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LiFi Integrated to Power-lines for Smart Illumination Cum Communication

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Abstract:
Visible light communication (VLC) is a data communications variant which uses visible light communication between 400 and 800 THz (780–375 nm). Is subset optical technologies. LiFi is a new technology for short range wireless technology to provide unprecedented connectivity within a localized data-centric environment. Li Fi is a transmission of data through illumination, sending data through a red light bulb that varies in intensity faster than human eye can follow. This sort of communication can be called as Visible light communication (VLC). Using this technique, the user can transmit the data through light from one device to another. Li-Fi technology works on a simple digital principle which is nothing but an led is ON a digital data 1 can be transmitted and if it is OFF digital data 0 can be transmitted. So, in this project work we are going to switching the LEDs very quickly . These fast switching can be achieved by PWM technique to transmit digital data stream containing strings

Keywords: LiFi, Visible light communication, Power-line communication, Discrete multitone modulation

I. INTRODUCTION

The technology is very new and was proposed by the German physicist Harald Haas in 2011. . LiFi (Light Fidelity) is an international standard for THz visible light communication (VLC) system. Recently due to widespread use of LEDs in intelligent lighting fixture, the LED market has skyrocketed to make comparable to NAND and DRAM markets in the near future. Researchers pledge that by 2013, LEDs will reach 7W and 1000lm.

This is brighter than a 60w bulb and yet draws a current provided by 4 D-size batteries. LEDs are the predominant choice for VLC-transmitters.. Meanwhile, over the past couple of years power-line communications (PLC) has emerged as a reliable wired Ethernet alternative. The advantages over CAT 5/6 cabling are obvious in that no new cables are required; the existing mains power cables being used instead. In the context of a home networking environment, “no new wires” is the term applied to PLC that utilize the existing wiring systems to distribute high-speed data and video throughout the home (or small office).

If we cothe backhaul and use the LiFi for wireless connection to devices by a simple plug-and-play technique. The idea of integration of these two systems for indoor networking was pioneered by Komine et.al which was based on single carrier modulation then to improve their old system to overcome the effects of power-line noises they used multi-carrier modulation (OFDM) method. In this paper, the details of the system architecture are described in Section III. The discrete multi-tone (DMT) modulation using 16-QAM is applied for PLC and VLC channel with presence of noises and the simulation results are shown in the section IV.

II. WHITE LEDS FOR LIFI

The vital part of Visible light communication (VLC) system are LEDs, which send data by flashing light at speeds undetectable to the human eyes. LEDs are more advantageous than the existing incandescent bulbs and fluorescent tubes in terms of long life expectancy, high tolerance to humidity, low power consumption, and minimal heat generation lighting. There are several advantages of LiFi based on white LEDs for communications over WiFi and IR for indoor access: LEDs are less expensive than laser sources used in IR. LiFi system is cheap, durable, robust, secure, aesthetic & fashionable with untrammelled bandwidth opportunities.The visible light occupies unregulated and unlicensed THz spectrum since it does not cause or suffer from any electromagnetic interference, whereas interference is common in using WiFi or any other RF systems. Visible light communication does not have any possibility of leaking out when the light is isolated, which offers better security than wireless LAN, and does not suffer performance losses even when a variety of computers are connected at once. Shadowing effect is much less compared to IR case because LED light fixtures are distributed throughout the room. Receiver obtains at least one strong Line of Sight (LOS) signal as the transmitters are on the ceiling. This is not the case in most IR transmission situations. Undoubtedly, VLC is free of any health concerns, as it uses eco-friendly green technology rather than microwaves, which can cause harm to the human body. The plural white LEDs, connected to power-lines, can be employed as internet access points, indoor navigation and positioning in homes, labs, offices. Besides these can be spotted as local information points in shops, airports, railway stations, museum etc.. More recently this system has found some applications like Intelligent Transport System (ITS) in particular military aircraft power-line network and onboard aircraft networking [5].

III. DESCRIPTION OF THE HYBRID SYSTEM

A. Introduction of VLC: Visible light communication (VLC) is the term given to an optical wireless communication system that conveys information by modulating light that is visible to the human eye. Communication is achieved by switching LED lights on and off at a speed higher than what is perceptible to the human eye. Eyes can detect changes in light brightness and power, but they cannot perceive light that is switched on and off rapidly. A photodiode, on the other hand, can easily recognize the rapid on-off modulation. A photodiode is a photo detector that produces an electrical current that is proportional to the optical power that is incident on the photo detector surface. This simple principle makes possible visible-light communication technology that supports both illumination and wireless communication using an LED. Unlike RF wireless communication, where specialized tools are needed to find a service area, the presence of a VLC service area will be easily detected. The visible spectrum is the portion of the electromagnetic spectrum having wavelengths from about 380 nm to 780 nm and in terms of frequency; this corresponds to a band of 385 - 789 THz .

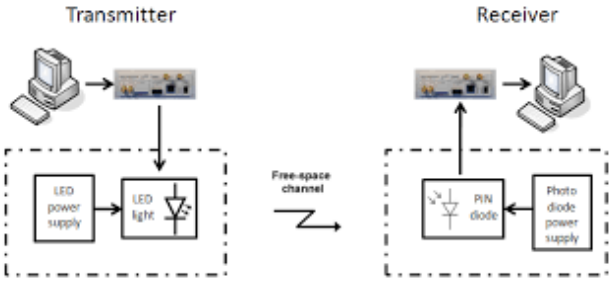

Figure.1. shows VLC Transmitter and VLC Reciever.

1)VLC Principle: In Figure 1, the VLC transmitter and receiver modules based on intensity modulation/direct detection , which consists of digital to analog convertor, transconductance amplifier, low pass filters and high speed LEDs in the transmitter section and photodiode, transimpedance amplifier, analog to digital convertor in the receiver section. The LED converts an electrical signal to optical energy that provides illumination as well as communication. Information is line-encoded and modulated by the DAC, and then conveyed on the optical signal by modulating the amplitude or some other feature of the LED light. At the receiver, the Photodiode converts the received optical power to an electrical signal, which is then amplified, demodulated and decoded by the TIA Amp, LPF and ADC to recover the user message bits.

2) *Introduction Of LIFI:* Li-Fi in contrast describes a complete wireless networking system. This includes bi-directional multiuser communication, i.e. point-to- multipoint and multipoint-to-point communication. Li-Fi also involves multiple access points forming a wireless network of very small optical attocells with seamless handover. This means that Li-Fi enables full user mobility, and therefore forms a new layer within the existing heterogeneous wireless networks. The fact that LEDs are natural beam formers enables local containment of Li-Fi signals, and because of the blockage of the signals by opaque walls, Co-channel Interference can effectively be managed and physical layer security can be enhanced. Illustrates the principal techniques that are needed to create optical cell Li-Fi networks. Li-Fi uses light for data transmission.

3) *Working Of LIFI:* There are two sections: transmitter and receiver. In the transmitter side, the data is first converted to binary through an ADC and then fed into a LED driver circuit which is controlled by a signal processor. The LED driver works on the On-Off Keying modulation. After this the high illumination LED blinks at high speed and transmits the data as optical pulses through the wireless channel. On the receiver side, these optical pulses are interpreted by a photo detector into an electrical signal which is amplified by a transimpedance amplifier and then converted back to binary data using a comparator. The LED lights will be networked, so multiple users can access data using a single LED light or move from one LED light to another without affecting their access.

3) *Photo Diode:* The photodiode is a semiconductor converting light into an electrical current. Most of the photodiodes in the market are produced for the purpose of fibre optics. In applications concerning fibre optics, the radiant sensitive area of the photodiode is small and the rise/fall time is short. With increased radiant sensitive area, the response time will be slower. Without fibre optics a larger radiant sensitive area allows for more light to be captured by the receiver. Therefore, the choice of 4) photodiode is limited. The requirements of the photodiode are quick response time, spectral sensitivity in the visible spectrum and large radiant sensitive area. The size of the radiant sensitive area is crucial and therefore the photodiode used is VISHAY BPW21R. It has suitable wavelength peak sensitivity at 565 nm. The spectral bandwidth is from 420 nm to 675 nm and gives a perfect range for the intended application. It has a linear light intensity to current ratio and the radiant sensitive area is 7.5 mm^2, which was larger than most photodiodes found. It has a rise and fall time of 3 µs each, which provides a switching frequency of 166 kHz.

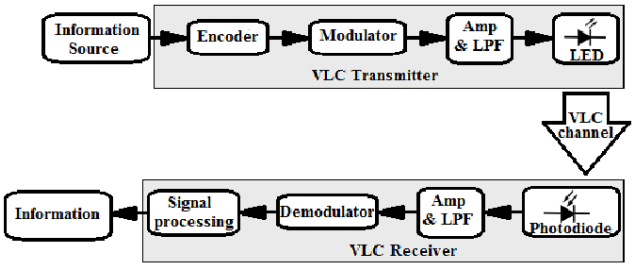

Figure.2. Block Diagram of the System

5) *Design Of A LIFI System:* The main objective is to build a prototype using off the shelf electronic devices, establish a successful link for the transmission of digital data and provide a working Li-Fi system. To achieve this goal, open source Arduino development board is used. Arduino is a small microcontroller board with a USB plug to connect to your computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones, etc. They can either be powered through the USB connection from the computer or from a 9 V battery. Arduino can be controlled by the computer or programmed to work independently. This section describes the

most commonly used encoding method that was used during this project. On-off keying (OOK) is the simplest method to represent data. The logic value zero corresponds to LOW and the logic value one to HIGH. In the VLC case, this means the LED is turned off to transmit a zero and turned on to transmit a one.

Comparison between Li-Fi and Wi-Fi

Parameter	LI-FI	WI-FI
Speed	High	High
Spectrum	10,000 times broader than that of Wi-Fi	Narrow spectrum
Data density	High	Low
Security	High security due to non-penetration of light through walls	Less secure due to transparency
Reliability	Medium	Medium
Bandwidth	High due to broad spectrum	Low
Transmit/receive power	High	Medium
Ecological Impact	Low	Medium
Device-to-device connectivity	High	Low
Obstacle interference	High	Low
Bill of materials	High	Medium
Market maturity	Low	High
Latency	In the order of microseconds	In the order of milliseconds

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