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LiFi : Fastest Data Transmission Scheme Using Visible Light Communication

Pavithra.E[1], Praveen Kumar.K[2]

Department of Electronics and Communication Engineering, Mahath Amma Institute of Engineering and Technology, Pudukkottai, Tamil Nadu, India

ABSTRACT: The main motto of this system is to prove the efficiency of Visible Light Communication (VLC) through Li-Fi technology as well as to perform the fastest data transmission without any network medium requirements. Light Wave Communications are the most powerful and fastest communication in the world. Emergency situations such as TSunami and other kind of natural disasters cause a huge damage to human especially in seashore environments. Unfortunately, we don't have any devices to interact with the person who are present in the boat, once they entered into sea. Only the satellite devices are eligible to communicate, but no fisherman have a right to handle those kind of devices. In this case, a new technology is required to establish a communication between fisherman and control room. Li-Fi, a medium or device which interfaces these two entities and performs successful communication via Light Houses to alert the fisherman in disaster cases.

KEYWORDS: Visible Light Communication (VLC), ARM, Embedded System, Light-Emitting Diode (LED).

I. INTRODUCTION

Light Emitting Diodes (LEDs) have been increasingly deployed for illumination, signaling and display applications since 2000s because of their high energy efficiency and high reliability. Apart from the illumination function, LEDs can be switched on/off at a relatively high frequency without affecting illumination. Therefore, LEDs have been widely considered as electrical-to-optical converters for visible light communication (VLC). Compared with the radio frequency (RF) communication, VLC has the following advantages: unlicensed spectrum, free electromagnetic interference and high security, which has attracted extensive attention for many applications in recent years. Most importantly, with the ubiquitous LED light, VLC has tremendous potential to be a part of the infrastructure supporting the Internet of Things (IoT).

For commercial LEDs, the illumination is usually implemented by using a blue LED coated with a yellow phosphor layer. Due to slow temporal response of the phosphor, the modulation bandwidth of the LEDs with white illumination is limited to a few MHz. Although many approaches are used to increase bit rate to hundreds Mb/s or even Gb/s, a low-speed VLC system is essential for voice transmission or broadcast as a beacon for location-based applications. The IEEE 802.15.7 standard for personal area networks (PANs) was published in 2011, which is now under revision by the IEEE 802.15.7r1 task group working on optical camera communications (OCC), tracking and localization. This standard supports both illumination and VLC-based data transmission with different modulation format and/or dimming control schemes. The standard also offers a low-speed physical layer (PHY) for VLC. PHY-I operates from 11.67kbps to 266.6kbps using a single ordinary LED source, targeting at low bit rate applications with on-off keying (OOK).

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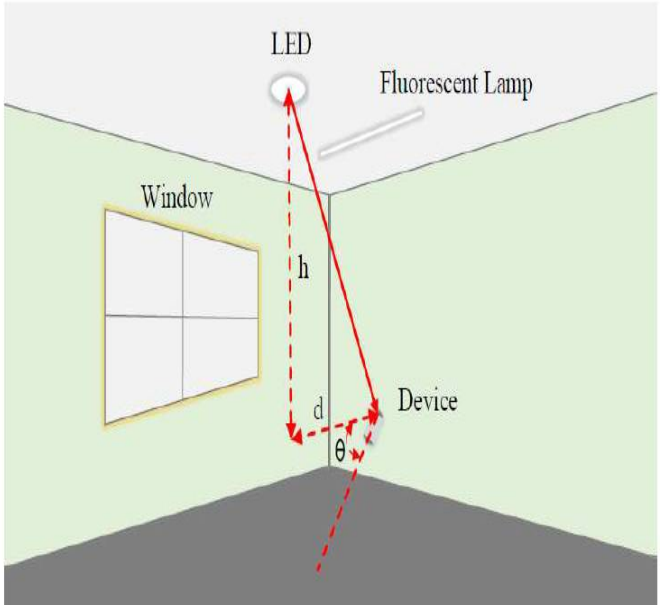

Fig.1 Indoor visible light communication system

For the purposes of power saving and energy efficiency improvement, the dimming function is an important aspect in the standard. Generally, dimming is performed by inserting compensation symbols (CS) into data frame to maintain different DC level with a variable duty cycle, which represents time duration of high pulse in the total period.

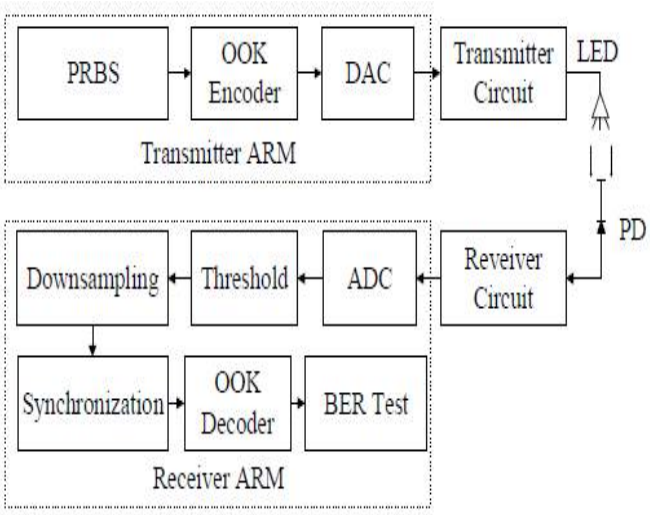

Fig. 2. Block diagram of a VLC system.

For instance, if the length of the CS frame is equal to that of the data sequence when 4B6B or Manchester encoding is used, the brightness of LEDs can be adjusted by varying the duty cycle of the whole sequence. In this system, a low-complexity transceiver is designed and implemented with advanced RISC machines (ARM) STM32F103 for an indoor VLC system as shown in Fig. 1. The h and d are vertical and horizontal distances between the LED transmitter and the receiver, respectively.

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The rotation angle θ is used to indicate the deviation angle from the horizontal plane. The VLC transceiver with the proposed design is implemented on integrated circuit boards, which enable variable levels of illumination. In order to study the influence of the interference from natural or artificial lights on the OOK transmission performance [13-15], real-time ARM-based 200kbps OOK transmission is experimentally investigated over the VLC links suffering from ambient interference including fluorescent light and sun light through the window.

II. VISIBLE LIGHT COMMUNICATION WITH ARM

As shown in Fig. 2, a complete VLC system consists of a transmitter ARM with LEDs and receiver ARM with a PD. The general ARM is used as a digital signal processing (DSP) unit for signal generation/recovery, whilst the micro-control operation system (μC/OS-III) is applied for multi-task support. To ensure the continuity of the information data, direct memory access (DMA) and double-buffer technology are applied. Because of the limited memory in the ARM, the ring queue is used for the data buffer.

A signal processing task is always in operation in the transmitter/receiver ARMs to deal with the data buffered in the ring queue. The VLC functions about signal processing are implemented on an integrated circuit board. Thanks to the embedded software system, the VLC system can be developed with the real-time μC/OS-III. Meanwhile, signal modulation and demodulation are realized by the software of the micro-controller unit (MCU). Considering the mobility of the receiver, a wide field of view (FOV) of the receiver is required, which results in lens-free detection in the receiver.

The ARM can be used as either an application development unit or a DSP unit. As an application development unit, the ARM is usually used to deal with voice data or generate identity tags for location-based applications. The transmitted data usually comes from peripheral circuits or external communication interfaces. As a DSP unit, the ARM is used to transmit or receive both the information of data and command for signal modulation/demodulation and coding/decoding in a physical-layer data unit (PDU). The PDU is composed of a synchronization header for frame synchronization, a physical layer header (PHR) indicating the data length, the modulation and coding scheme identifier (MCA ID), and a PHY payload containing data information for transmission. In the transmitter ARM, “0” and “1” are simply mapped to a low and high voltage level, respectively. Because the maximum sampling rate of the ADC in the ARM is less than 1MSa/s, the raw data rate is set to 200kbps at a sampling rate of 600kSa/s.

III. EXISTING APPROACHES – A SUMMARY

In existing system we all know the communication such as Bluetooth, ZigBee and Radio Frequency (RF). All these communications are falling into certain limitations such as range and speed. GSM is an option to tolerate the range, but it cannot be used in deep sea. Slower Communications between transmitter and receiver end. Performance is low, because of its time taken procedures and Cost is high. There are many disadvantages in the existing system, some of them are listed below: there is no proper light communication system, Big Devices are required to transmit data via Optical communications, Slow in Processing and takes more time to transmit data and High cost and performance is too low.

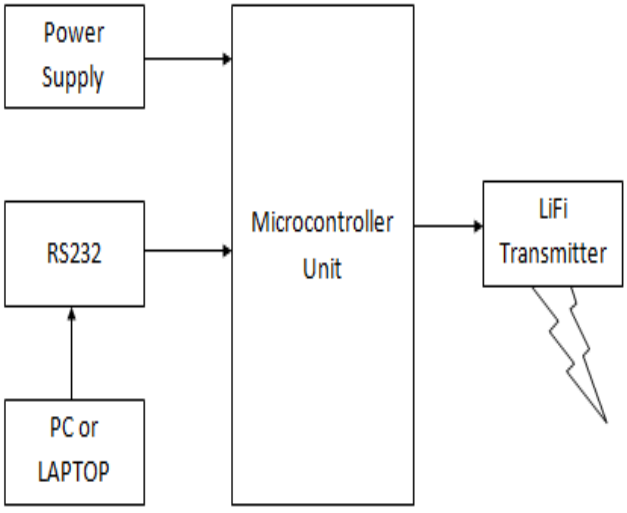

Fig.3 Block Diagram –Transmitter Unit

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IV. PROPOSED SYSTEM SUMMARY

Advanced Li-Fi technology is used instead of regular communication principles. It can be used in both indoor and outdoor communication system. Speed is amazing and unpredictable compare to the other communication devices. Good in Performance because of its fast transmission. Circuit Designing is Simple and Cost effective. There are many advantages in the proposed system, some of them are listed below: Simplicity, Portability and low price, this system has the ability of using by common people, especially children and aged people, and don't need any special training, Power consumption is low and Compatible in size and good in Performance.

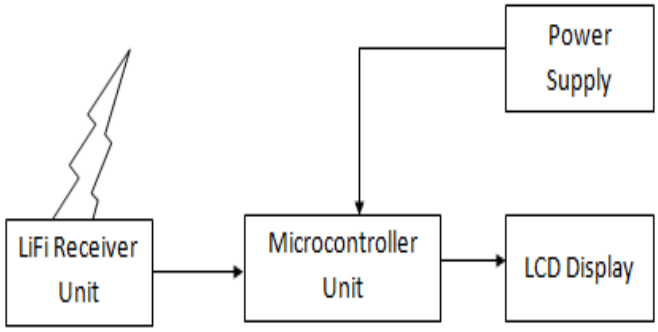

Fig.4 Block Diagram – Receiver Unit

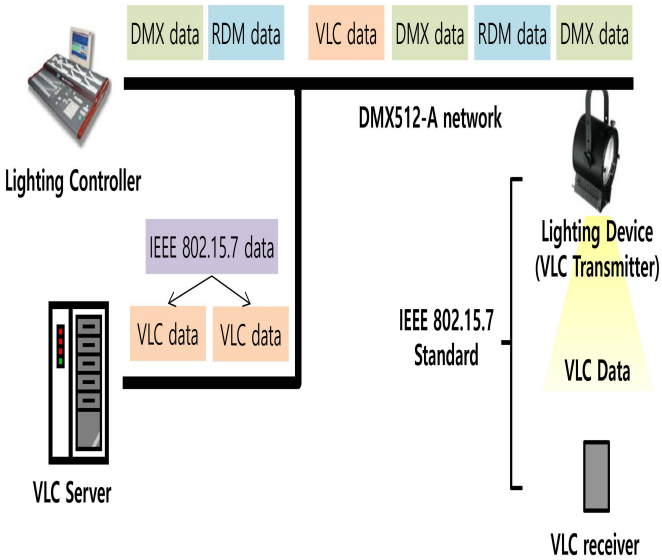

Fig.5 VLC Data Transmission on DMX512-A Network

V. LITERATURE SURVEY

In the year of 2013, the authors "Lim, S.K., Karl, R., Kim" proposed a paper titled "Entertainment lighting control network standardization to support VLC services", in that they described such as: VLC technology is receiving increasing attention in research and product development these days because high lumen/watt LEDs are becoming the dominant sources for artificial lighting. Successful VLC data transmission from luminaires requires that the data first be moved to the luminaires over a backbone network.

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This article addresses the lighting control network as a backbone for VLC services and describes a standards-drafting project, designated BSR E1.45, for entertainment lighting control to support the transmission of data for VLC from luminaires. E1.45 specifies a data frame format that can coexist with ANSI E1.11 messages on lighting control network, and thus deliver VLC data to luminaires for transmission from those luminaires.

In the year of 2013, the authors "Chow, C.W., Yeh, C.H." proposed a paper titled “Mitigation of optical background noise in light-emitting diode (LED) optical wireless communication systems", in that they described such as: One challenge faced by the in-home light-emitting diode (LED) optical wireless communication is the optical noises. Here, we first experimentally characterize the effect of optical background noise to the performance of the LED optical wireless communication channel.

We demonstrate using Manchester coding for the LED to mitigate the optical noise. No adaptive monitoring, feedback, or optical filtering is required. The theoretical and numerical analysis of Manchester decoding process to mitigate the optical background noise is provided. Our experimental result shows that Manchester coding can significantly eliminate optical noise generated by the AC-LED operated at <; 500 kHz and fluorescent light.

In the year of 2011, the authors "Elgala, H., Mesleh, R., Haas, H." proposed a paper titled “Indoor optical wireless communication: potential and state-of-the-art", in that they described such as: interest in optical wireless (OW) as a promising complementary technology for RF technology has gained new momentum fueled by significant deployments in solid state lighting technology.

This article aims at reviewing and summarizing recent advancements in OW communication, with the main focus on indoor deployment scenarios. This includes a discussion of challenges, potential applications, state of the art, and prospects. Related issues covered in this article are duplex transmission, multiple access, MAC protocols, and link capacity improvements.

VI. EXPERIMENTAL RESULTS

The following figure shows the Simulation view of the proposed system.

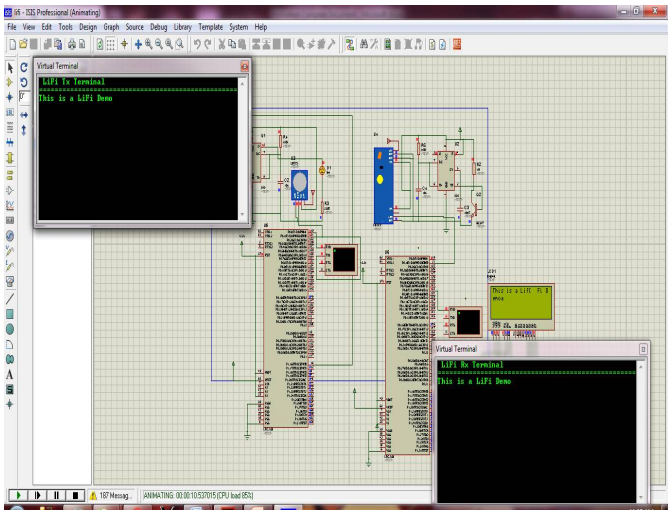

Fig.6 Simulation Design of the proposed System

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The following figure illustrates the Hardware view of the proposed system.

Fig.7 Overall Hardware Design

VII. CONCLUSION

The exploitation of Li-Fi Transmitter and Receiver results in commissioning procedures for data oriented communications and commissioning time is drastically reduced. With this configuration, data transmission configuration is more ease to use with light house oriented communications are possible. A low-complexity on-off keying transceiver for indoor VLC systems using a commercial LED module with white illumination has been designed and implemented based on ARMs. Experimental results have shown that real-time 200kbps On-Off Keying transmission has been successfully demonstrated over 7m VLC links with ambient light interference from fluorescent light and sun light through the window. For all the result of this system is a data based efficient Li-Fi Communications with innovative transceiver unit.

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