

Visible Light Communication In Aviation

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Abstract—With the advent of the upcoming technologies we are obliged to use light source as a medium to make it feasible to use the technologies efficiently. Visible light communication (VLC) is a new technology which provides a substitution to the application operating on radio frequency and has the potential to provide wide range of benefits to aviation industry. Thus, our paper includes an effective way to use light source as a medium of communication without compromising with the quality of service. The paper outlines the basic components which can be fruitful to the user and help them to operate technology smoothly and various implementation.

Index Terms—Wireless Fidelity, Light Fidelity, Light Emitting Diode, Energy Efficient, Aviation, Future Technology.

1 INTRODUCTION

VLC is a fast-growing technology which provides low-cost, high speed, power efficient and secure data communication in addition to lighting using low cost Light Emitting Diodes (LEDs) which can be modulated at high-speed, offering the possibility of using them for simultaneous illumination and data communications [1].

Research on VLC was originated in Japan with the majority of research carried out by the Visible Light Communications Consortium (VLCC) [2]. Due to concerns over energy consumptions, fluorescent and incandescent light sources are being replaced by solid-state light sources like LEDs and it is predicted that they will become the dominant source of illumination in future. The use of such LEDs inside stations and trains opens up various possibilities for enhancing the railway operations through VLC.

This position paper proposes some of the possible applications of VLC in a railway environment. The main components of VLC are discussed in the next section [3].

2 COMPARISONS BETWEEN RADIO COMMUNICATION AND VISIBLE LIGHT COMMUNICATION

Maturity: As compared to the visible light communication (VLC) the use of radio frequency is been used since a long time. VLC is a developing technology as compared to RF. The RF technology is more matured.

Range: - The range of VLC is relatively short (few meters), whereas WiFi can achieve 10s per meters. This is one of biggest disadvantage of VLC.

Power needs: -A powerful radio transmitter, such as a regional broadcast station, requires large amounts of electricity at all times to send out its signal. On the other hand, VLC already has power available for the LED lamp.

Data density/Frequency reuse: - WiFi causes a lot of co-channel interference and deploying more WiFi nodes does not increase capacity linearly, for VLC interference is confined and

so the re-use efficiency is much greater.

Security: - WiFi uses encryption for security but it is difficult to constrain the data transmission within a set area, whereas VLC by its nature confines the data to areas which are intentionally illuminated. So, the data is more secured in VLC than RF.

Bandwidth: - Radio communication relies on a very limited spectrum of bandwidth frequencies. VLC is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination.

3 POTENTIAL AVAITION APPLICATION

3.1 On board aircraft internet facilities

In today's world the number of people using electronic devices such mobiles, tablets, laptops, etc are very large. From figure 1, it is clearly seen that the main purpose of these devices is nothing but to access internet. Almost in each and every place people are able to use the internet. One of the places where people are kept away from doing so is aircraft. Following is the idea in which the people will be able to use the internet even in aircrafts. Here we will fit an antenna inside the tail of the aircraft. This antenna will help the pilot to use the internet through RF [4].

Now to provide this internet to passengers we will use here light. The lamp light which is above each seat in the aircraft can be designed and programmed to serve this purpose. By doing this we can separate the bandwidth of the internet in two parts i.e 60% for the pilot and 40% for onboard passengers. Passengers sitting on the seat will be able to access online application which requires less data access through online. This will help many people to online transactions and do all their online activity.

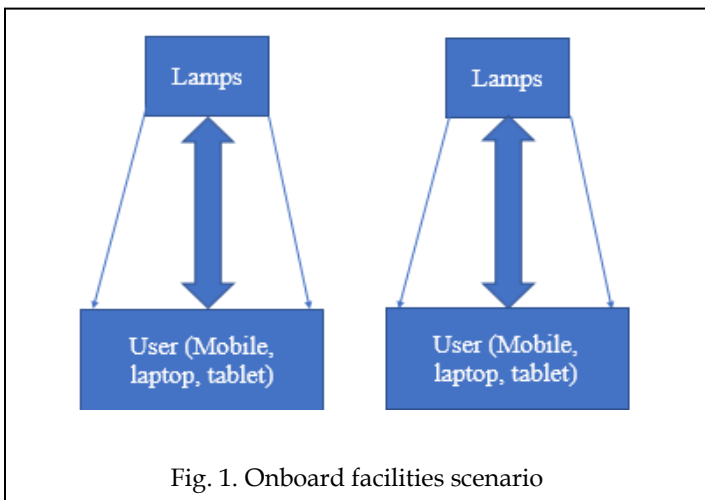


Fig. 1. Onboard facilities scenario

3.2 Floor cleaning motor car

We all know that there is a great need of cleaning devices that can be used in malls, airports, industries, etc. [5] Mostly we have seen these days that all these places use motor cleaning car for this purpose. These cars work on a battery. So, it requires a need of charging it again and again. But there is a theory put forward that these cars can also being run on light. The above-mentioned places are all of great purpose and requires 24/7 light facilities [6]. From figure 2, instead of using battery to drive these car LEDs which are used in these places can be programmed and made to function to run these cleaning cars. The technology used here is nothing but Visible Light Communication.

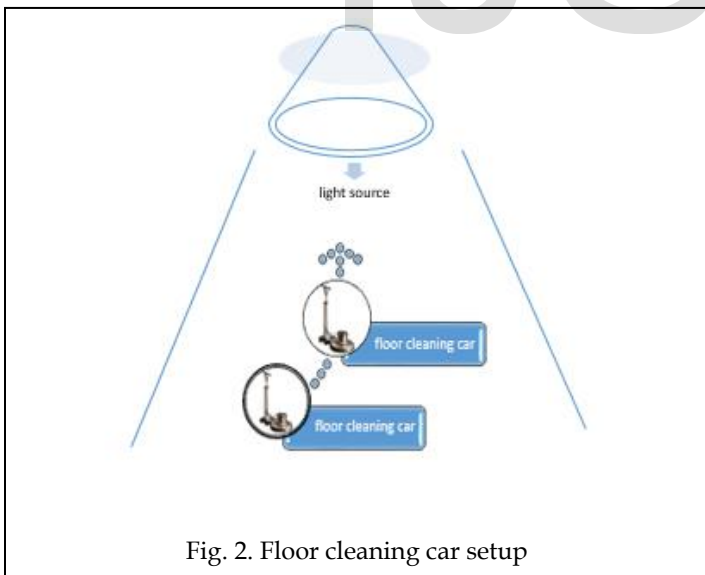


Fig. 2. Floor cleaning car setup

3.3 Announcement speakers working on LEDs

Basically, the original method of functioning of speakers in aircraft was through wires. These wire connections are very complex and difficult since there are many speakers used in a single aircraft. This method can be replaced by VLC [7]. In this we will use LEDs for transmitting the audio signal and solar panel to receive the audio signal which will be connected to the speakers [8].

It is common where we use wires which are connect from transmitter to receiver but this technique can now be modified by replacing the wire medium to light [8]. With the use of this technique there will be tremendous reduction in the cost of the authority which is spent regularly to buy a good quality of wire for the development of the structure. We can minimize the cost by using the daily available light which is used to illuminate into transmission of this audio signal [9].

Figure 3 clearly explain the block diagram of announcement speakers working through light source and solarpanel is used at the receiver side.

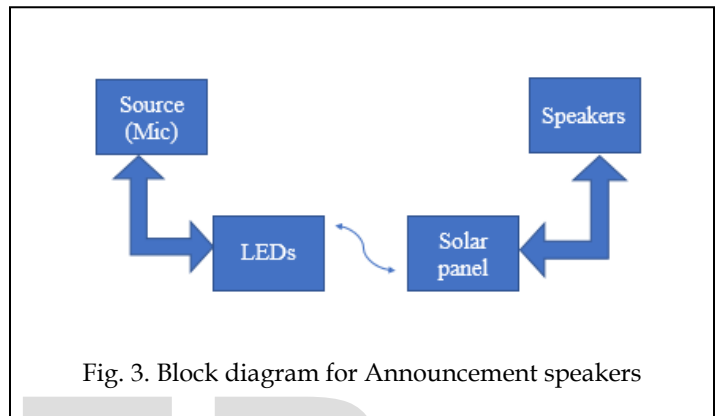


Fig. 3. Block diagram for Announcement speakers

3.4 Security camera working on the principle of visible light communication

Security cameras have been installed in large numbers at places where there are extensive grounds and many humans gather (railway stations, airports, hospitals, temples etc.).

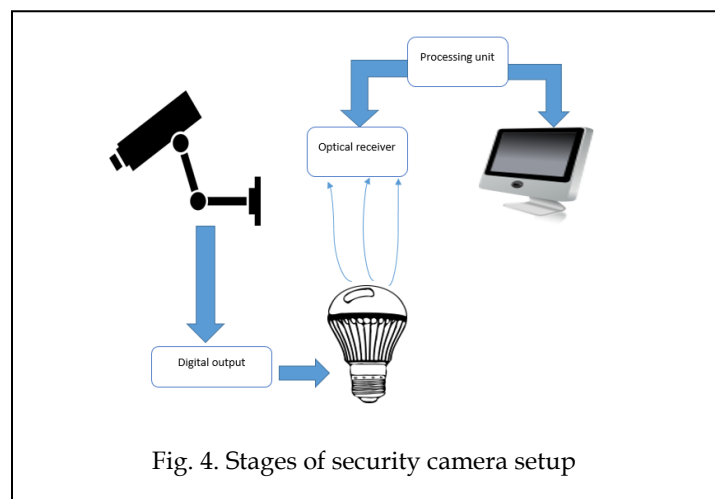


Fig. 4. Stages of security camera setup

The number of installed security cameras has been increasing year by year. The main reason is security enhancement including the prevention of incidences of terrorism. From figure 4, this camera uses a lot of electricity as they are in large numbers. This electricity can be provided by the preexisting light source in the venue. Now, a day we are using led lights as a dominant light source. According to the principle of visible light communication (VLC) we can use these led's as a trans-

mitter to the security camera [10]. These led's are programed in such a way that it controls the functioning of the camera. A photo receiver is applied to the security camera, this receiver receives information from the led's and the functioning of the camera is done. The information provided to the leds is in the form of digital signal. These leds have high switching rates so it can be used for transmission of digital signal. The control panels in the airport provides information to the leds and these leds act as a transmitter for the security camera. Security camera can also be installed in the floor cleaning cars which are seen on the airports [10]. These cameras also will receive information from the led which are already available at the airports.

4 ADVANTAGES

4.1 Reduction in management Expenditure

With visible light you can shine a beam of light in a very controlled way. Not only that, you can see exactly where it goes, so positioning of antenna is much easier. VLC therefore has inherent security so there is no need to confirm or accept the device pairing. So, the expenditure for additional encryption and decryption is saved. The short-range data rates of a VLC system can also be very large - e.g. 1Gbit/s could be achieved [10]. In VLC as there is no need of a powerful transmitter, so device-to-device VLC could be achieved relatively easily, and it would be much easier to use than wireless radio connections. The only power required for transmission is a simple power supply which is used to switch on the leds that it. And also, on the receiver side a simple photo receiver is used.

4.2 Low cost of wiring

In RF, along with the management of power for transmission and security the cost of wiring is also very high. The wiring is also very complicated. In VLC the wiring is also quite simple. The cost of wiring is very less. Also, the cost of leds use for the transmission of data is also quite cheap. Data transmission using Li-Fi is very cheap. LED lights consume less energy and are highly efficient. Availability is not an issue as light sources are present everywhere [11]. There are billions of light bulbs worldwide, they just need to be replaced with LEDs for proper transmission of data.

So, this is how we are combining the cost of two structure at single cost by using the illuminating LEDs for communication purpose.

4.3 Double profit at single cost of Leds

In Li-Fi we use led light for communication or for transmission of any data. as we all know light plays major role in our daily life. Our life is full of light e.g. tube light, lamp, street-light, headlight, small led light to decorate our house in festival, mobile torch like this we use light in our life. If we start use the light for data transmission so in one cost, we have the benefits of two things [11]. The speed of lifi is so much faster than WiFi and Li-Fi is very cheaper then WiFi so any one can use lifi. Li-Fi is very helpful to our country because we are getting double profit in one cost of led so we can save the money which we can use on our development.

4.4 Light can be used as a green energy

Fossil fuels are non-renewable, that is, they draw on finite resources that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve. In contrast, the many types of renewable energy resources-such as wind and solar energy-are constantly replenished and will never run out. Most renewable energy comes either directly or indirectly from the sun. Sunlight, or solar energy, can be used directly for heating and lighting homes and other buildings, for generating electricity, and for hot water heating, solar cooling, and a variety of commercial and industrial uses. Solar energy is also used to drive a car [11]. If we start using the solar energy, then there is no need of any green energy and it will very helpful to us because there will be no damage of environment.

5 CHALLENGES

5.1 Trans receiver need to be upgraded

In visible light communications all the applications which we have made uses photo diode and solar panel. It is very important to know that solar panel and photo diode is not an intelligent device. The work of the solar panel and photodiode is to absorb the light falling on it.

But many times, it happens that if the source(LED) is not directed properly towards the solar panel or photo diode then there will distortion in the received message. Many times, it also happens that since the function of these devices are to absorb light, it absorbs all the light which is present in the project environment rather than the source [12].

We can also add here a point that these devices are not smart. Suppose if we have a project which is totally based on selection of output, these devices are also not capable of it. One of the major drawback of solar panel and photo diode is duplex communication is not possible.

5.2 Change of infrastructure requires time

Nowadays everyone using WiFi. If we bring lifi so it will take some time because we need time to adopt the new things. In WiFi we use the radio frequency and in lifi we use the VLC for data transmission so we have to change from radio frequency to VLC which is not so easy that's why we need time. we cannot change so quickly WiFi into Li-Fi it will take time. In WiFi we use the router to transmit the radio frequency but in lifi we use led light to transmit VLC because of all these problems it will take time to change the infrastructure.

5.3 Change of infrastructure requires time

As we all know in lifi we use led lights but light cannot travel through any solid thing. So, in hacking lifi is secured as compared to WiFi but if we keep any barrier between led and mob then there will be some loss of communication. This is a big problem of lifi because some time there is a barrier coming between transmitter and receiver which gives a problem to

communicate or to transmit any data [12]. Obstruction will be anything for e.g. paper, cloths, any body part of human etc. So this problem will definitely come when we use lifi because many time this obstruction are placed accidently between transmitter and receiver. If we got the solution to solve this problem, then the lifi is secured and very helpful as compared to WiFi. The big cargo goods which are packed for courier and need to be transported to foreign then these goods come to the airport which can block the light source.

5.4 VLC standards

The VLC standard needs to consider both communication and illumination practices of solid-state devices like LEDs. It will turn into a havoc if new technology is not fitted in the current generation of technologies which will lead to its non-acceptance. All devices capable of VLC need to be compatible with this standard. A draft IEEE 802.15.7 standard was produced by the IEEE 802 work group [13], but it is out-of-date as it fails to consider the latest advances in optical wireless communications like the optical orthogonal frequency division multiplexing (O-OFDM) modulation techniques [13].

6 CONCLUSIONS

VLC is a rapidly growing technology which has immense possibilities in aviation environment for providing better user experience. It has the potential to provide a cost effective and secure transmission system [12]. VLC is a substitution to radio frequency applications. There are challenges that can come while implementing the project but these limitations can be easily eliminated by taking some simple measures. VLC is going to be the best resource helping vast applications to work on this principle [13].

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