VISIBLE LIGHT COMMUNICATION IN MARITIME INDUSTRY

Andrija Mišković

University of Rijeka, Faculty of Maritime Studies in Rijeka, Rijeka, Croatia

Abstract. The main goal of this paper is to present Visible Light Communication (VLC) technology and highlight the benefits of its implementation in ships and other maritime structures such as offshore platforms and docks. This could be the solution to the problem of many disadvantages which are present in today's communication technologies. The VLC technology refers to communication technology which utilizes Light Emitting Diodes (LED) as a transmitter of visible light through the air as a transmission media and a photodiode as a signal receiver. Since communications took a huge role in our daily lives, people should give a better understanding of it and should work on its improvement. Transferring data from one point to another became a very common routine. Most of the communications are radio wave based. The number of communications is rapidly increasing, which results in an overcrowded radio spectrum. Therefore, Visible Light Communication technology is becoming an alternative solution for wireless technology. Compared to a standard wireless communication, VLC technology has several advantages. There are many reasons and advantages for its use. The most important one is reducing the electromagnetic interference to other instruments or communication channels in specific environments where the technology is present, e.g. Hospitals, airplanes, ships etc. Also, it reduces the overloaded radio frequency spectrum. Furthermore, the advantage of this technology is the utilization of a lot of sources for broadcasting and transmission data when the certain area is illuminated. Data security is also a feature of this technology since the visible light cannot break through the walls. There is an unlimited range of developing different applications with this technology since the light is the safest source of energy and its frequency spectrum is free of charge.
Key words: Visible Light Communication, communication network, maritime, LED, photodiode

1. Introduction

This paper introduces the Visible Light Communication (VLC) as an alternative to many disadvantages in modern technology and communication industry and maritime industry as an aim of this study. Nowadays, communications have a very important role. Today's communications are mostly radio wave based which means that a radio wave from the radio frequency (RF) specter is used to transmit a signal from one point to another. VLC presents an optic wireless communication technology that uses visible light frequency band (400nm to 700nm)[1], but physical components such as wires and cables also could be used for data transmission. The light created from the LED diodes is used to transmit the signals and photodiodes to receive them. There are several goals that should have been considered for the purpose of using this technology. The main goal of the use of the VLC is to reduce the overcrowded radio part of an electromagnetic specter as more communications are developing. This results in creating a communication technology with higher data rates compared to RF communication. VLC data rate can reach up to 500 Mbps. The VLC provides a high level of security since the visible light can not penetrate through the walls which make a specific room or building more secure. Compared to radio frequency (RF), Visible light communication (VLC) presents a powerful alternative mostly because of the electromagnetic interferences that RF produces on other devices. Implementation of VLC for indoor communication is more practical as people living in urban areas spend most of their time indoors. This implementation of VLC can add to the existing capacity of data communication with use of the same infrastructure which is already there. It can be used in areas where RF can be harmful; like a hospital, an areoplane and other electromagnetic sensitive areas. It is necessary to consider this technology very well since the LED has become very common in lighting because of its cost efficiency, long life service, safety and high resistance to vibrations. Moreover, the current maritime wireless communications at sea mainly rely on satellite links that are relatively slow than HF, VHF and expensive Inmarsat. Like on land, sea users need a high-speed, low-cost maritime wireless communication and special service. Therefore, new technology is needed to improve existing maritime communications.[2] The use of VLC technology could be a very attractive solution in the maritime industry for shore-to-ship, ship-to-ship communications eg. sea beacons or even in offshore platforms as a solution for indoor communications.

[1] K. Siddiqi, A.D. Raza and S. Sheikh Muhammad, "Visible Light Communication for V2V Intelligent Transport System", pp.1, 2016.

[2] Hyeongji Kim, Atul Sewaiwar and Yeon-Ho Chung, "Maritime Visible Light Communication with Sea Spectrum Models", vol.9, pp.67, 2015.

2. Transmitter

LED (Light Emitting Diode) diode is an electronic component which converts electrical signals into optical and represents a suitable component in optical communication performances. A transmitter can be made in a shape of a lamp which is made of a number of LEDs. To achieve data transmission from the transmitter it is necessary for the control circuit to manage the current flow usually in a form of titration of the LEDs. These titrations are representing the binary states of zeros and ones (0 and 1) which the receiver recognizes and reads as an information. The LEDs, in this case, have a double role, to emit the necessary light which is the primary one and to transmit data to the receiver. It is important that the second role has not a negative influence on the first one. Therefore, the system of VLC depends on the quality of design of the LEDs. The most common color of the light which used to achieve the transmission is white which is achieved by using the RGB (Red- Green-Blue) diodes. Objects illuminated with white light have their most natural look. RGB diodes use a combination of three colors illuminated at the same time, red, green and blue. The product of a combination of these three is the white light. The use of RGB diodes in VLC can give a maximum data rates.

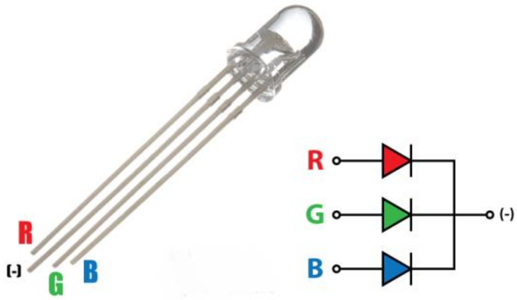

Fig 1. RGB diode

3. Receiver

A photodiode is usually used to receive the transmitted signal. The photodiode has an opposite role from the LED. Its role is to convert the electrical signal into the shape of light from the LED to the electrical signal which represents a useful information for the user. Different modulation techniques are used to single out the useful information from the transmitted electrical signal. The VLC is sensitive to interferences created from other light sources e.g. sunlight, therefore it is necessary for the receiver to implement an optical filter for the purpose of reducing the noise in the received signal. The photodiode is distinguished by low price with high reliability. The principle of communication between the transmitter and the receiver is based on the titrations of the LED. The LED with it titrations gives the indication to the photodiode that the data transmission has started. The current which flows in the set after the detection of photodiodes as a change of light of the LEDs convert to the useful information.

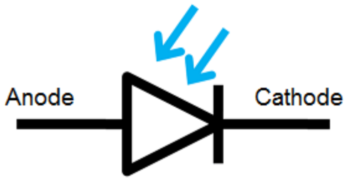

Fig 2. Photodiode

4. Applications of the VLC system

An important characteristic of the VLC is a large broadband which enables communications at high data rates. Also, it has no negative affects on human health such as harmful radiations and it is also characterized by its low power utilization which made this technology as a potential candidate in many applications. The one which it should pay attention to is called the Li-Fi (*Light Fidelity*). Li-Fi is an optical wireless communication system which is characterized by high data rates. It is similar to Wi-Fi (Wireless Fidelity) in which for communication radio waves are used. For this specific reason, Li-Fi presents a better solution in industries where interferences aren't acceptable (hospitals, airplanes, ships etc.). Wi-Fi with its radio frequency produces harmful interferences on other neighboring RF signals. Also, it is possible to reach data rates up to 10Gbps with the Li-Fi which is not possible in the case with the Wi-Fi.[3] With this application is possible to achieve a source of light which illuminates a specific room and at the same time acts as a source of data. This possibility reduces the "extra" power consumption since there is the same source for light and data while also, reduces a lot of cables. VLC can also find its place in hospitals, intelligent transport systems, aircraft, underwater communication etc.

[3] Latif Ullah Khan, "Visible light communication: applications, architecture, standardization and research challenges", pp.80, 2017.

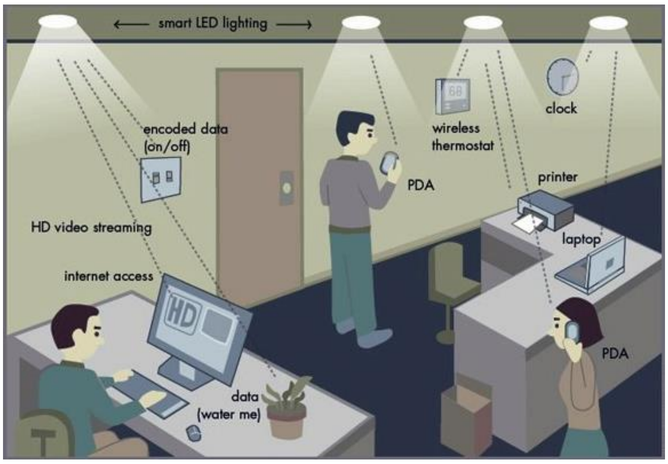

Fig 3. Concept of Li-Fi

5. VLC in maritime industry

Today's maritime communications and its devices are represented by radiotelephony (eg. VHF DSC). The RF is used to establish a communication between two ships or a shore and a ship. Radiotelephony represents voice signal in the electromagnetic specter which is made of different bands such as Medium Frequency (MF), High Frequency (HF), Very High Frequency (VHF) etc. Maritime communication technology represents a powerful industry which improves its characteristics day by day. The side effect of this development is a high price which inspires engineers to create a communication technology that offers a low-cost and high data rates technology. It is possible to enlarge the communication specter for 10 000 times by implementing the VLC technology. In maritime, VLC could be implemented in a shape of sea beacons and lighthouses that are performing a task of transmission data and maritime information to other ships or offshore platforms. Also, could be implemented on ships in a shape of Li-Fi technology to provide internet communication. TRI-media Telematic Oceanographic Network (TRITON) based on IEEE 802.16 and IEEE 802.16e implemented a mesh network in Singapore for maritime communication using a ship, buoys, and lighthouse as communication nodes with the intetion of developing a low-cost and high-speed system for maritime communications close to the shore and in narrow water channels.[4]

[4] Hyeongji Kim, Atul Sewaiwar and Yeon-Ho Chung, "Maritime Visible Light Communication with Sea Spectrum Models", vol.9, pp.67, 2015.

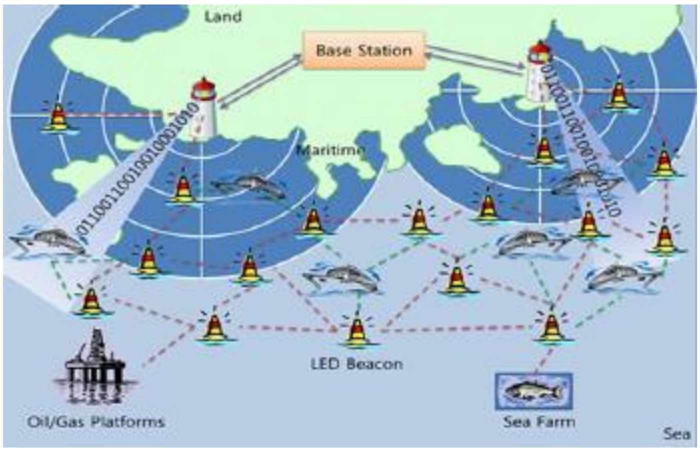

Fig 4. Shore-to-sea communication

Fig 4. shows how a VLC network can be set. The network is formed of ships, sea beacons, and buoys which are all connected via VLC to the terrestrial networks. The base station covers a large area and it consists of power LEDs, while the receivers (sea beacons, platforms, buoys etc.) consists of photodiodes.[5]

6. Conclusion

The aim of the study is to give a clear insight into the Visible light communication wireless technology to make it as a potential candidate for many industries in near future. VLC provides important characteristics and advantages which could be useful in searching an answer to eliminate previous disadvantages. Its high data rate, low-cost and resistance to interferences compared to currently using RF, make this technology of a very high interest. Also, provides a high data security which is of great importance. Light sources surround us everywhere, this is why this technology should have a wide application in order to reduce the high prices of RF and also to reduce a lot of necessary cables. With all the mentioned characteristics, the VLC could be used in numerous applications such as aircraft, medicine, maritime, business building, schools, colleges etc.

[5] Hyeongji Kim, Atul Sewaiwar and Yeon-Ho Chung, "Maritime Visible Light Communication with Sea Spectrum Models", vol.9, pp.68, 2015.

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