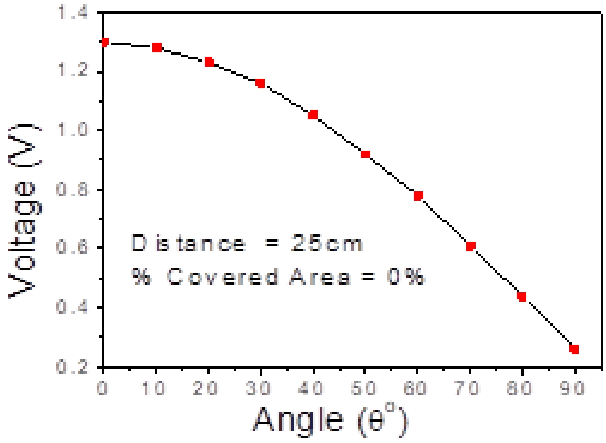

Fig 7. Voltage across solar panel vs the angle between the surface and incident ray from LED transmitter.

However, with increasing distance, the noise and delay also increases. This is due to the lowering of intensity at the surface of solar cell by increasing the distance as shown in Fig 6. and as indicated by eqn. 1[8].
Variation in the angle of incidence of the light from bulb also shows that as the angle of incidence rises the signal strength decreases as shown in Fig 7. and subsequently signal tends to get noisy [13].

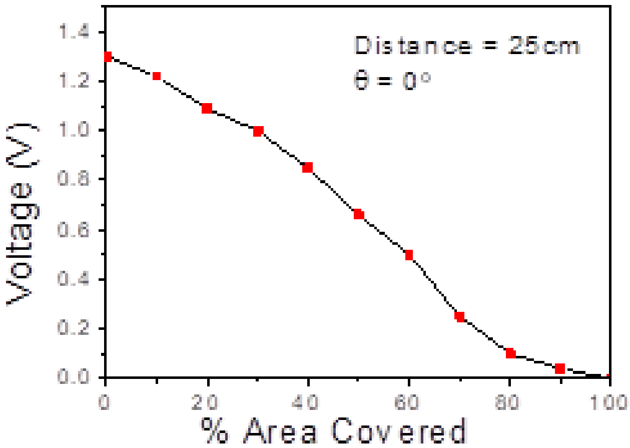

Fig 8. Voltage across solar panel vs the percentage area covered of Solar panel by an opaque object.

An experiment to show that the receiver could also detect the signal when partially covered with a cloth to simulate the visibility condition of the natural environment was also performed. When covered with a white cloth it continued to transmit the audio signal with small noises and a decrease in the amplitude of the sound through the speaker. An opaque object covering the receiver at different steps indicated that with the decrease in the area of a cell a proportional decrease is observed in the amplitude of the signal. Fig 8. Shows the graph between Voltage across solar panel and area covered.

V. APPLICATION

There are ubiquitous uses of Li-Fi which makes it an extremely dominating candidate in the future of communication and technology. These systems are fast, readily available, efficient and most importantly secure. Li-Fi systems could allow public to access the internet through everyday household devices and can play a major role in making Internet of Things (communicating all electronic devices through internet) a reality [14].
Li-Fi systems can be used in place where Wi-Fi can't be employed or where Radio interference is of major concerns such as operation theatres where radio signals might affect the patient by radiations. Use of Li-Fi will not only enhance the medical equipment control but also can give access of internet to rural hospitals while performing a major procedure or operation to be administered remotely by top professionals. Li-Fi systems can be used in airplanes to provide cheap and fast internet to the passenger without interfering with the radio communication of aircraft [15].

On the other end, it can also find its uses in underwater vehicles which requires long cables for communication and supply power, which can be tackled with the above-proposed model as it provides simultaneous transfer of energy and information through a single transmitter source and receiver. Li-Fi offers a safer communication in sensitive areas such as power plants especially nuclear power plants that need monitoring of core temperature as in such places the radio communication is considered unsafe [16] [17].

With these inescapable demands of future Li-Fi systems with street lights providing free internet access, cars communicating through headlights and traffic lights regulating them, light bulbs securing the important information within the buildings with restricted access, and abundant use in education systems, disaster management and mobile connectivity provides the driving force to help and develop the future communication system.

CONCLUSION

Li-Fi is a suitable technology for the future as it provides higher bandwidth, increased data rate and more security as compared to Wi-Fi technology. The success of the experiment conducted above shows that setup of Li-Fi can be made with the very basic material. Based on the experiment it can be concluded that the distance between receiver and source, the relative angle of the receiving solar panel and the transmitting LED, and the area of solar panel exposed to the solar panel to the light plays an important role in the transmission of data using the Li-Fi system. These factors are to be considered before implementing the system.

REFERENCES

[1]. Saini, H., 2012. Li-Fi (Light Fidelity)-The future technology In Wireless communication.
[2]. Shetty, A., 2016. A Comparative Study and Analysis on Li-Fi and Wi-Fi. International Journal of Computer Applications, 150(6), pp.454-460.
[3]. Haas, H., Yin, L., Wang, Y. and Chen, C., 2016. What is lifi?. Journal of Lightwave Technology, 34(6), pp.1533-1544.
[4]. Pujapanda, K.P., 2013, April. LiFi integrated to power-lines for smart illumination cum communication. In Communication Systems and Network Technologies (CSNT), 2013 International Conference on (pp. 875-878). IEEE.
[5]. Tsoutsos, T., Frantzeskaki, N. and Gekas, V., 2005. Environmental impacts from the solar energy technologies. Energy Policy, 33(3), pp.289-296.
[6]. Tsonev, D., Videv, S. and Haas, H., 2014, February. Light fidelity (Li-Fi): towards all-optical networking. In Broadband Access Communication Technologies VIII (Vol. 9007, p. 900702). International Society for Optics and Photonics.
[7]. Uysal, M., Miramirkhani, F., Baykas, T., Serafimovski, N. and Jungnickel, J., 2015. LiFi channel models: office, home, manufacturing cell. IEEE.
[8]. Jordane, D., 1967. Electromagnetic waves and radiating systems. Prentice-Hall Of Lndia Private Limited; New Delhi.
[9]. Bialic, E., Maret, L. and Kténas, D., 2015. Specific innovative semi-transparent solar cell for indoor and outdoor LiFi applications. Applied optics, 54(27), pp.8062-8069.
[10]. Huang, Q., Li, X. and Shaurette, M., 2014. Integrating Li-Fi wireless communication and energy harvesting wireless sensor for next generation building management.
[11]. Benghanem, M., 2011. Optimization of tilt angle for solar panel: Case study for Madinah, Saudi Arabia. Applied Energy, 88(4), pp.1427-1433.
[12]. Diakopoulos, D. and Kapur, A., 2011, May. HIDUINO: A firmware for building driverless USB-MIDI devices using the Arduino microcontroller. In NIME (pp. 405-408).
[13]. Wang, Z., Tsonev, D., Videv, S. and Haas, H., 2015. On the design of a solar-panel receiver for optical wireless communications with simultaneous energy harvesting. IEEE Journal on Selected Areas in Communications, 33(8), pp.1612-1623.
[14]. Haas, H., 2016, October. LiFi: Conceptions, misconceptions and opportunities. In Photonics Conference (IPC), 2016 IEEE (pp. 680-681). IEEE.
[15]. Karthika, R. and Balakrishnan, S., 2015. Wireless communication using Li-Fi technology. SSRG International Journal of Electronics and Communication Engineering (SSRG-IJECE), 2(3), pp.32-40.
[16]. Sharma, R.R. and Sanganal, A., 2014. Li-Fi Technology: Transmission of data through light. International Journal of Computer Technology and Applications, 5(1), p.150.
[17]. Karthika, R. and Balakrishnan, S., 2015. Wireless communication using Li-Fi technology. SSRG International Journal of Electronics and Communication Engineering (SSRG-IJECE), 2(3), pp.32-40.