VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

Project Report

Analog Electronic Circuits

Submitted by:

1. Ayushman Mookherjee 18BEC0888
2. Sunandan Chakrabarty 18BEC0865
3. Havish C 18BEC0897

Submitted to: Professor Jasmin Pameena

ABSTRACT

Light Emitting Diodes (LED) are used in different areas of everyday life. The advantage of this device is that in addition to their lightening capabilities, it can be used for data transmissions as well. In this project, we have made an exhaustive study on technology of Li-Fi and its applications in transferring data. We have tried to learn the future scope of this new technology for using visible light as the carrier in data transmission and networking through this project.

Introduction

All of us have increasingly become dependent on the internet some way or the other. It is impossible to think of a day in our lives, when we are not “connected” to the “net”. We are using the internet for a variety of purposes, chief among them being sharing of data. In scenarios where we want to transmit data quickly and efficiently, low internet speeds can be quite annoying. With Li-Fi, we can connect to the internet simply by being within range of an LED beam, or we could conceivably transmit data using our car headlights. The ramifications of this are huge, especially with the internet of things in full swing and the much-mooted spectrum crunch expected to bite increasingly hard in the coming years.

Li-Fi (short for light fidelity) is a technology for wireless communication between devices using light to transmit data and position. In its present state only LED lamps can be used for the transmission of visible light. LiFi is a new way to establish wireless communication links using the Led lightning networks. Li-Fi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through LED light bulb that varies in intensity faster than

the human eye can follow. LiFi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication

Working principle

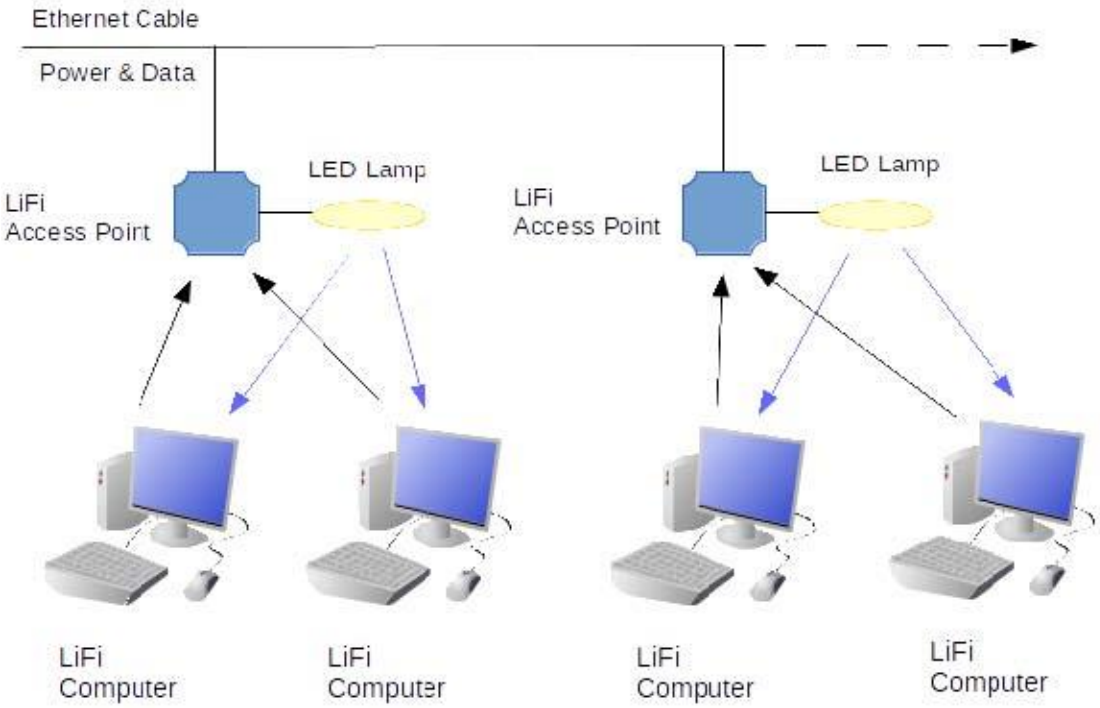
By varying the current through the LED at a very high speed, we can vary the output at very high speeds. This is the principle of the LI-FI. The working of the LI-FI is itself very simple—if the LED is ON, the signal transmitted is a digital 1 whereas if it is OFF, the signal transmitted is a digital 0. By varying the rate at which the LEDs flicker, we can encode various data and transmit it. Li-Fi and Wi-Fi are quite similar as both transmit data electromagnetically. However, Wi-Fi uses radio waves while Li-Fi runs on visible light.

As we now know, Li-Fi is a Visible Light Communications (VLC) system. This means that it accommodates a photo-detector to receive light signals and a signal processing element to convert the data into 'stream-able' content.

An LED lightbulb is a semi-conductor light source meaning that the constant current of electricity supplied to an LED lightbulb can be dipped and dimmed, up and down at extremely high speeds, without being visible to the human eye.

For example, data is fed into an LED light bulb (with signal processing technology), it then sends data (embedded in its beam) at rapid speeds to the photo-detector (photodiode).
The tiny changes in the rapid dimming of LED bulbs is then converted by the 'receiver' into electrical signal.

The signal is then converted back into a binary data stream that we would recognise as web, video and audio applications that run on internet enables devices.


Ethernet Cable
Power & Data
LED Lamp
LiFi
Access Point
LED Lamp
LiFi
Access Point
LiFi
Computer
LiFi
Computer
LiFi
Computer
LiFi
Computer

Components Required

PARTS LIST	
Semiconductors:	
T1-T3	- BC337 npn transistors
LED1	- White LED, 1W
R1, R3, R5	- 4.7-kilo-ohm
R2, R4, R6, R8-R10	- 1-kilo-ohm
R7	- 2.2-ohm, 1W
Capacitors:	
C1-C3	- 2.2µF, 25V electrolytic
Miscellaneous:	
CON1	- 2-pin connector
BATT.1	- 9V battery
	- Stereo/mono audio jack*
	- Li-Fi speaker*
	- 3V, 200mA solar panel*
	- Audio source (like MP3 player or mobile phone)*

Procedure

The first thought in making such type of wireless connection possible was understanding how we will transfer the digital signal (music) to analog signal (led light) varying at several kHz . This was the place where digital modulation came into picture. The aim of digital modulation is to transfer a digital bit stream over an analog communication channel, for example over the public switched telephone network (where a bandpass filter limits the frequency range to 300–3400 Hz) or over a limited radio frequency band.

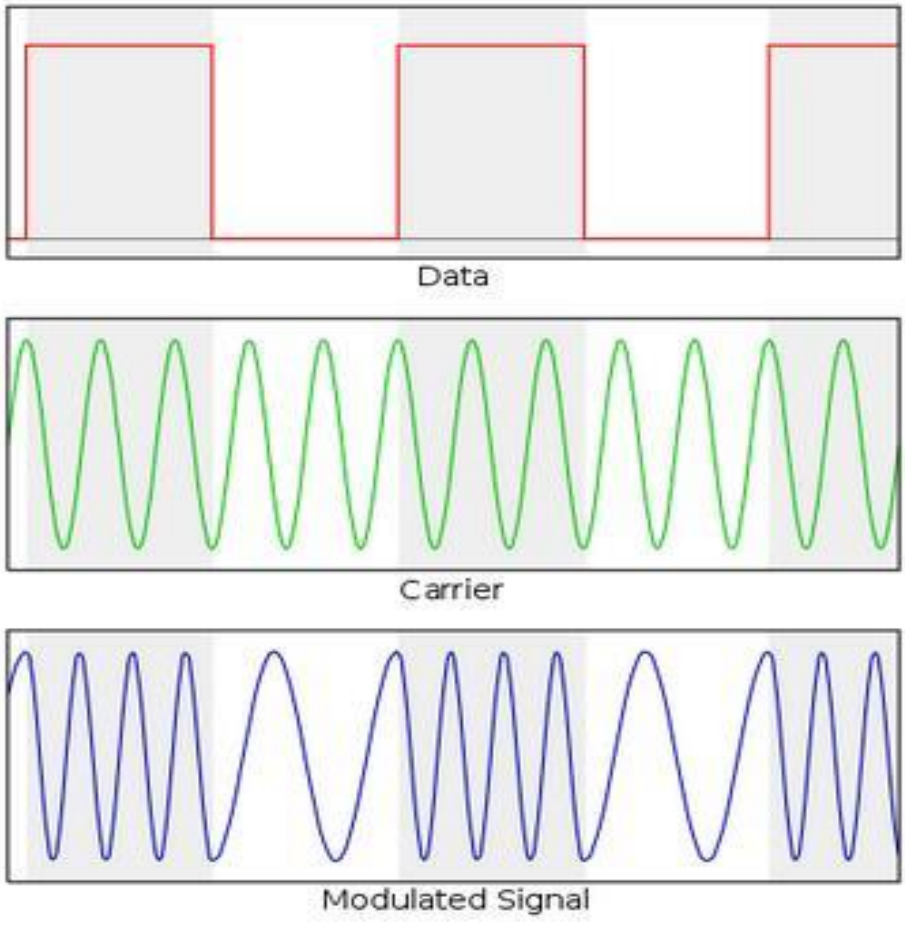
Instead of using the radio frequency band we tried using light source such as an led. Led light from naked eye looks stable but is varying with several kHz frequency to transmit the data . We tried signal modulation for music signal by encoding it within the light.

How does a digital signal look like?

A digital signal refers to an electrical signal that is converted into a pattern of bits. Unlike an analog signal, which is a continuous signal that contains time-varying quantities, a digital signal has a discrete value at each sampling point.

It is simply a value 0 or 1. When we send several such values in a stream it happens very quickly with transmission of sound signal

by putting led on for 1 and off for 0 that is not sensed by our naked eyes .



The data is just simply encoded in the carrier signal i.e. the light signal and passed through the transmission module. Now we tried checking the output as this was the simple modulation.

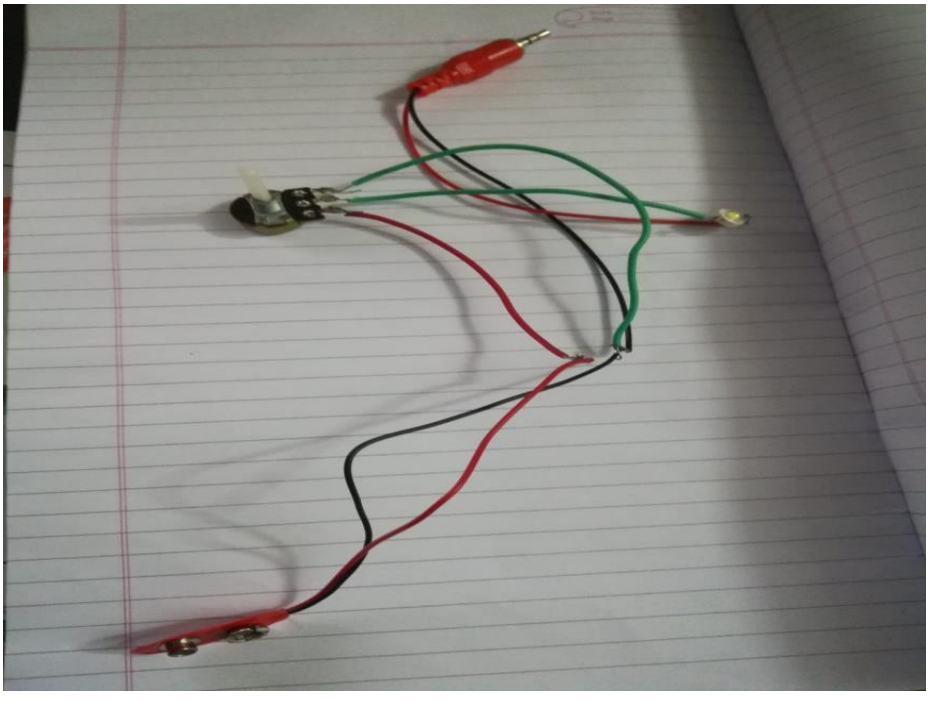


Figure: 1st prototype of the Lifi dongle

The first initial modulation was completed but what we needed was a receiver for the analog signal .

Before that let’s see how conventional speakers work?

Speakers work by converting electrical energy into mechanical energy (motion). The mechanical energy compresses air and converts the motion into sound energy or sound pressure level (SPL).

When an electric current is sent through a coil of wire, it induces a magnetic field.

In speakers, a current is sent through the voice coil which produces an electric field that interacts with the magnetic field of the permanent magnet attached to the speaker.

Like charges repel each other and different charges attract. As an audio signal is sent through the voice coil and the musical waveform moves up and down, the voice coil is attracted and repelled by the permanent magnet.

This makes the cone that the voice coil is attached to move back and forth. The back and forth motion create pressure waves in the air that we perceive as sound.

As we saw the highlighted point when we change the voltage across the terminal of a conventional speaker it produces sound .

Figure: a conventional speaker with its positive and negative terminals

So, it is very clear that varying electric current or voltage can help us get back the sound we wrote on lights carrier signal.

The next step is how will we vary the voltage with the varying intensity of light. There were many options such as a LDR or photodiode, but with them comes the complexity of building the circuit and its surface areas are very less so we might lose some of the beats from our music.

Only 1 Device which could properly vary voltage with varying light was Solar Plate.

Figure : Solar panel with its positive and negative terminals.

A solar panel works by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity. Solar panels actually comprise many, smaller units called

photovoltaic cells. (Photovoltaic simply means they convert sunlight into electricity). So, by varying the light signal to encrypt the sound and then varying the voltage through solar plate to decrypt the voltage completes the total pair of transmitter and receiver.

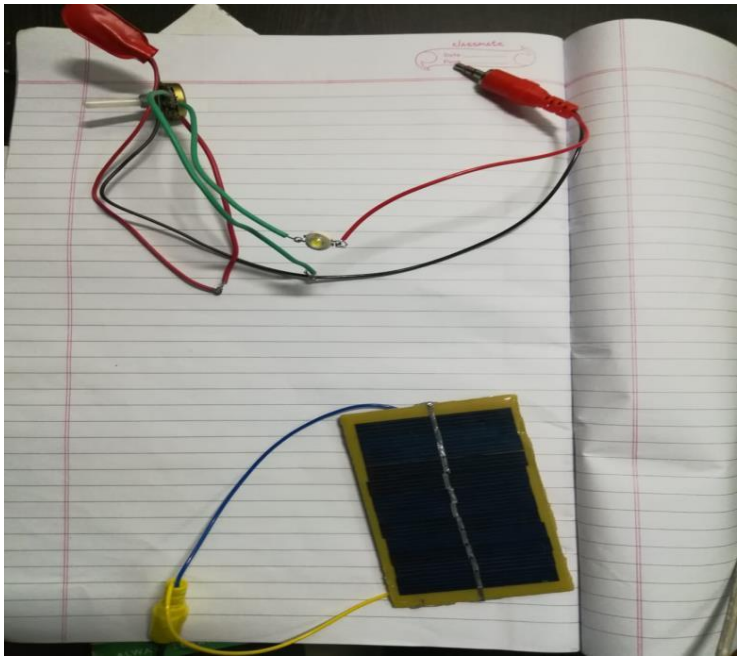


Figure: 1st prototype of transmitter and receiver.

We are ready to test our basic circuit of transmission and receiver by connecting one end of the audio jack to the mobile phone and other to the speaker.

Issues faced in 1st prototype:

The issue what we faced was a lossy signal, we directly tried modulating the signal from our mobiles phones audio jack to

the led by giving it some power through a 9-volt battery. This made a successful transmission but was very low volume at the speaker end.

The signal needed a boost or amplification from the existing prototype. The next step was making an amplifier for boosting the audio signal.

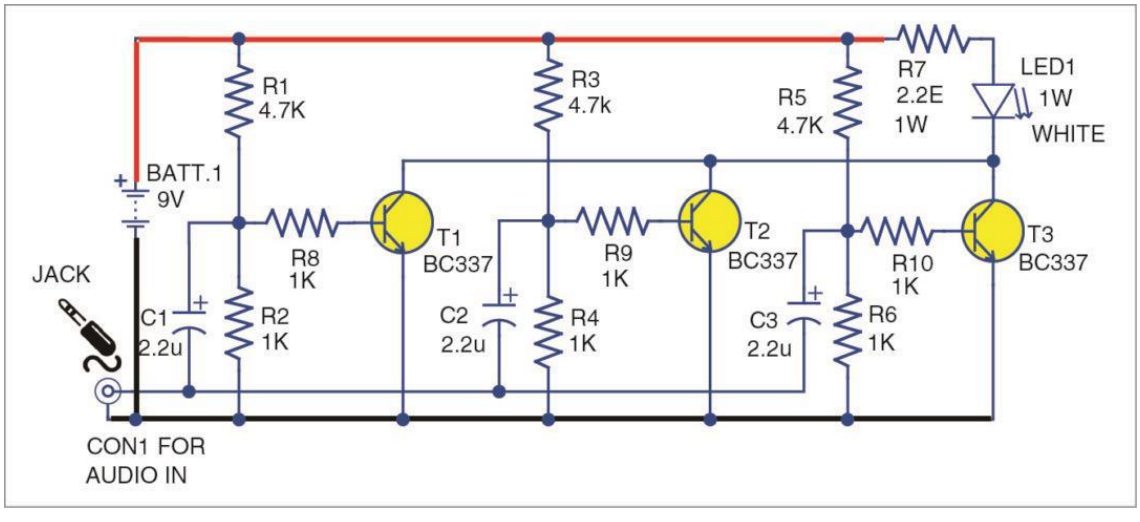


Figure: The audio amplifier needed for the LiFi

The audio amplifier increased the circuitry to a very lengthy looking circuit but was a well more filtered and amplified.

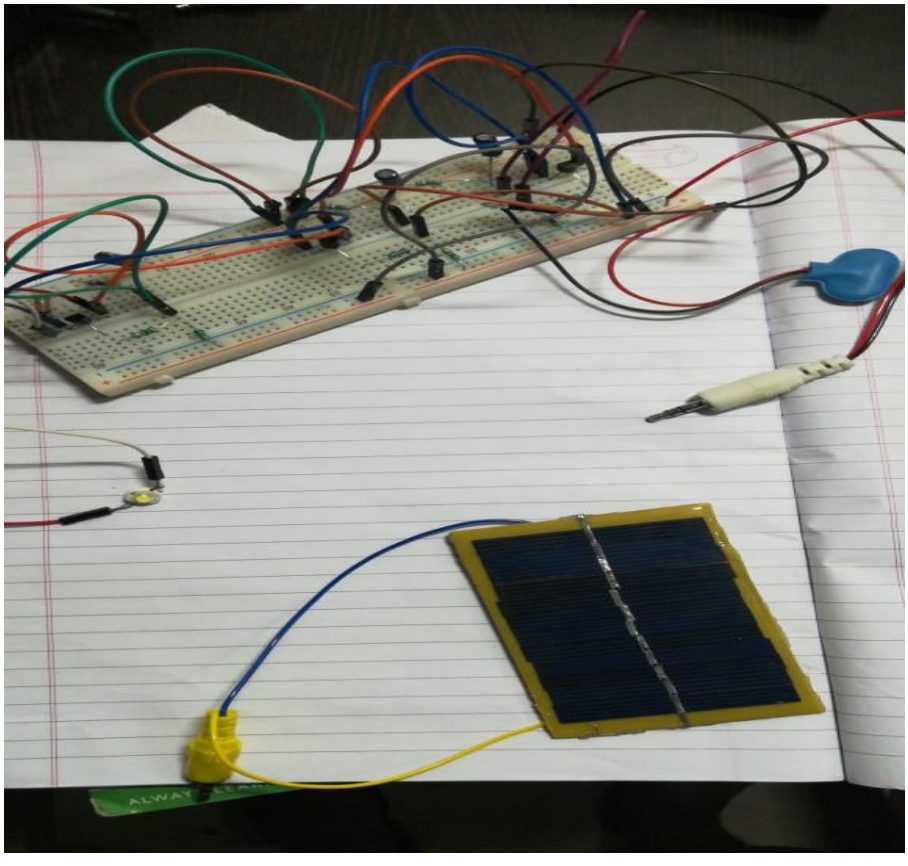


Figure: The final prototype.

As we can observe only the dongle is changed from the previous prototype as the dongle is given the required amplification from the previous version.

The final prototype was tested and the sound was way more clear and better as compared to the older generation LiFi dongle .

Depending on the the transmission it is clearly seen light is medium with highest bandwidth and any type of signal can use it as a carrier signal , carrier signal. The bandwidth of this type of

signal is huge and its easily used by numerous signals at a time, the same concept goes for video transmission just it need a larger bandwidth!

Conclusion

There is ample room for growing innovation in Li-Fi technology. Like conventional broadband and Wi-Fi, Li-Fi can also function as a bidirectional communication system. Li-Fi is no longer a concept or an idea but a proven technology, albeit still at its infancy. Li-Fi technology would soon become a standard adjunct to Wi-Fi. That is, until its inherent limitations could be overcome.

With LI-FI ,every bulb can be used something like a Wifi Hotspot to transmit wireless data and we will proceed towards the cleaner,greener,safer and brightest future."

Due to its impressive speeds, Li-Fi could make a huge impact on the internet of things too, with data transferred at much higher levels with even more devices able to connect to one another.

Acknowledgement

We would like to thank our Professor Dr Jasmin Pameena, who provided us with the opportunity to work on the project and guided and advised us along the way. We would like to thank VIT University for giving us the platform to work on the project. Lastly, we would like to thank all the support we have received from our seniors and peers who offered their help in times of need and doubt.

Ayushman Mookherjee (18BEC0888)
Sunandan Chakarabarti (18BEC0865)

Havish C (18BEC0897)

October 2019

Vellore Institute of Technology, Vellore

References

http://www.ijirae.com/volumes/Vol2/iss6/01.JNAE10083.pdf

https://purelifi.com/technology/

https://www.techopedia.com/7/31772/technology-trends/what-are-the-advantages-and-disadvantages-of-li-fi-technology

http://tec.gov.in/pdf/Studypaper/lifi%20study%20paper%20-%20approved.pdf