PC-PC COMMUNICATION USING LI-FI

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ABSTRACT: Li-Fi or light fidelity refers to 5G visible light communication system using light emitting diodes and laser light, as a medium to high-speed communication in a similar manner as Wi-Fi . Li-Fi is a better alternative to WI-FI in wireless communication. It has more capacity in terms of bandwidth in visible region therefore it does not poke its noise in other communication which uses radio frequency range.
Here for establishing communication between two PCs Light- Fidelity communication is used. An analog signal generated in one PC is transmitted to another PC using LI-FI transmitter and receiver. Then nonlinearity introduced in the received signal is studied.

KEYWORDS: LI-FI,WI, FI,GIFI,VLC,LASER,LED,IR,EMI,FFT.

INTRODUCTION

Light Fidelity (Li-Fi) is a bidirectional, high speed and fully networked wireless communication technology similar to Wi-Fi. Visible light communication (VLC) using white LEDs offers several advantages over the RF-based wireless systems, i.e., license-free spectrum, low power consumption, and higher privacy. Li-Fi, as coined by Prof. Harald Haas during his TED Global talk, is bidirectional, high speed and fully networked wireless communications, like Wi-Fi, using light. Li-Fi is a subset of optical wireless communication and can be a complement to RF communication (Wi-Fi or Cellular network), or a replacement in contexts of data broadcasting. The concept of Li-Fi is data communication on fast flickering of light which is not detected by human eye but it is focused on photo detector which converts the on-off state into binary digital data.
Li-Fi, like Wi-Fi, enables electronic devices like computers, laptop and smart phones to wirelessly connect to the internet. It is so far measured to be about 100 times faster than some Wi-Fi implementations, reaching speeds of 224 gigabits per second.
Visible light communications (VLC) works by switching the current to the LEDs off and on at a very high rate, too quick to be noticed by the human eye. Although Li-Fi LEDs would have to be kept on to transmit data, they could be dimmed to below human visibility while still emitting enough light to carry data. The light waves cannot penetrate walls which makes a much shorter range, though more secure from hacking, relative to Wi-Fi. Direct line of sight is not necessary for Li-Fi to transmit a signal, light reflected off the walls can achieve 70 mbps.
Li-Fi has the advantage of being useful in electromagnetic sensitive areas such as in aircraft cabins, hospitals and nuclear power plants without causing electromagnetic interference. Both Wi-Fi and Li-Fi transmit data over the electromagnetic spectrum, but whereas Wi-Fi utilizes radio waves, Li-Fi uses visible light. While the US Federal Communications Commission has warned of a potential spectrum crisis because Wi-Fi is close to full capacity, Li-Fi has almost no limitations on capacity. The visible light spectrum is 10,000 times larger than the entire radio frequency spectrum Researchers have reached data rates of over 10 Gbps, which is much faster than typical fast broadband in 2013. Li-Fi is expected to be ten times cheaper than Wi-Fi. Short range, low reliability and high installation costs are the potential downsides.
Pure Li-Fi demonstrated the first commercially available Li-Fi system, the Li-1st, at the 2014 Mobile World Congress in Barcelona. Bg-Fi is a Li-Fi system consisting of an application for a mobile device, and a simple consumer product, like an IoT (Internet of Things) device, with colour sensor, microcontroller, and embedded software. Light from the mobile device display communicates to the colour sensor on the consumer product, which converts the light into digital information. Light emitting diodes enable the consumer product to communicate synchronously with the mobile device.

Figure 1 shows the block diagram of experimental set-up used for implementation of PC- PC communication using LI-Fi. Upper part of the block diagram is a transmitter section and lower part is a receiver section.

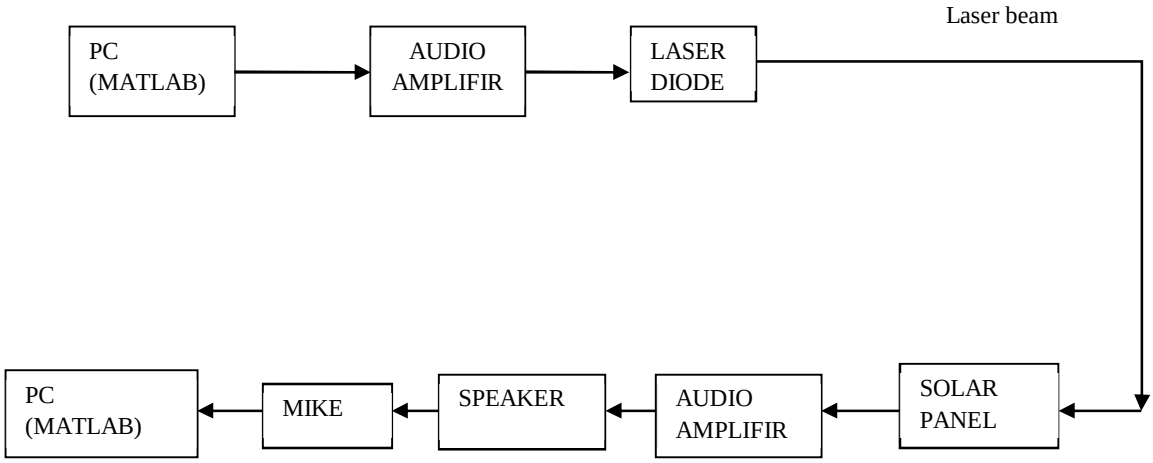

Figure. 1. Block Diagram for Experimental Set-Up

First an analog signal i.e. a sine wave is generated using MATLAB program in first PC. Then it is amplified and converted into laser beam. This laser beam falls upon the solar panel. The electrical signal i.e. the voltage output from solar panel is first amplified and given as input to speaker. There is a one mike connected to the analog input port of second PC. The sound generated by speaker is given as input to the mike. This audio signal from mike is used to reconstruct the original transmitted sine wave using a MATLAB program in second PC.

TRANSMITTER SECTION

Transmitter section consists of a PC and a LI-FI transmitter. PC is used to generate a sine wave signal of particular frequency. This signal is given as input to the LI-FI transmitter by using a connector connected to the analog output port of PC. Circuit diagram for LI-FI transmitter is shown in figure 2. The analog signal received from PC first passes through the low power audio amplifier, IC LM386, here the signal gets amplified. The output of the LM386 is encoded in the form of light which transfers the data at high speed.

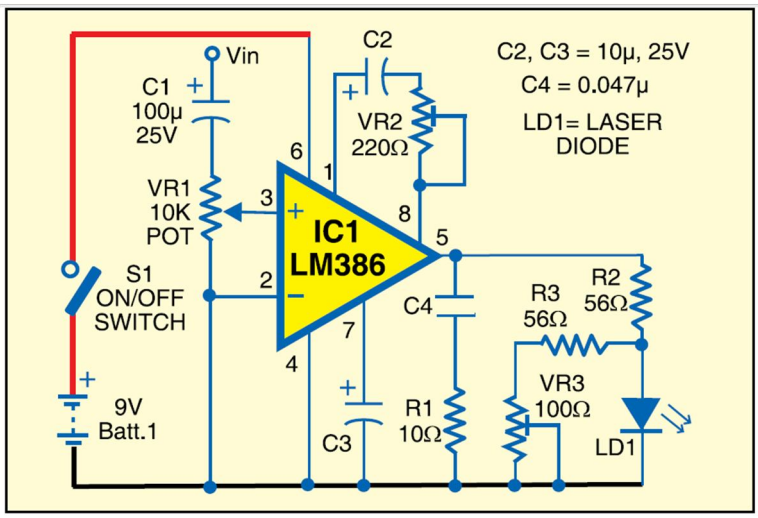

Figure 2. Li-Fi Transmitter Circuit

RECEIVER SECTION

Receiver section consists of a LI-FI receiver and a PC. Here the transmitted signal from a LI-FI transmitter in the form of LASER beam is incident on the optical detector (solar panel) of LI-FI receiver shown in figure 3. The solar panel is

connected to the low power audio amplifier. The output of audio amplifier LM 386 is given to speaker. Now the sound generated from speaker is received by the mike connected to the analog input port of second PC. The spectrum of this signal received from mike is plotted using a MATLAB program.

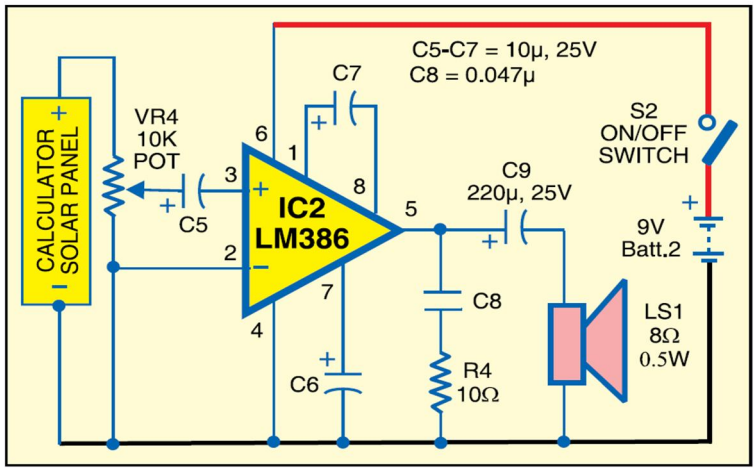

Figure. 3. Li-Fi Receiver Circuit

PERFORMANCE EVALUATION

Experimental set up for performance evaluation requires,

- Two PCS
- Software MATLAB
- LI-FI Transmitter and Receiver
- Audio analog connectors
- Mike

After making hardware connections as explained in the above section simulation is carried out by first generating a sine wave of frequency 500 Hz using MATLAB in the first PC then transmitting it using LI-FI transmitter. This transmitted signal will be received by LI-FI receiver and given as input to second PC. Analysis of this received signal is carried out using MATLAB. The distance between LI-FI transmitter and receiver is varied and then for each case analysis of the received signal is done.

Distance Between LI- FI Transmitter and Receiver - Two Meters

In this case the distance between LI-FI transmitter and receiver was set as two meters.That is information from the first PC will be transmitted in the form of a Laser beam over a distance of two meters.This LaserIn beam fall upon a solar panel connected to LI-FI receiver and got converted into voltage . This voltage is given as an input to second PC.The received signal is plotted in time domain and in frequency domain as shown in figure below.
Figure 4 shows that the received signal is having very less distortion in time domain plot and sine wave is recovered. Also in frequency domain plot signal is present at only one frequency i.e. of 500 Hz, which is the frequency of transmiited signal, no harmonics are present in frequency domain.
In this way non linearity in the received signal is negligible as no harmonics are present in the frequency plot.

Distance Between LI- FI Transmitter and Receiver - Six Meters

In this case the distance between LI-FI transmitter and receiver was set as six meters. The signal i.e. sine wave is transmitted from first PC and received by second PC as stated in the first case. The received signal is plotted in time domain and in frequency domain as shown in figure 5 below.
As the distance between transmitter and receiver is increased nonlineariry gets introduced in to the transmitted signal and after reception of signal it was found that distortion has been introduced in the form of change in the shape of sine wave in time domain. In frequency domain also even though the main peak of the signal is only one, it has been shifted to the right of 500 Hz frequency as compared previous case of two meters. Also the noise introduced in the signal during transmission in the frequency range of 0 – 1000 Hz is clearly appearing in the frequency domain plot.

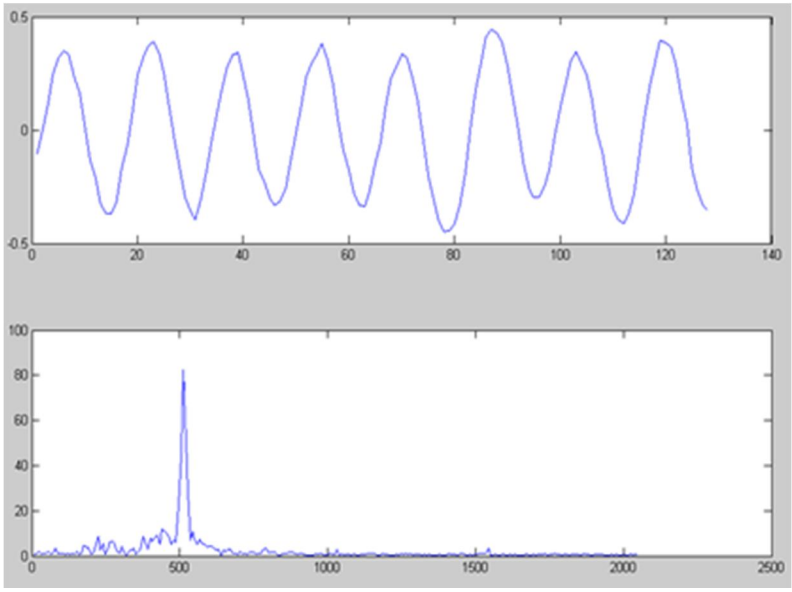

Figure. 4. Received Signal in Time Domain and in Frequency Domain When Distance is 2 Meters

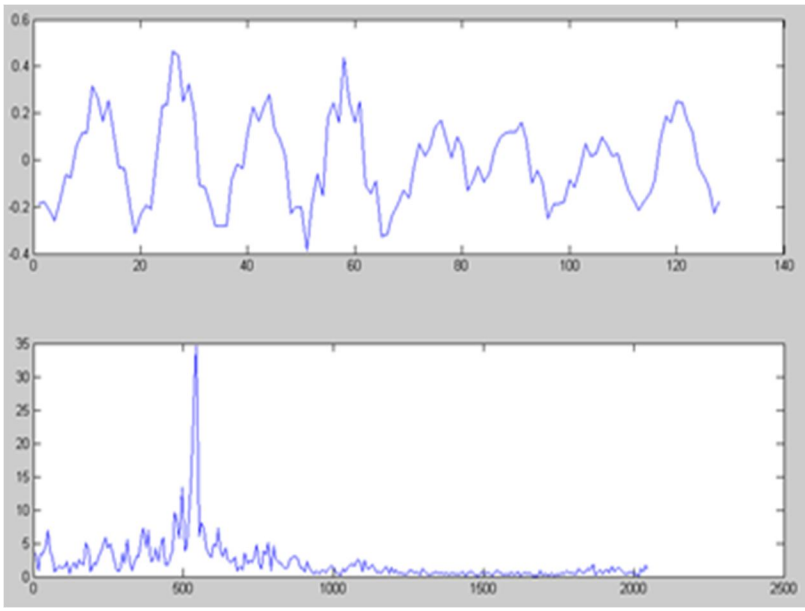

Figure. 5. Received Signal in Time Domain and in Frequency Domain When Distance is 6 Meters

Distance between LI- FI Transmitter and Receiver - Eight Meters

In this case the distance between LI-FI transmitter and receiver was set as eight meters. The same procedure is followed here for transmitting an analog signal i.e. sine wave from one PC to another PC.

As the distance between transmitter and receiver is again increased by two meters as compared to previous one. More noise gets introduced in to the transmitted signal and after reception of signal it was found that the received signal is totally distorted as can be observed in time domain plot.

Correspondingly in frequency domain plot it can be clearly observed that two harmonics are present with the main signal at 500 Hz. First harmonic is present at 1000 Hz and second harmonic is present at 1500 Hz. The amplitude of distortion present at 1500 Hz is more as compared to the signal component present at 500 Hz. Therefore it is not possible to get sine wave after reception.

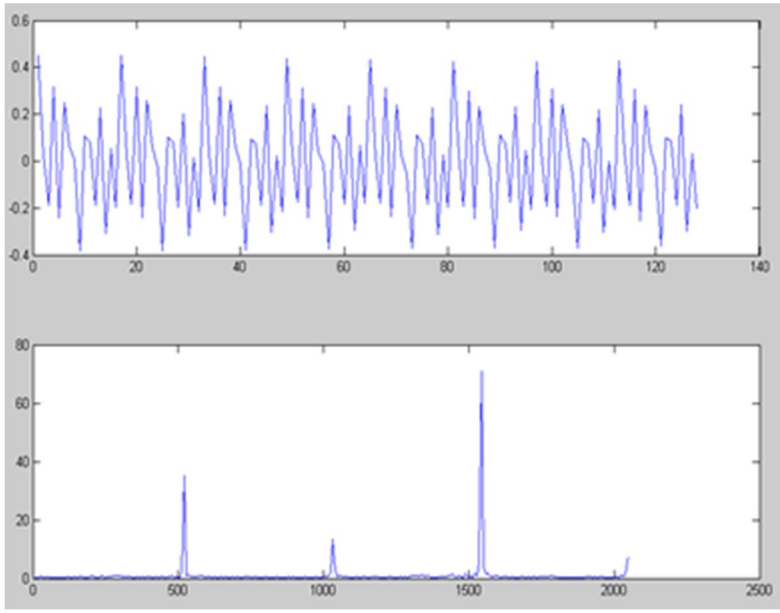

Figure. 6. Received Signal in Time Domain and in Frequency Domain When Distance is 8 Meters

CONCLUSION AND FUTURE SCOPE

LI-FI is an emerging technology and hence it has vast potential. A lot of research can be conducted in this field. This technology, pioneered by Harald Haas, can become one of the major technologies in the near future. If this technology can be used efficiently, we might soon have something of the kind of WI-FI hotspots wherever a light bulb is available. It will be cleaner and greener and the future of mankind will be safe. As the amount of available bandwidth is limited, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. The LI-FI technology can solve this crisis. Moreover, it will allow inter access in places such as operation.

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