Novel Receiver Sensor for Visible Light Communication in Automotive Applications

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Abstract—In recent years, there is a rapid development in the solid state Light-Emitting Diode (LED) materials which gave way for the next generation data communication known as visible light communication. VLC has a promising future and it acts as a complement to the present RF communication by achieving larger bandwidth and high data rate. At present, the day to day activities use lot of LED based lights for illumination, which can also be used for communication because of the advantages like fast switching, high power efficiency and safe to human vision. Hence, this project presents about eco-friendly data communication through visible light which consists of the white LEDs that transmit audio signals to the receiver. The receiver circuit consists of solar panel connected with the amplifier and speakers to recover back the amplified version of original input signal.

Keywords—Light-Emitting Diode; LI-FI Technology; Receiver Sensor; Solar Panel; Visible Light Communication.

Abbreviations—Intelligent Transportation System (ITS); Light-Emitting Diode (LED); Light Fidelity (Li-Fi); Signal to Noise Ratio (SNR); Visible Light Communication (VLC).

I. INTRODUCTION

IN recent years, there is a rapid development in the solid state Light-Emitting Diode (LED) materials which gave way for the next generation data communication known as visible light communication. VLC has a promising future and it acts as a complement to the present RF communication by achieving larger bandwidth and high data rate [1].

At present, the day to day activities use lot of LED based lights for illumination, which can also be used for communication because of the advantages like fast switching, high power efficiency and safe to human vision. Hence, this project presents about eco-friendly data communication through visible light which consists of the white LEDs that transmit audio signals to the receiver. The receiver circuit consists of solar panel connected with the amplifier and speakers to recover back the amplified version of original input signal.

II. LITERATURE SURVEY

2.1.1. A Survey on Visible Light Communication Appliances used in Inter-Vehicular and Indoor Communication

Visible Light Communication (VLC) is an embryonic form of wireless communication. Visible light communication uses light waves instead of radio waves for data transmission.

Visible light communication provides higher capacity, greater efficiency, better security and availability than radio frequency communication. Light Emitting diodes (LEDs) are used as transmitters as they are more cost effective sources and hence can be used for multiple data transmission. They can be considered as an alternative to radio frequency communication. The evoking area of interest namely indoor and vehicle to vehicle to communication is surveyed in this article.

Author: S. Vijay PG Scholar, School of Computing, SASTRA University, Thanjavur.

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2.1.2. Novel DSP Receiver Architecture for Multi-Channel Visible Light Communications in Automotive Applications

This article presents a novel visible light communications receiver architecture, designed for automotive applications. A crucial problematic in this area is the design of a suitable receiver able to face the problems caused by the dynamic situations, by the long distances and also by the environmental conditions. In such circumstances, a solution would be to adapt the communication's data rate to channel conditions, meaning that the communication would take place using different data rates depending on the signal to noise ratio (SNR) and the message priority. The visible light communication receiver proposed in this article addresses the upper mentioned issues and enables a robust communication even at low SNR.
Author: Alin-Mihai Căilean, Mihai Dimian, Valentin Popa, Luc Chassagne and BarthélemyCagneau.

2.1.3. Novel Receiver Sensor for Visible Light Communications in Automotive Applications

This paper presents an easy-to-use sensor aimed for traffic safety applications using visible light communications. A central problem in this area is the design of a suitable sensor able to enhance the conditioning of the signal and to avoid disturbances due to the environmental conditions. The visible light communication sensor proposed in this article addresses these issues and enables a robust communication for short to medium distances. The presentation is focused on hardware aspects and low-level coding techniques. The experimental validation of the proposed sensor has been conducted by analyzing communication performances between a commercial traffic light and the sensor, for distances up to 50 m. The measurements exhibit bit error ratio lower than 10-7 in an outdoor configuration, using two well-known codes (Manchester and Miller) without any error-correcting codes or complex signal processing.
Author: Demosthenes VouyioukasIlias Maglogiannis
Publish: Dalhousie Univ on November 10, 2014

2.1.4. Vehicle to Vehicle Communication using Visible Light Communication Technology

This paper is determined to enhance the quality of Intelligent Transportation System (ITS) with the help of Visible light communication technology using an LED transmitter and a camera receiver, which employs a special CMOS image sensor which is an optical communication image sensor (OCI). The OCI consists of a "communication pixel (CPx)" that can easily respond to light intensity variations and an output circuit of a "flag image" in which only high-intensity light sources, such as LEDs, have emerged.
Author: Mehboob Raza Haider, Manoj M. Dongre
Publish: "Dept. of Electronics & Telecommunications, R.A.I.T. Nerul, Navi Mumbai.

2.1.5. Novel Receiver Sensor under VLC for Automatic Applications

Today ambulance dead rate towards traffic jams and population management has raised and hence the due of challenge is projected towards this system. In this paper, we have proposed a novel receiver approach under Visible light communication channel for an economical and most reliable approach for communication.
Author: Noor Sameera Firdose, Shrikant S Tangade, Syed Thouheed Ahmed
Publish: School of Electronics and Communication, REVA University

2.2. Existing System

The existing prototypes have been developed focusing on specific issues and were tested in particular conditions, without considering all the impediments of the vehicular environment. Therefore, even if they have high potential, being able to ensure reliable, long-distance, high-data rate communications the existing hardware prototypes aren't able to comply with all the requirements – further postponing the technology deployment [Zhu et al., 2].

2.2.1. Disadvantages of Existing System

- Expensive to implement
- Bandwidth problem
- Cannot be implemented in all type of vehicles

III. Proposed System

The visible light communication sensor proposed in this article addresses these issues and enables a robust communication for short to medium distances. To overcome the implementation cost of technology, Low cost Light Fidelity (Li-Fi) technology is introduced. Light is available in all vehicles, so using the light, communication is done between vehicles [Yoo & Kim, 3].

3.1.1. Advantages of Proposed System

- The avoidance of radio frequency spectrum crunch
- Enabling high peak data rates
- No complex protocol

3.2. Applications of LI-FI Technology

- Traffic Management
- General tourist places
- Hospitals and big industries

3.3. Block Diagram

3.3.1. Traffic Signal Section

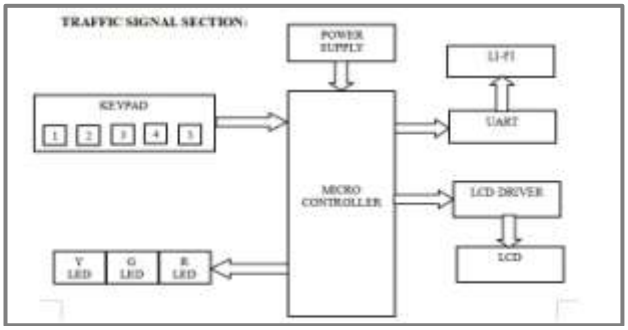

Figure 1: Block Diagram of Traffic Signal Section

As the contributions of this paper, the models proposed in this thesis were designed with RS-232 and USB.As a result, they can be easily integrate with the present infrastructure. The first prototype was integrated with the existing Terminal Emulation Program (Hyper-terminal), which was already present in the computer [Bantin & Siu, 4].

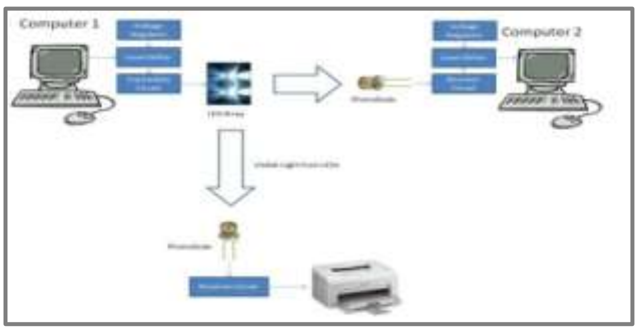

Figure 2: Working

3.4. OFDM (Orthogonal Frequency Division Multiplexing)

3.4.1. Orthogonality of Sub-Channel Carriers

OFDM communications systems are able to more effectively utilize the frequency spectrum through overlapping sub-carriers [Velayos & Karlsson, 5].

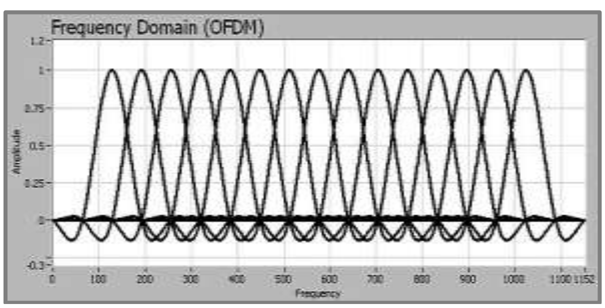

Figure 3: OFDM Signal Generation

Note that OFDM channels are different from bandlimited FDM channels how they apply a pulse-shaping filter.

3.4.2. Transmitter / Receiver Implementation: (Signal Generation):

In order to use multiple sub-carriers to transmit an individual channel, an OFDM communications system must perform several steps [Li et al., 6].

A. Serial to Parallel Conversion

In an OFDM system, each channel can be broken into various sub-carriers. The use of sub-carriers makes optimal use out of the frequency spectrum but also requires additional processing by the transmitter and receiver [Ramani & Savage, 7].

B. Modulation with the Inverse FFT

The modulation of data into a complex waveform occurs at the Inverse Fast Fourier Transform (IFFT) stage of the transmitter. Here, the modulation scheme can be chosen completely independently of the specific channel being used and can be chosen based on the channel requirements. In fact, it is possible for each individual sub-carrier to use a different modulation scheme.

The role of the IFFT is to modulate each sub-channel onto the appropriate carrier.

IV. RESULT

4.1. Hardware Section

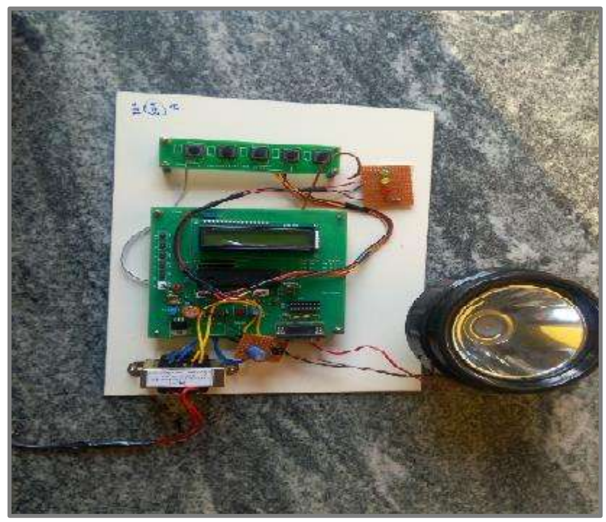

Figure 4: Transmitter

Figure 5: Receiver

The embedded kit shown in figure demonstrates the overall assembly for the ambulance Unit. This unit is initialed with the system model behavioral approach of detecting the ambulance in open environment. Thus this kit is connected to a light sensor under the active configuration of RED light detection and thus the system signals are processed and simulated under the PIC controller (Under Ambulance) and thus the same is emitted under the light for achieving the terminology of VLC [Jiang et al., 8].

V. Conclusion

The proposed system is designed with an objective to utilize the Visible Light Communication (VLC) technology in retrieving and processing the data. Thus the objective is successfully achieved under this thesis. The embedded kit under two independent modules are successfully working and thus as the same as discussed. The proposed system also featured the detection of red light under the active environment for processing and segregating the other wavelength light. Thus the system has successfully detected the ambulance and triggers the same at the traffic signal unit. The main agenda of the proposed system is founded towards the improvisation of efficiency in transmitting data from one hop to another hop under a heterogeneous network environment. Effective cost on installing the protocol is estimated to be comparatively low from the existing manually controlled devices.VLC path communication with higher efficiency of communication, secure and authentic data transmission and alerts is done.

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