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Visible Light Communication

Ayush Sharma[1], Sugandha Bajaj[2], Sonia Ahlawat[3]

[1]Electronics & Communication, ITM University, Gurgaon

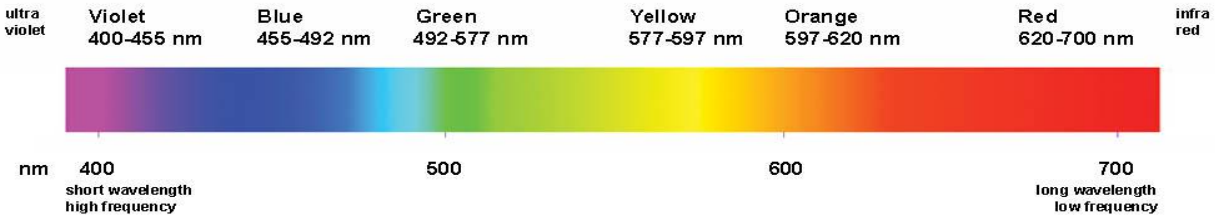
[2,3]Department of Electronics, Shaheed Rajguru College of Applied Science for Women, University of Delhi, Delhi, India

Abstract: ***Visible Light Communication (VLC) is a new and safer way of transmitting data using visible light spectrum (375nm-780nm). It allows a comparatively safer data transfer and uses a safer spectrum than radio spectrum which is being used at present times. LED lights which are used widely in our day to day life because of their low cost and luminous competence are used for the data transmission in VLC. Transmission of data takes place through visible light LEDs at transmitter end and reception takes place using Photodiodes or Photoreceptors at the receiver's end. While using Wi-Fi (wireless fidelity), sometimes there occurs a problem of slow speed when more than certain devices are tapped into the network, as a result of shortage of bandwidth. To overcome this, light is used to transfer data (audio signals in case of this paper) which is known as "DATA TRANSFER THROUGH ILLUMINATION". In this paper, visible light communication is used to transfer audio signals using LEDs.***

Keywords: Communication, LED, Visible light spectrum

1. Introduction

As the social dependency on wireless networking is growing, the wireless technology has to expand to meet the needs of the world. In comparison to ever increasing demand the wireless domain is too much limited, and is not necessarily safe. And this gives an opportunity to explore more alternatives to let the world be in ease of accessing their digital data and communicate with secure data. In today's era there is a rapid development in field of illumination and lighting. The phasing out of incandescent sources and development of solid-state sources is due to the concern in the world about energy consumption. With recent advancement in semiconductor technology, the source can be Light Emitting Diodes (LEDs), especially for low or medium ranged applications. Systems that use visible light as their carriers are termed as visible light communication (VLC) systems. The visible light spectrum is the portion of the electromagnetic spectrum that can be seen through the human eye. It is a very narrow band of wavelengths located to the right of the infrared region and to the left of the ultraviolet region.



SOURCE: ((http://www.physicsclassroom.com/class/light/Lesson-2/The-Electromagnetic-and-Visible-Spectra))

For personal use, VLC provides high speed, low cost, power efficiency, and more secure data transmission in addition to provision of light. The issue of security is solved because the medium for transmission used in VLC system is visible light rather than Radio waves (can penetrate through walls) and light cannot leave the room, keeping our data in one location. There is absolutely no way to access and retrieve data unless someone is in direct contact of the path of light being used for the data transmission. And finally the LEDs are adding to the integrity of the system by being highly efficient and durable. In VLC, the information is converted into bits and transmitted through blinking LEDs. The blinking of LED will not be visible to human eye because they are blinking at very high frequency.

2. About Visible Light Communication (VLC)

VLC means transmission of data using illumination source (LEDs in our case) which in addition to illumination also transmits data using the same illumination source. Although there does not exist any universal definition of VLC, but in literal terms, any light signal (visible to human eye) that can send any form of information can be considered as VLC system. But accordingly the light must be seen but not the "data". The opportunity of sending data usefully in this manner has only arisen due to widespread use of LED bulbs. LEDs are basically semiconductor chips (Previously in form of semiconductor diode) and thus the bulb can switch at very high frequency which was not possible with the old technology. And some other factors that are creating market for VLC are congestion in radio spectrum and availability of LEDs at considerable low cost. Visible light is available in abundance. And also it cannot penetrate through walls, hence making our data transmission secure. And catalyst behind usage of VLC is the improvement in LEDs. LEDs have a quick response to fast switching signal's 'on' or 'off', unlike the previously used light sources. Data can be sent by flickering an LED light on and off in a pattern at such high speeds that are undetectable to human eye.

3. Potential Applications

Visible Light spectrum is available everywhere and that too in abundance, which provides us with several opportunities to apply visible light communications. Some of the potential applications of VLC are:

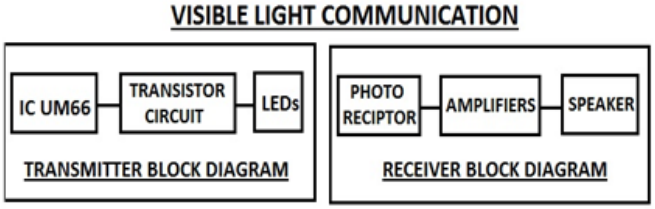
a) **Connectivity**
A very high speed data link can be created securely with visible light. It can provide high data rate than Wi-Fi or Bluetooth.
b) **Wi-Fi Expansion**
Wi-Fi is not able to meet the demands for data transmission and communication. VLC provides much higher data rates than current Wi-Fi and that too at very low cost because costly antenna and other RF components are eliminated.
c) **Environment Suitability**
VLC provides suitable and safe communication for the areas which are hazardous and have risk of explosions such as chemical plants, mines, petrol and gas stations etc.
d) **Country's Defence**
The data can be transferred in a secure way with VLC and also that the visible light can't penetrate through walls, keeping the data safe, which is the key feature to make it useful for defence and security of a country.
e) **Underwater**
Visible Light Communication can provide high speed communication for short distance underwater whereas RF signals don't work inside water. This can indeed be a boon for underwater divers or submarines and other vehicles to communicate.
f) **Health Care**
VLC can be useful in hospital because RF signals are to be kept away from patients in operation theatres, especially away from MRI scanner.

4. Experimental Work

Till now, all the discussion was about visible light communication technology. The implementation of the discussion has been done in form of project. The following components are the key components of the circuit:

- Electrolytic Capacitors
- Zener Diodes
- Resistances
- Transistors
- Op-Amp (IC 741)
- Melody generator IC (UM66)
- Photo Transistor
- Super Bright LEDs
- Audio amplifier IC (LM386)
- Potentiometers
- Speaker
- Battery (9V)

Block Diagram of Visible Light Communication (VLC)



5. About the Circuit

The circuit is divided into two parts: Transmitter and receiver. Both of them operate upon 9V battery. The transmitter circuit basically consists of UM66, Zener diode, transistor circuit (consisting of resistors and capacitors as well) and super bright LEDs. The IC UM66 generates musical tones, then the output of this IC is fed to a network of resistances for limiting the current value. The limited current output is fed to the base of the transistors which is further forwarded to the super bright LEDs.

On the receiver side, we have the photo transistor, a network of resistances with electrolytic capacitors, 741 op-amp IC and LM386 audio amplifier circuit, terminating with a speaker at the end. For the best sound transmission, the LEDs at the transmitter side should be in line with the phototransistor at the receiver side. Then the signal received at the photo transistor is carried to the amplification unit (IC 741 & LM386). Finally, the musical tone is heard through the speaker.

6. Experimental Results

Using the above circuit, there was successful completion and demonstration of transfer of audio signals through visible light. Thus, using a safer mode of transmission, economical set up and line of sight property of the light, the audio signal transmitted at one side of the circuit could be heard at the other side using a suitable speaker. Thus, the emerging technology of transfer through illumination was practically implemented on a small scale basis.

7. Conclusion

In this project a low cost VLC system was implemented for indoor and outdoor applications. It is seen that the system is capable for communication in a power efficient manner. Visible Light Communication (VLC) using LEDs can become a viable option for last mile access and ubiquitous availability. Visible Light Communication (VLC) present fascinating challenges for using appropriate techniques to construct cheap processing units and high brightness LEDs. The technology promises a great mix of importance, from high energy saving using Solid State Lighting technology and high rate data transmission in indoor applications to traffic safety in outdoor environment. VLC will be able to solve many of the problems people have been facing for many years, mainly environmental and power usage issues. VLC is still in its beginning stages, but improvements are being made rapidly, and soon this technology will be able to be used in our daily lives.

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Author Profile

Ayush Sharma is currently pursuing B.Tech in Electronics and Communication Engineering from ITM University, Gurgaon. He is currently working on a project which further explores the visible light communication technology.

Sugandha Bajaj is pursuing her B.Tech degree in Electronics and Communication Engineering from Shaheed Rajguru College of Applied Sciences for Women, University of Delhi, Delhi. Currently indulged in research on Li-Fi (Light Fidelity) and is working on a project based on spiker-box and human-human interfacing (neural science).

Sonia Ahlawat birth Place Delhi received her B.A.Sc. (Hons) degree in Electronics from Shaheed Rajguru College of Applied Science for Women, University of Delhi, in the year 2005, and M.Sc. Electronics degree in Electronics from Department of Electronics Science, University of Delhi South Campus, Delhi in the year 2007. Sonia is currently working as an Assistant Professor in the Department of Electronics Shaheed Rajguru College of Applied Science for Women, University of Delhi, Delhi. She has 8 Years of Service experience in teaching electronics subject. Her area of interest is digital signal Processessing, filter designing, and neural science.