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# Audio Communication and Device Switching using Power LED's through the Visible Light Technology

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**ABSTRACT:** Visible light communication (VLC) is data communication using light photons. VLC uses power Light Emitting Diodes (LED's) which will provide illumination and also used for communication due to their fast switching time which send data by flashing light at speeds undetectable to the human eye. LED's ability to transfer information signals over light which is between 400 THz to 800THz of frequency makes it a very good communication medium. A lot of research is being done to make this technology available for commercial use in various fields including internet access and vehicle to road communication using traffic signal lights.

***Keywords :*** ***VLC, Power LED, OWC, FSO, Li-Fi***

## 1. INTRODUCTION

Optical communication have been used in various forms for thousands of years. After the invention of light amplification by stimulated emission of radiation (LASER) sources and light emitting diodes (LED') in the 1960s, optical communication quickly revolutionized and spread around the world. Wireless networking is dominated by the use of radio frequency (RF) techniques. The desire for low cost, high speed links motivated recent interest in infrared (IR) wireless communication. The theoretical background for visible light communication (VLC) systems is similar to that found in IR communication except that VLCs uses a much wider visible spectrum. Recent report shows that usage of mobile web and Wi-Fi by smart phone is increasing sharply. Accommodating this growing wireless demand with cellular capacity does not seem possible in the long run. At the same time rapid development of new LED materials in the visible spectrum, specially white LED's motivates considerations of visible light communication medium since it is expected to widely used as the next form of illumination. Full use of the capacity provided by fiber delivered to homes will necessitate the use of broadband links including indoor wireless access technologies capable of operating at Gbit/s. In recent years optical wireless (OW) has emerged as a strong candidates for high speed indoor communication.

Indoor optical wireless communication includes two main technologies: visible light and infrared communications.

Concerns about energy saving in general lighting are leading to the replacement of incandescent and fluorescent lamps with more energy efficient solid-state lighting (SSL) devices. These SSL visible light sources can provide communications as well as illumination. And this emerging technology has recently drawn great interest in research and practical applications. The LED-based visible light optical channel becomes a very attractive complement or even substitute for RF techniques. It has advantages of large potential bandwidth (THz) with no regulation or license fee. Finally in addition to lower energy consumption LEDs have a significantly longer lifetime and are safer for the environment lifetime as they lack the harmful ingredient of mercury.

## 2. TECHNOLOGIES USED

### 2.1 Visible Light Communication Technology

The visible light communication (VLC) refers to the communication technology which utilizes the visible light source as a signal transmitter, the air as a transmission medium and the appropriate light dependant resistor as a signal receiving component. LEDs' ability to transfer information signals over light which is between 400 THz-800THz of frequency and whose wavelength is between 400nm-700nm makes it a very good communication medium.

Visible light is the form in which electromagnetic radiation with wavelength in a particular range is interpreted by the human brain. Visible light is thus by definition comprised of visually perceivable electromagnetic waves.

The Visible Light Communications Consortium (VLCC) which is mainly comprised of Japanese technology companies was founded in November 2003. It promotes usage of visible light for data transmission through public relations and tries to establish consistent standards.

There are other terms used in the VLC space which are quite widely used but have slightly different meaning to VLC**. Three terms closely associated with VLC are:**

**Free space optical (FSO) communication** is similar to VLC but is not constrained to visible light, so ultraviolet (UV) and infrared (IR) also fall into the FSO category. Additionally, there is no illumination requirement for FSO and so this tends to be used in narrow beams of focused light for applications such as

communication links between buildings. FSO often uses laser diodes rather than LEDs for the transmission.

**Li-Fi** is a term often used to describe high speed VLC in application scenarios where Wi-Fi might also be used. The term Li-Fi is similar to Wi-Fi with the exception that light rather than radio is used for transmission. Li-Fi might be considered as complementary to Wi-Fi. If a user device is placed within a Li-Fi hot spot (i.e. under a Li-Fi light bulb), it might be handed over from the Wi-Fi system to the Li-Fi system and there could be a boost in performance.

**Optical Wireless communication (OWC)** is a general term which refers to all types of optical communications where cables (optical fibres) are not used. VLC, FSO, Li-Fi and infra-red remote controls are all examples of OWC.

## 2.2 DTMF (Dual Tone Multiple Frequency) Technology

DTMF coding and decoding is implementation based on Hyper signal. The DTMF coding is based on two tones used to generate a digit. Two of eight tones can be combined to generate sixteen different DTMF digits.

The DTMF decoding is based on the discrete Fourier transform (DFT). Using this algorithm, 16 DTMF receivers can be implemented on four frequency Goertzel algorithm function blocks. Then, the output of Goertzel algorithm can be decoded into a digit.

### 2.2.1 DTMF Signal Generation

In a DTMF signal generation a DTMF keypad could be used for digit entry the resultant DTMF tones are generated mathematically and added together. The values are logarithmically compressed and passed to the receiver.

Decoding a DTMF signal involves extracting the two tones in the signal and determining from their value the extended DTMF digit tone detection is often done in analog circuits by detecting and counting zero crossings of the input signal.

## 3. POWER LED'S

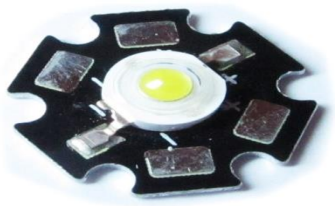

**Fig1: Power LED**

For appropriate VLC transmitter design, the LED characteristics need to be understood. Here we focus on the high-brightness LED for visible wavelength range. Inexpensive, commercial, off-the shelf LED's has good energy efficiency, power reduction, durability, size reduction.

There are two types of visible wavelength LEDs.One category is single color LED, for example, red (R), green (G), blue (B) LEDs. The other category is white LED, which uses phosphors for converting the emission wavelength from the original active area. We will discuss the white LEDs later in this section. Typically, red, green, and blue LEDs emit a band of spectrum, depending on the material system. Red LEDs emits the wavelength around 625 nm, green LEDs around 525 nm, and blue LEDs around 470 nm

The output optical power versus the input current into the LED is one of important parameter. The linear dependence of the output optical power on the input current makes the LED operation easy and is closely related to the data modulation performance. The output optical power depends on the ambient temperature. Depending on the material system, the temperature dependence of the output optical power varies. Generally, the temperature increases, the output optical power decreases.

On the other hand the white LED draws much attention for the illumination devices. Comparing the LED illumination with the conventional illumination such as fluorescent lamps and incandescent bulbs, the LED illumination has many advantages such as high-Efficiency, friendly manufacturing, design flexibility, long lifetime, and better spectrum performance.

Most of white LEDs is comprised of LED chip emitting short wavelength and wavelength converter (for example, phosphor). The short wavelength light from the LED chip is absorbed by the phosphor and then the emitted light from the phosphor experiences wavelength shift to a longer wavelength. As a result, the many wavelength components are observed outside the LED. A white light can be generated from a blue LED with appropriate phosphor. The emission spectrum of a phosphor based LED has the strong original blue spectrum and the longer wavelengths shifted by the phosphor.

1W Power LEDs are high performance energy efficient devices which can handle high driving current and high temperatures. The exposed pad design enables excellent heat transfer from the package to the motherboard. An electrically isolated metal slug option is also available.

The White Power LED is available with color temperatures ranging from 2700K to 10000K. The low profile package design is suitable for a wide variety of applications especially where height is a constraint and the package foot print is compatible with most high power LEDs available in the market today.

## 4. BLOCK DIAGRAM

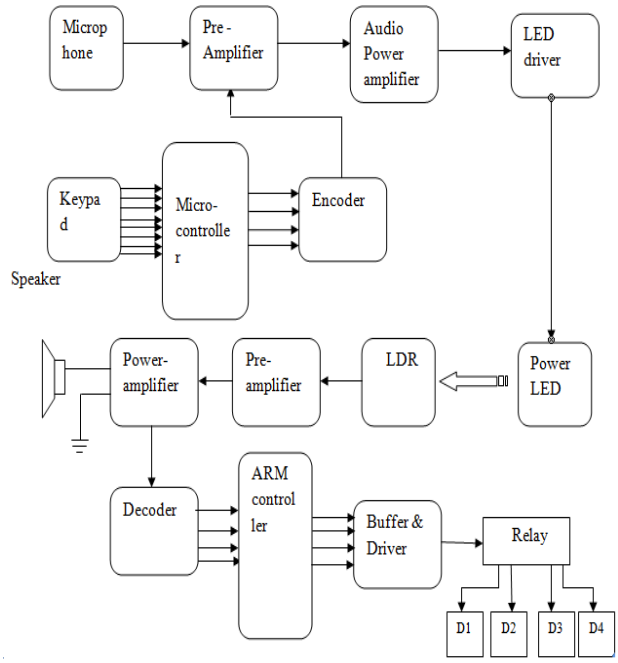


**Fig 2: block diagram of voice communication and device control using power LED's.**

A VLC system used to transmit high quality video and audio signal was proposed and demonstrated by using illumination LEDs. The analog signals were transmitted using the illumination LEDs in the transmitter. The photodiode at the receiver senses optical signals from the LEDs and is converted into electrical signals. The electrical signal is then amplified to recover the digital signal and converted back to analog signals. To obtain this we are amplifying the signal strength such that it will drive the preceding stage such as power LED and its driver and to remove noise we are using capacitor filter.

In this paper we are making use of Light as a source of medium to transmit the signals as we know that light is ambient and it doesn't affect the human's life or nature here we are transmitting the audio signals via light.

## 4.1 Audio Communication

In the process of voice communication through the visible light on the transmitter side voice is used as the input signal. This signal is converted to an electrical signal through a condenser or microphone. This electrical signal is amplified by the amplifier circuits and fed into the power LED. The light signal from the LED varies according to the intensity of the voice signal. The more louder is voice the glow of the LED will be more. At the receiver side light dependant resister will receives the light signal and correspondingly generates an electrical signal proportional to it. This electrical signal is processed by a demodulator circuit, which is then fed to a speaker and it produces the audio signal which was at the input of the transmitter side.

### 4.1.1 Algorithm for audio communication:

- First the input voice is taken through condenser or microphone.
- The voice signal is amplified through pre-amplifier phase.
- Then the signal is transmitted through power LED.
- The light dependent resistor at receiving side converts signal into electrical signal.
- The electrical signal is passed through two amplifier phases.
- Then LM386 audio amplifier amplifies the signal and drives speaker to generate voice output.

## 4.2 Device Switching

In device control application input is given from the keypad. When you press the button on the keypad a connection is made that generates two tones at the same time. A "Row" tone and a "Column" tone. These two tones identify the key pressed for any device to be controlled. When the user presses any particular switch then the DTMF encoder IC will generate a unique pair of frequencies. And accordingly the different keys is pressed signals of different frequencies are generated. This code sequence will be fed to an LED which will emit the light according to the sequence generated i.e. it will turn on for logic 1 and turn off for logic 0. Then this light signal is transmitted to the receiver side where it is reproduced as an electrical signal through a light dependant resistor. On the receiver side the received signals of different frequencies is passed to the DTMF decoder IC which will convert it to BCD signal. These BCD signals are used to control the equipment.

### 4.2.1 Algorithm for device switching:

- First the data are inputted to microcontroller through keypad.
- Microcontroller gives the corresponding pulses to power LED.
- The Light dependent resistor detects the light incident on it and converts it into electrical signal.
- These electrical signals are fed to ARM Controller which process the data and switches the devices.

## 5. CONCLUSION

Using visible light for data transmission entails many advantages and try to eliminates most of the drawbacks like interference, noise transmission via electromagnetic waves outside the visible spectrum. Since no interference with electromagnetic radiation occurs visible light can be used in hospitals and other institutions. Light communication is considered as the best system for ecological and human health perspective. In this light communication LED's are used which has the ability to be switched on and off again in very short intervals and power consumption of LED is very low compared to incandescent bulbs.

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