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An Optical Version of WIFI for Indoor Application

P.M. Joel* and S.T. Aarthy**

ABSTRACT

Visible Light Communication is an efficient bidirectional immense speed and entirely networked system for wireless data transmission. Visible light using the light-emitting diode (LED) is an emerging alternative to the radio frequency communication technology for indoor communication. The power line communication uses the existing power line cables to power the LEDs and also to send the data via the power lines. So this power line cables along with the visible Light can easily eliminate the Wi-Fi communication in the near future. This paper describes the modification to the existing Wi-Fi communication system with a secure indoor communication using light. This proposed work reduces the complexity of the VLC network protocol, thus requires least modification to the current infrastructure, thereby providing better signal coverage.

Index Terms: communication, Visible Light communication, Power line Communication, LED, Li-Fi, Wi-Fi,

1. INTRODUCTION

Wireless communication refers to the transfer of data over a wireless medium like mobile communication, satellite communication and so on. At present Radio Frequency communication is widely used. It is an electromagnetic wave having a frequency range of 3 KHz to 300 GHz. The main drawbacks of RF communication are Finite bandwidth allocation, Regulated channel, radiation which affects human health and also it consumes more power.

In order to overcome these drawbacks a secure and much safer communication system is emerged which uses the illumination light source as the communication medium. This way of communication using light as a medium is Visible Light Communication. It has a frequency range of 400 to 800 Thz and a wavelength of 780 to 375 nm in the electromagnetic spectrum. It is the subspace of Optical Wireless Communication. Therefore it uses the Light emitting Diodes which forms the backbone of Visible Light Communication.

2. PRESENT THEORIES AND PRACTICES

Presently there are many types of wireless communication schemes like mobile communication, satellite, infrared, Radio frequency communication. The wireless technology yields a variety of wireless devices and inventions ranging from smart phones, tablets, Bluetooth devices, printers etc.

In the past decades connecting a device to the internet needs a dedicated wire connection. After 1971 many research are handled in order to make a device to access the internet without the need of any physical wiring. This makes the way for Wi-Fi technology which allows any electronic devices to get connected to WLAN. It uses 2.4-5 GHz radio bands. The mobile phones communicate in 700 MHz -2.6 GHz. The increasing number of electronic gadgets like mobile, tabs, laptop, i-pods makes the spectrum range to manipulate tremendously around 6 GHz.

* Department of Electronics and Communication Engineering, SRM University, Chennai, *Email: Johnyjohnpm@gmail.com*

** Asst. Professor, Department of Electronics and Communication Engineering, SRM University, Chennai, *Email: aarthy.s@ktr.srmuniv.ac.in*

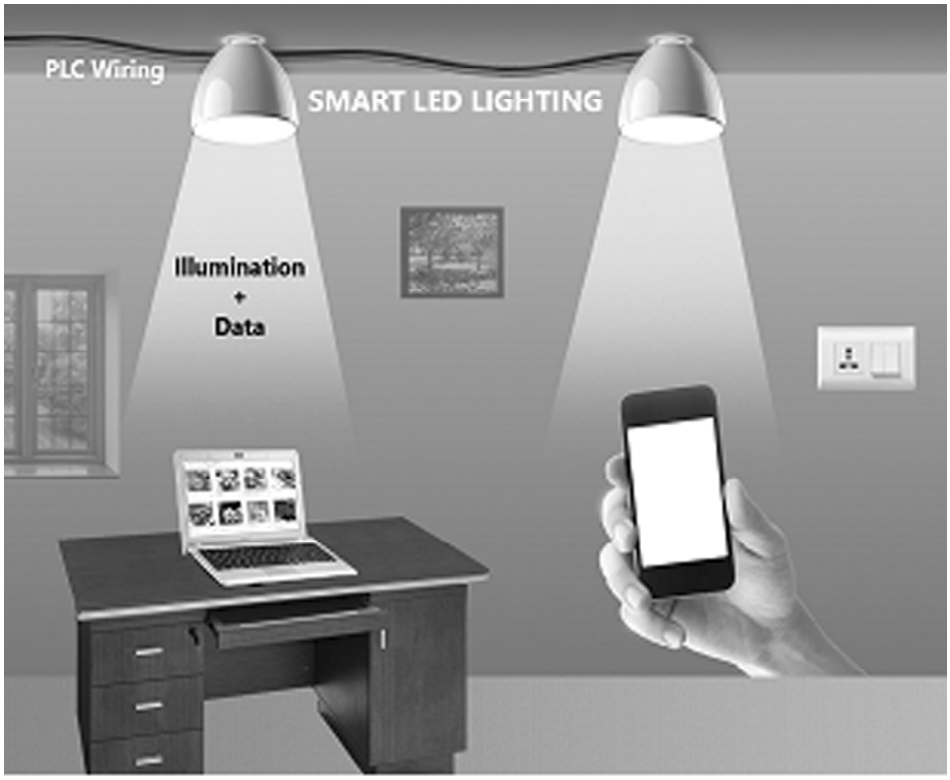

Figure 1: PLC and VLC concept diagram

This ceaseless evolution of the electronic gadgets causes lack of available spectrum which is known as spectrum crisis or spectrum crunch. This problem makes the researchers to think for a communication scheme beyond 6GHz.

3. COMPARISON

The following tables clearly state the advantages and outcomes of the proposed technology over the existed technologies.

Table 1
PLC Vs Wireless communication

	Power Line Communication	*Wireless*
Speed	High	Comparatively Low
Problems	noise due to electrical appliances	Hacking, fringe of coverage
Health issues	No health issues	Non thermal radiation
security	highly secure	Can be hacked
Bandwidth	Unlimited	Limited

Table 2
Visible Light Communication Vs Wi-Fi

	Visible Light Communication	*Wi-Fi*
Operation	LED bulbs	Wi-Firouters
Interference	No interference	Interference by routers
Merits	Pass through sea water, used in dense region	Cannot pass through sea water used in less dense region
Privacy	Secure data transfer	Need protection techniques

4. DESIGN

To overcome all the drawbacks encountered in the existing communication schemes, the proposed work has a communication setup as shown in the fig: The advantages of this design are: this communication system provides visibility security; it has more concern with human health thus it does not affect human body. It does not create any harmful-radiation.

4.1. LCD Display:

It is a flat panel type display which uses the light modulating phenomenon of liquid crystals. In this design a 16x2 LCD module is used. The LCD is interfaced with the microcontroller unit in order to display the data to be transmitted.

4.2. MCU UNIT

The type of controller used is Atmel AT89S52.It is a low power, very high performance CMOS 8-bit controller which has a programmable flash memory of 8K bytes. The text message to be send is encrypted by the controller and displayed in the LCD. It also provides data generation and simultaneity. This unit converts the parallel data to serial data and sends it to the PLC modulator unit for digital modulation process.

4.3. PLC TRANSMITTER

It contains the PLC modulating circuits which have a FEC especially for VLC to detect the error as earlier before transmitting to an extinct. It has a framing block so that the data send in the form of frames as concern of serial transmission and a Digital to analog converter. The analog data is send through the existing power lines. The transmitted signals are added to the cyclic waveform of the alternating current (AC).

The transmitted signal from the transmitting circuit is picked by BPF through the power-line, and biased before sending to the LED lights. The current AC mains power line is used as a transmission medium

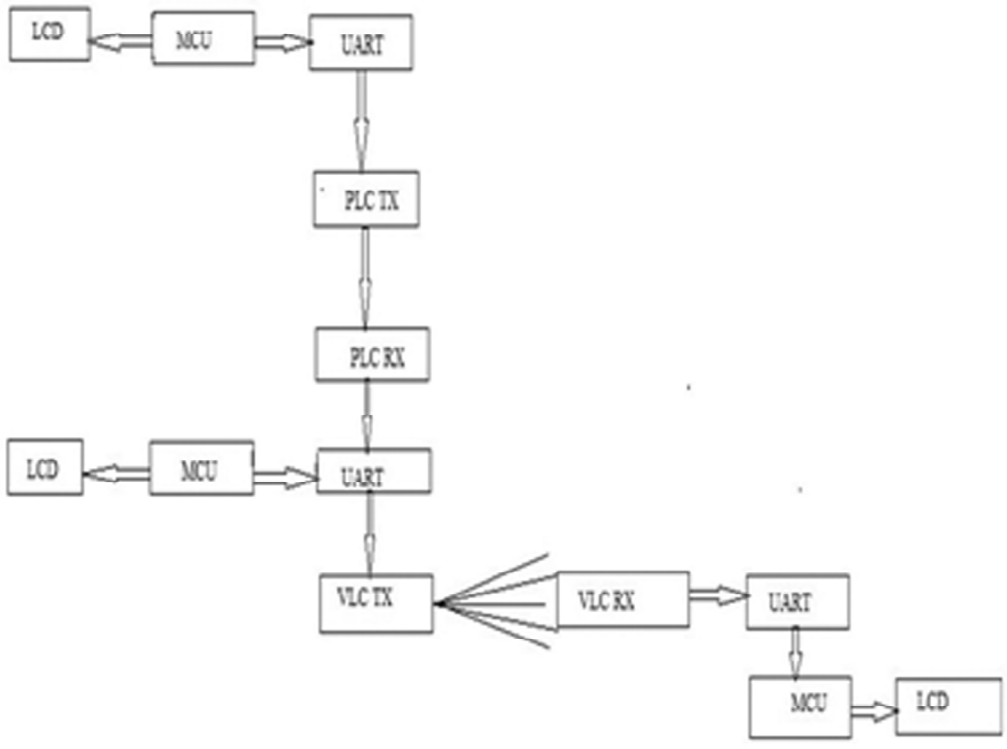

Figure 2: Block diagram of the proposed work

and additional coupling circuit is required in the power line modem for better protection, isolation and impedance matching.

4.4. PLC Receiver

The PLC to VLC module receives the data from the power line. It incorporate coupler unit for coupling the data from the power line to the LED lights and an advanced array of LED drivers. The pre-compensator has some compensation technique which is connected to the LED drivers. The coupler couples the module to the incoming power lines and this coupler couples the power line with the LED driver circuit.

4.5. VLC Transmitter

The LED lights deployed in the infrastructure for illumination purpose can also act as a transmitter of data because it has high switching rate which cannot be detected by human eye and changes electrical energy into light energy. There are more varieties of LED lights but White LED is used for communication purpose because it has lingering brightness, reliability, low power consumption and extended lifetime.

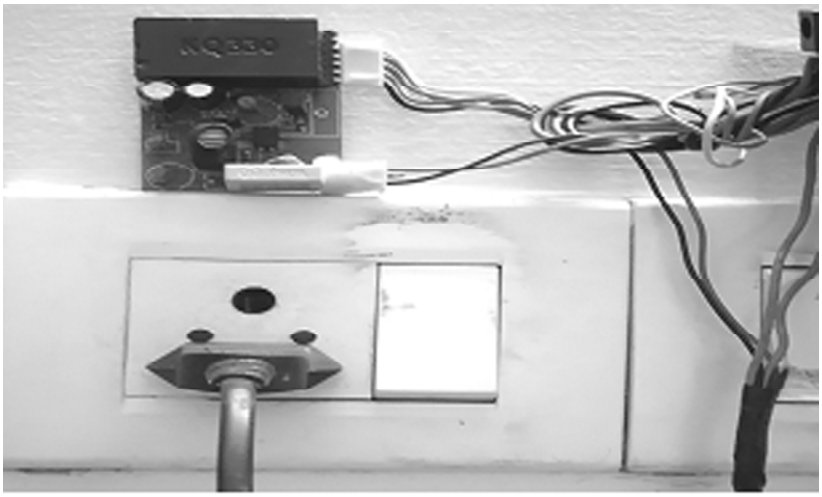

Figure 3: Power line carrier modem connected to power supply

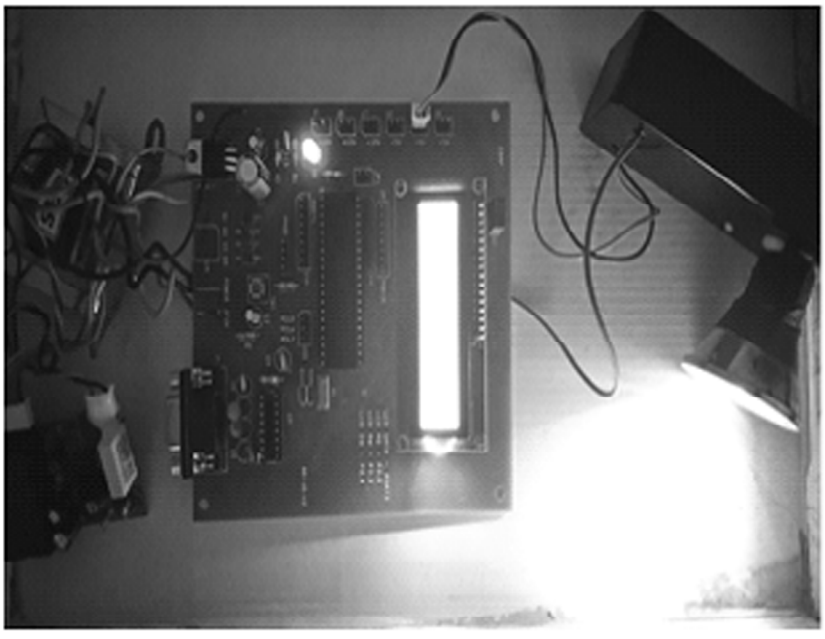

Figure 4: VLC Transmitter section

4.6. VLC Receiver

Photodiode act as a light sensor in the receiver side. A photodiode converts the incident light into the current. It works on the principle called photo-conduction, whereas LED works on the principle of electro-luminance. The photodiode is a type of photo detector which converts the light to either current or voltage.

The data which is detected by the photodiode is given to the demodulation block. PLC demodulator consists of AGC amplifier, A/D converter, PN remove arrangements, Decoder. The AGC amplifier manipulates the output as per the amplitude requirements. The ADC converts the analog to digital signal and the PN removing circuit removes the Phase Noise in the incoming signal

4.7. Sine Wave Detection Circuit

The role of Sine wave detection circuit is to detect Zero crossing point in the power line. When the sine wave withstands the zero point, the data signal can be transmitted steadily and the wave form amplitude does not vary.

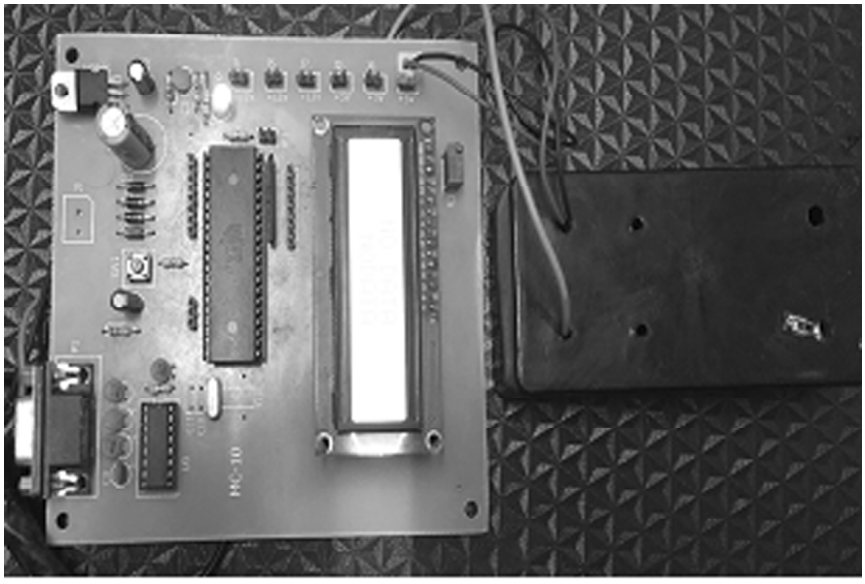

Figure 5: Photo detector (VLC receiver section)

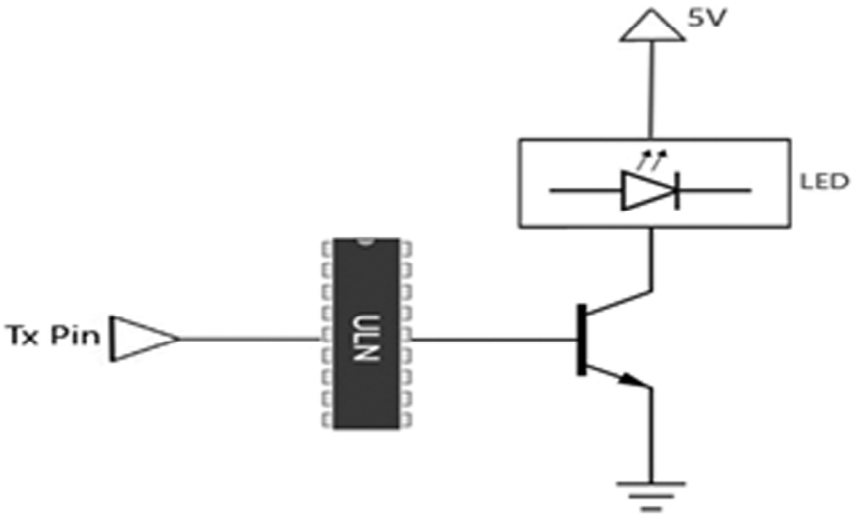

Figure 6: LED driver circuit

4.8. LED as light receiver

The reason behind of using LED as a light receiver is reduces complexity and it is also a cost effective method. A photodiode converts the incident light into the current. It works on the principle called photo-conduction.

The Photodiode when receives the incident lights gets activated and the converted current is given to the AGC amplifier. It provides a control signal amplitude at it output. The AGC effectively reduces the volume if the signal is strong and raises it when it is weaker.

4.9. FSK-KQ330 module

This module uses the power line as the medium of the wired signal transmission. The carrier of the signal is modulated by this module to a range of 50 KHz to 350 KHz. The main features of this module are it can transmit and Receive serial data at 9600 bps and it is low cost also built in error checking dexterity is available.

It can furnish a bi-directional half-duplex data transfer over the mains of any voltage up to 250V AC and for frequency 50Hz or60Hz. Half Duplex communications means it can either transmit or receive data at a time but not both at same time. Transmission is based on byte by byte basis.

5. IMPLEMENTATION AND WORKING

The design setup consists of a function generator in the transmitter section which generates the required data. This data is fed to the Power Line communication modem in this the digital data is converted to the analog form. PLC modem generates a 120 KHz carrier signal which carries the data to the low or high voltage power lines in the Zero crossing point of sine waveform. The other end of the power line is provided with LED light. The data transmitted through the power line is coupled to the LED by a coupling unit. It has PLC to VLC module which converts the analog data to digital form. The LED light is operated by the driver circuit which makes the fast ON /OFF switching for data transmission each ON/OFF scenario represents 1/ 0.therefore along with the light rays data is also send.

The receiver side has a photo detector. Each ON/OFF switching data transmission is detected by placing the photo detector in the line of light rays. It has a decoding blocks which is used to get the required information in the receiver and the receiver data is amplified by the Automatic Gain control amplifier .There will be chance of data corruption by noise due to the voltage fluctuations and also influences from other electronic appliances the receiver section has an excellent Phase noise remover which removes all sorts of noise added by the power line. Finally the original data is displayed in the LCD display.

6. CONCLUSION

The data transmission using Power line communication integrated with visible light Communication can be used as a secure way of communication for indoor applications. It reduces the upcoming and existing spectrum problems. The LEDs which can be used as a source of illumination is only used here as a data transmission medium so it can reduce the cost as well as there is no need to modify the existing infrastructure. It can be widely used in Museums, hospitals, Shopping malls, music halls, Airport, Space research centers, Stadiums etc. to provide better signal coverage and also secure data transmission with less expenditure.

7. FUTURE SCOPE

The future scope of this paper deals with the making of the communication in indoor as well as in outdoor environment even in the presence of sunlight or any other light sources so which can be mainly used for

EXPERIMENTAL EQUIPMENT

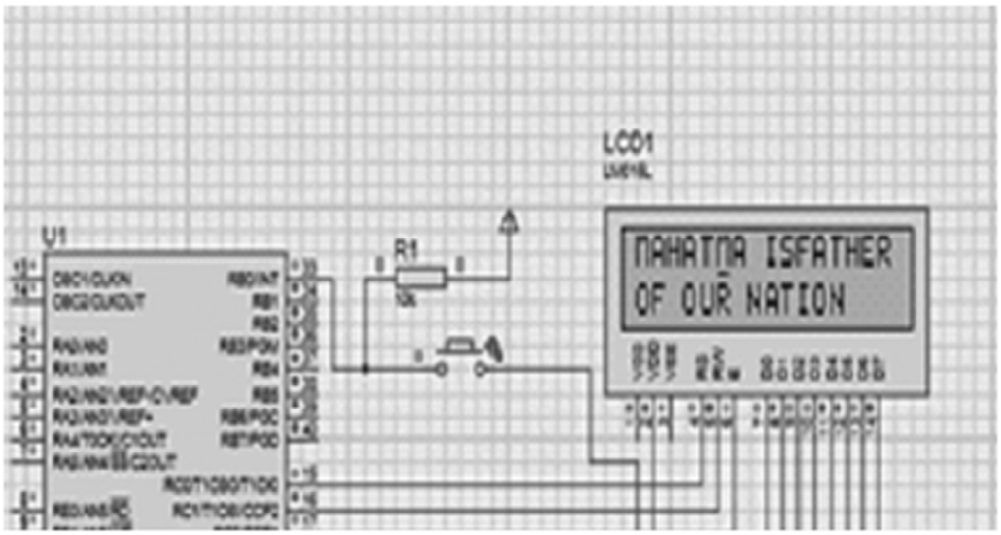

Figure 7: Data to be transmitted is displayed in the LCD

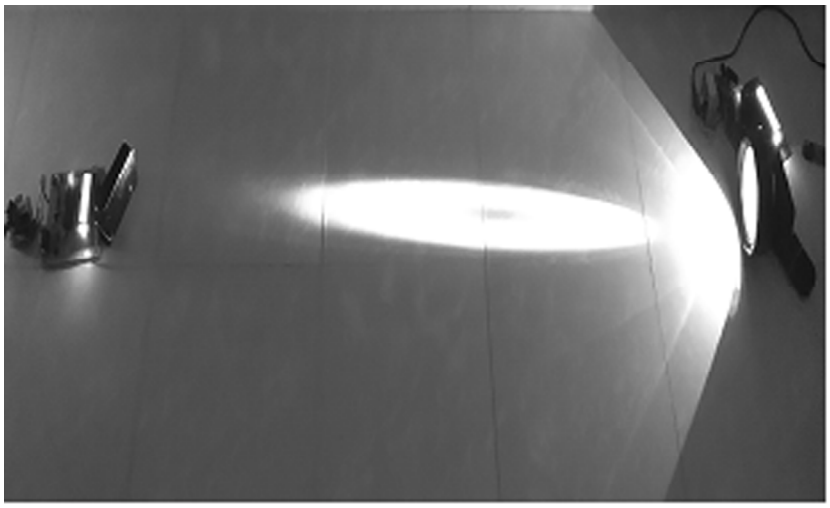

Figure 8: VLC Transceiver using 3 W LED

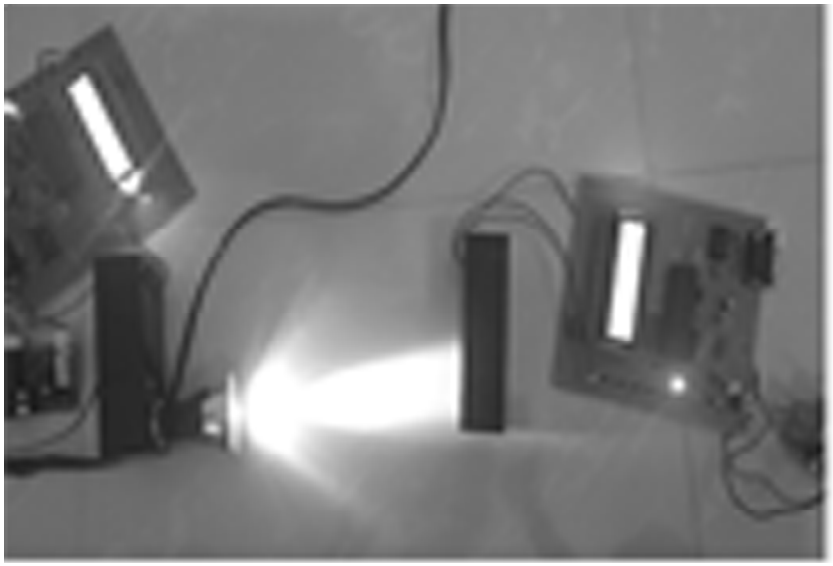

Figure 9: VLC Transceiver using 0.005 W LED

Table 3
Tested by distance

	RESULTS AND ANALYSIS	
	0.005 Watts	*3 Watts*
Distance in Ambience Light	20 CM	1 M
Distance in Low Lighting	30 CM	2M-2.5 M
Distance in no other Light source	50 CM	3.5-4 M

traffic monitoring applications as well as vehicle to vehicle communication. Thereby forms a challenging alternative to RF and other existing communication schemes.

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