IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 1, Issue 5, Oct-Nov, 2013
ISSN: 2320 - 8791
www.ijreat.org

Visible Light Communication for an In-flight Entertainment and finding DPPM interference

S.ABINAYA[1], V.ELAVARASI[2] and D.JHANAVI[3]

[1,2,3] ELECTRONICS AND COMMUNICATION ENGINEERING, ANNAUNIVERSITY/ PRATHYUSHA INSTITUTE OF TECHNOLOGY AND MANAGEMENT/THIRUVALLUR

Abstract — This paper established a reading lamp based visible light communication (VLC) for an in-flight entertainment. We established a full optical wireless strategy for passenger connectivity in planes. It uses a VLC system as a downlink, while an infrared link provides the uplink channel. The work is based on the research of VLC local access network. This paper also include the automatic ON and OFF of the receiver system using LED and shows the experimental results and interference of the users.

Keywords — Visible Light Communications, In-flight communications.

I.INTRODUCTION

Visible light communication (VLC) uses the white LEDs has aroused global attention. Visible light communication (VLC) is a data communications medium using visible light between 400Thz to 800Thz Using visible light is less dangerous for high-power applications because humans can perceive it and act to protect their eyes from damage.The technology uses fluorescent lamps(ordinary lamps, not special communications devices) to transmit signals at 10 kbit/s, or LEDs for up to 500 Mbit/s

At present, many famous research institutions and universities, such as the Visible Light Communications Consortium (VLCC) [1-2], the European OMEGA project [3], the Wireless World Research Forum (WWRF) [4] and so on, have dedicated much to area. Wi-Fi-based solutions to deal with compatibility problems with the flight instrumentation. However, the existing system is based on the available baud rate.the available baud rate for each user is limited and the EM compatibility problems are still present (not with the plane systems, but among other users when the amount of them increases). Other proposals are devoted to multimedia delivery inside the aircraft so as to provide seatback entertainment [5]. Wireless optical communications is a way of reducing the overall system weight induced by wiring each passenger seat.

In previous works, they showed how to solve the connection of the lamp with the Ethernet link [6] and a first approach based on an USB connection [7]. In this paper we propose a full optical wireless strategy for passenger connectivity in planes during flight. It uses a VLC system as a downlink, while an infrared link provides the uplink channel. Modulations and circuit implementations for a system prototype are also studied. Moreover, we introduce a new network adapter architecture, an exhaustive description of the system performance and an analysis of the power budget on the passenger seat.

Wireless optical connectivity offers some advantages on a typical plane cabin as it has no EM concerns. The position of the passenger during flight is well defined: s/he is usually placed on a seat with a reading lamp pointing to her/his position at a distance of about 1.5 m, and having a data device (laptop, tablet or phone) over the table. The coverage area of a typical infrared emitter pointing upwards has a diameter of about 50 cm, so focusing the uplink channel should be easy.

We shall employ an existing resource as the illumination lamp is always present. As the use of LEDs instead of other illumination sources does not present major regulation concerns, many plane providers appreciate their lifetime, low power consumption and chromaticity properties. There are several research groups working in this area. M.Kavehrad [8] has also studied theoretically the use of onboard power line networks for providing both electricity and communications by modulating LED lamps, while Elgala *et al* have proposed creating infrared communications cells to implement the user link [9].

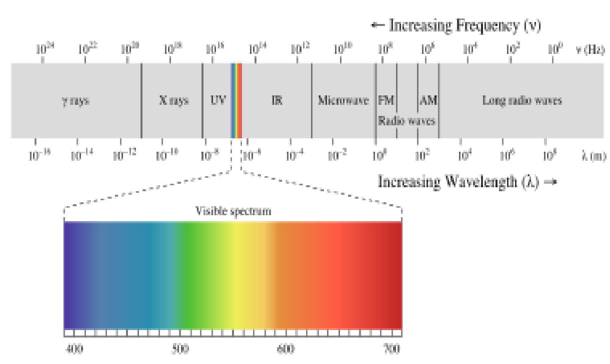

Fig 1 : Visible Light Spectrum

IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 1, Issue 5, Oct-Nov, 2013
ISSN: 2320 - 8791
www.ijreat.org

Specially designed electronic devices generally containing a photodiode receive signals from such light sources,although in some cases a cell phone camera or a digital camera will be sufficient.The image sensor used in these devices is in fact an array of photodiodes (pixels) and in some applications its use may be preferred over a single photodiode. Such a sensor may provide either multi-channel communication (down to 1 pixel = 1 channel) or a spatial awareness of multiple light sources

II.EXISTING MODEL

The existing model of the in-flight entertainment was in wired network which shown in the figure 2.

Fig 2:wired system

III .PROPOSED MODEL

An internet In-flight system consists :

User link: With the aim of reducing the amount of needed cable, a wireless link seems to be an optimal solution. This work focuses on this subsystem.

Let us consider a line-of-sight VLC data link from the reading lamp and an uplink channel based on a line-of-sight infrared channel from the computer (or data device) to a photodiode on the plane ceiling (close to the reading lamp, see Fig. 2). Two communication devices working as adapters have been developed: the first one, known as **"lamp adapter"**, gets the packets from the regular distribution network (Ethernet or PLC) and behaves as a bridge, replicating the information at the optical interface. The second one, known as **"passenger data adapter"**, is characterized by having a similar behavior, using the Ethernet or USB port of the mobile devices instead of the aircraft distribution network as data source or sink.

Therefore, the only difference between the adapters is the working wavelength of the optical link (VLC from distribution network to user, and IR in the other direction). each passenger is considered to be inside a microcell.

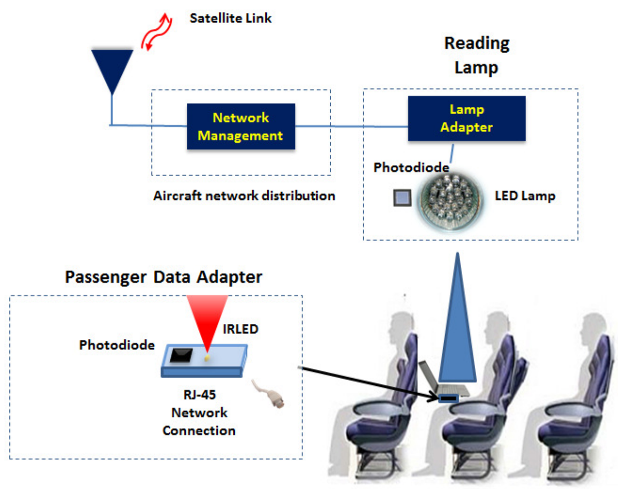

Fig 2: Description

However, it could be possible that nearby users or cabin illumination lamps generate harmful interference due to a wide lamp emission pattern or a high photodiode FOV. In addition, reflections on different objects could dramatically reduce the system performance. Here we use the optical lenses for collimating the light beam in the passenger's table.

In order to use an illumination lamp as a VLC device, a codification scheme that allows a constant illumination level at the lamp and data transmission is needed. In this work, CRDPPM (Constant Rate DPPM) is considered because of its simplicity and low cost of implementation, which is only based on an edge detector and a counter. This scheme does not only offer the advantages of DPPM (which encodes the data by modifying the distance between the pulses) [7-8], but also allows a constant bit rate, which makes the implementation of multimedia applications easier. In addition, it is suitable to be used simultaneously in communications and illumination systems due to the absence of light flickering.

IV.HARDWARE ARCHITECTURE

Since no well defined channel models for such transmission systems exist in literature, it was decided to evaluate the performance using an experimental setup.

A. Link chain

Fig. 2 shows the principle block diagram of the demonstrator. The link chain consists of two msp430 launch pads boards, one for the transmitter (Tx) and one for receiver (Rx). In particular, the msp430g2553 evaluation board with the Texas Instruments , which is based on the family of ultralow power microcontrollers is used. The evaluation boards contain 16-bit inputs. Matlab is used for the development of the algorithms and the code for dppm interference

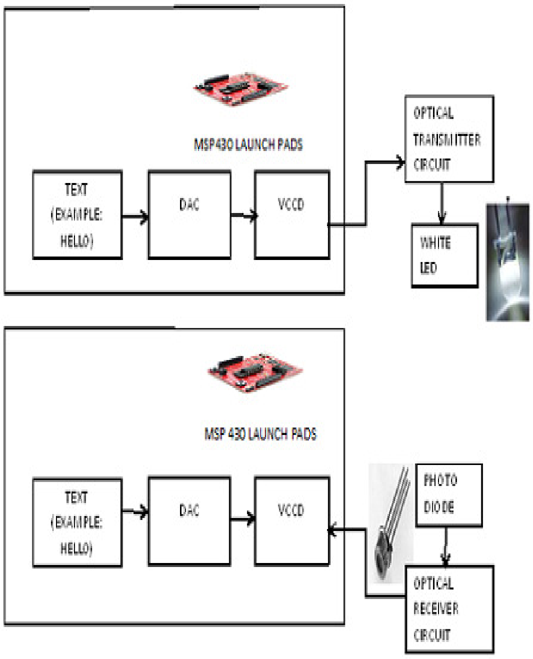

Fig. 2: visible data transmission prototype

.

B. LED characteristics

White LEDs are classified into two types. Some are fabricated using a blue LED chip and a phosphor. These types of LEDs have a phosphor layer on top of an InGaN-bases blue LED chip. The other types of white LEDs are fabricated by mixing light from LEDs of the three primary colours, such as red, green, and blue. All the three colours are emitted simultaneously. The optical source used in the prototype is a single chip (the first type as described above) 5mm white LED with a luminous intensity of 11000mcd. This type is chosen as it can be considered standard and inexpensive.

The circuit employs a *P* (positive) on *N* (negative) siliconplanar photodiode designed to deliver a maximum response through the visible part of the spectrum. The 9.8mm2 planar photodiode has a built in infrared rejection filter and provides a high shunt resistance,

and low dark current of 2000pA maximum. The generated photocurrent is proportional to the incident light power and it is converted to voltage using a transimpedance configuration. The photodiode can be operated with an applied reverse bias, photoconductive mode, or unbiased, photovoltaic mode. The photodiode was chosen with the previously mentioned characteristics to achieve very low offset when the photodiode is operated in the photovoltaic mode, and when it is used in a high gain trans-impedance operational amplifier circuit. For our application in the low frequency range, photovoltaic mode provides reasonable linearity and low noise.

V. VLC DOWNLINK IMPLEMENTATION

In order to use an illumination lamp as a VLC device, a codification scheme that allows a constant illumination level at the lamp and data transmission is needed. In this work, CRDPPM (Constant Rate DPPM) is considered because of its simplicity and low cost of implementation, which is only based on an edge detector and a counter. This scheme does not only offer the advantages of DPPM (which encodes the data by modifying the distance between the pulses), but also allows a constant bit rate, which makes the implementation of multimedia applications easier. In addition, it is suitable to be used simultaneously in communications and illumination systems due to the absence of light flickering.

Different codification schemes have been studied as well. OFDM techniques offer both good multipath and narrowband interference rejection response, but imply quite expensive hardware requirements. VOOK and VPPM schemes have been proposed in the under development VLC standard (802.15.7) as modifications of the OOK and PPM codifications respectively, with the aim of adding dimming capabilities. However, OOK does not guarantee the absence of flickering and both of them (OOK and PPM) have lower spectral efficiency than DPPM. Regarding the PPM scheme, it is characterized by having a better system performance against AWGN, but it is not a real necessity in VLC applications as the SNR values are commonly really high.The synchronization task, on its part, turns out to be much more difficult to accomplish than in CR-DPPM. If VPPM or VOOK are eventually defined as the codifications for the standard, many of these results would be also applied without significant modifications.

The communications behavior of LED lamps is limited by rise and fall times (100 ns for white phosphor LEDs), so the pulse width should be at least 200 ns, which is the upperbound of the lamp switching rate. In addition, the LED switching should be fast enough to avoid light flickering, fixing the lower frequency limit at several hundreds of Hz. The ratio between the ON and OFF periods determines the illumination level of the lamp.The proposed topology might work with data coming from VLC, twisted pair cables or optical fiber. The first solution avoids the necessity of performing any changes in the cabin topology as it uses the power lines of the aircraft itself to transmit the data. However, it could be noisy and generate EM interference with the aircraft instrumental systems. We shall consider, as an alternative, Ethernet as a distribution network inside de aircraft and the use of a Power over Ethernet (PoE) system to feed them up, and so the same shielded twisted pair cable will be used to transmit the data and to power the lamps.

This fact generates a weight reduction in the aircraft installation needed to offer this kind of services. As commented on above, there are two different adapters: the lamp adapter and the passenger adapter. Both of them have a similar functionality, but they differ in the power supply needed and the final optical interface they use to make the electro-optical conversion. The lamp adapter is fed with a PoE device and uses a visible light LED to do the transmission, whereas the passenger adapter uses the USB port as power supply, which offers up to 500mA at 5V.

VI. UPLINK AND DOWNLINK CHANNELS

The designed passenger adapter contains a VLC receiver, an IR emitter and the receiver part of the optical-to-Ethernet interface. The generated electrical signal is pre-amplified using a trans-impedance amplifier which is used to reduce the effect of spurious capacities in the photodiodes. This circuit improves the frequency response, especially when several photodiodes are parallel connected to increase reception area.

The downlink electro-optical conversion is based on a commercial blue-phosphor simple LED lamp which allows a bandwidth up to 5-6 MHz, although RGB multichip configurations will easily provide 50-60 Mbps of joint baud rate.To excite this lamp we have implemented a driver configuration using open collector-logical gate chips driving 3 LED parallel blocks. These devices are able to switch current values up to hundreds of mA, as required for the illumination LED.

Each passenger is considered to be inside a microcell. However, it could be possible that nearby users or cabin illumination lamps generate harmful interference due to a wide lamp emission pattern or a high photodiode FOV.

VI. EXPECTING RESULTS

From this paper we are expecting a low cost VLC system for in-flight applications. Full wireless optical connectivity is need to obtain by using a VLC system for the downlink and an IR system for the uplink. The adapter for the passenger laptop offers a versatile solution using the Ethernet port without the installation of an extra driver. The presented system can be rapidly implemented and provides personalized in-flight entertainment and services by wireless media. This technology does neither suffer nor produce interference with radio. Baud rates can be significantly increased using RGB LEDs lamps and microcontroller devices. Protocol requirements on the optical channel are also reduced because each couple lamp-photodiode acts as a dedicated access point for each singular seat.

REFERENCES

1) VLCC, “Visible Light Communications Consortium,” 2008.

2) M. Nakagawa, “Visible Light Communications,” 2007.

3)“Home Gigabit Access project,” funded by European Framework 7.’’ http://www.ict-omega.eu/.

4)“Wireless World Research Forum.” http://www.wireless-world-research.org/.

5)Y. Zheng and M. Zhang, "Visible light communications-recent progresses and future outlooks", *Symposium on Photonics and Optoelectronic (SOPO)* 2010, pp. 1-6, China, June 2010.

6)R. Perez-Jimenez, J Rufo, J. Rabadan, C. Quintana and F.J. Lopez-Hernandez, “Visible Light Communication Systems for Passenger In-Flight Data Networking”, *IEEE International Conference on Consumer Electronics*, pp. 445-446, USA, Jan. 2011.

7) C. Quintana, V. Guerra, J. Rufo, J. Rabadan and R. Perez-Jimenez, "Ethernet to Visible-Light Communications Adapter for In-Flight Passenger Data Networking", *World Congress on Engineering and Technology 2011*, China, Sept. 2011.

8) M. Kavehrad, Z. Hajjarian and A. Enteshari, “Energy-Efficient Broadband Data Communications using White LEDs on Aircraft Powerlines”, ICNS Conference 2008, pp. 1-6, USA, May 2008.

9) H. Elgala, R. Mesleh and H. Haas, “Indoor broadcasting via white LEDs and OFDM”, IEEE Transactions on Consumer Electronics, vol. 55, no.3, pp. 1127-1134, Aug. 2009.