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Visible Light Communications Illuminates the Future

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The use of Internet, video and audio calls at a very low cost is now common for all people around the world. This implies a tremendous carrying capacity for the carrier wave. The credit gets back to the use of light as a carrier wave, leading to Optical Communications.
The use of visible optical carrier waves or light for communication has been common for many years. Simple systems such as signal fires, reflecting mirrors and, more recently, signaling lamps have provided successful, information transfer. Moreover, as early as 1880, Alexander Graham Bell reported the transmission of speech using a light beam.

Depending on their wavelengths, these electromagnetic carriers can be transmitted over considerable distances, but are limited in the amount of information they can convey by their frequencies. In this context, it may also be noted that communication at optical frequencies offers an increase in the potential usable bandwidth by a factor of around 104 over high-frequency microwave transmission. A renewed interest in optical communication was stimulated in the early 1960s with the invention of the laser, considering it as a single frequency source. This device provided a powerful coherent light source, together with the possibility of modulation at high frequency.

However, the previously mentioned constraints of light transmission in the atmosphere tended to restrict these systems to short-distance applications. The proposals for optical communication via optical fibers fabricated from glass to avoid degradation of the optical signal by the atmosphere were made in 1966 by Hockham. Such systems were viewed as a replacement for coaxial cable or carrier transmission systems [1].

Many studies were conducted to depict the best carrier wavelengths to be used in optical fiber communications. Two windows were chosen: 1.3 µm and 1.55 µm, where single mode fibers achieved minimum loss and maximum transmission bit rates. Millions of kilometers of optical fiber cables, either underground or undersea, are responsible of carrying different data around the globe.

In addition to optical fiber communications, the wireless optical communications shared the revolution of optical communications in both outdoor and indoor applications. This was achieved using visible light, leading to Visible Light Communications (VLC) [2, 3]. The VLC system can also be referred as LiFi (Light Fidelity), analogous to the term WiFi. In 2011, Harald Haas was the first to coin the term Light Fidelity (Li-Fi). Li-Fi is a high speed bi-directional fully connected, visible light wireless communication system. In the areas that are sensitive to electromagnetic radiation (such as aircrafts), Li-Fi can be a better solution. A Li-Fi also lends support to the Internet of Things (IoT). VLC uses wavelengths between 380 nm to 750 nm (i.e. 430 THz to 790 THz) for communication, Fig. 1.

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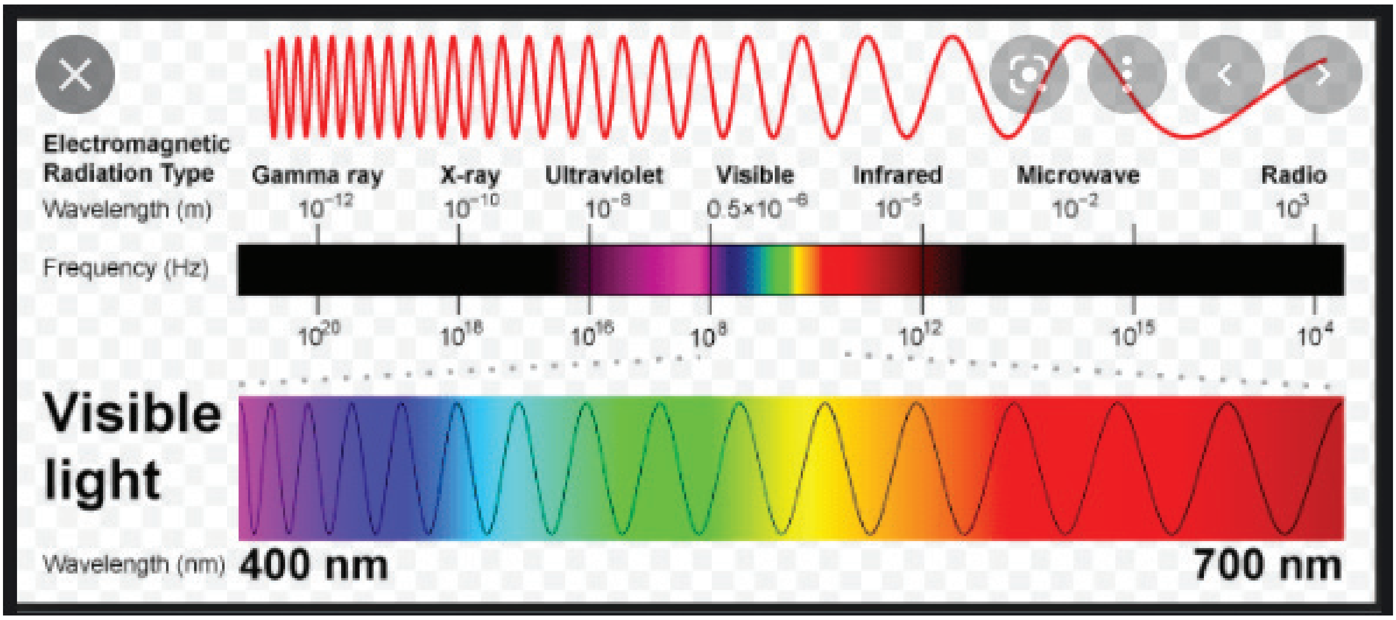
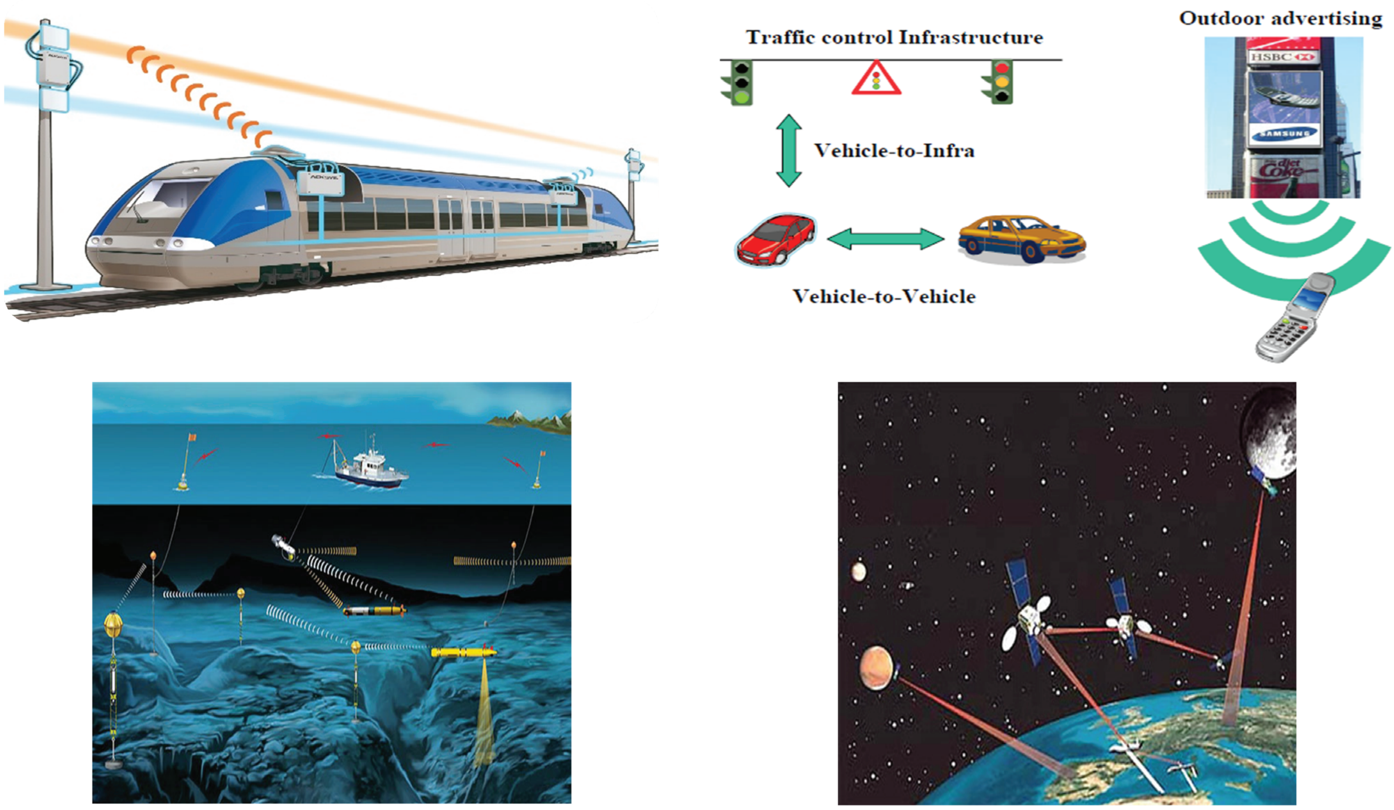


Figure 1 Light spectrum [1].

Some of VLC applications include under water communication, vehicle to vehicle communication, indoor broadcast system for internet use and inside airplane communication. In indoor applications, the light emitting diodes (LEDs) are used for dual purposes: illumination and communications [4]. Examples of these applications are illustrated in Figure 2.



(a)

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(b)

Figure 2 (a) VLC outdoor applications [2, 4]. (b) VLC indoor applications [3].

VLC has many advantages including:

- It supports larger bandwidth and hence overcomes bandwidth limitation of RF communication.
- It provides secured communication unlike RF communication.
- The VLC source is used for both illumination and communication. Hence, VLC is power efficient system.
- VLC is light based communication. Hence, it is not affected by electromagnetic radiation from RF systems, leading to safety from health risks. It is easy to install.
- No license is required.

The VLC still has some drawbacks and challenges that have to be solved. This includes:

- VLC based communication has interference issues from other ambient light sources.
- VLC communication supports short coverage range. So, there are challenges to integrate VLC with WiFi systems.
- Atmospheric effects.
- A fundamental challenge in VLC systems is that they require the light ON all time. Then, how to communicate when the lights appears "OFF"? Here, it appears a new and a promising expression: "Dark Light", where visible light can be used to transmit data even when the light appears dark or off. The VLC minimum illumination to receive power is investigated to enable users to receive data when the light is "OFF" [5].

REFERENCES

[1] J.M. Senior, Optical Fiber Communications: Principles and Practice, 3rd ed., Pearson Education Limited, London, UK, 2009.

[2] Latif Ullah Khan, "Visible light communication: Applications, architecture, standardization and research challenges," Digital Communications and Networks, vol. 3, no. 2, pp. 78-88, 2017.

[3] G. Tiwari, R. Chandra, and S. Chauhan, "A review on inter-satellite links free space optical communication," Indian Journal of Science and Technology, vol. 13, no. 6, pp. 712 – 724, 2020.

[4] G.A. Mapunda, R. Ramogomana, L. Marata, B. Basutli, A.S. Khan and J.M. Chuma, "Indoor visible light communication: A tutorial and survey," Wireless Communications and Mobile Computing, vol. 2020, Article 8881305, pp. 1-46, 2020.

[5] Marwa M. El-Gamal, Maheswar R, Heba A. Fayed, Moustafa H. Aly, Nour Eldin H. Ismail, and Amr Mokhtar, "Dark light visible light communication positioning system with received signal strength technique," Optical and Quantum Electronics, vol. 53:42(1-16), 2021.

BIOGRAPHY

__Moustafa H. Aly__ was born in 1953, Alexandria, Egypt. He received his B.Sc., M.Sc. and Ph.D. from Faculty of Engineering, Alexandria University, Alexandria, Egypt, respectively, in 1976, 1983 and 1987. He is a professor of Optical Communications, Electronics and Communications Engineering Department, College of Engineering and Technology, Arab Academy for Science, Technology and Maritime Transport, Alexandria, Egypt. He was a co-supervisor of 150 M.Sc. and Ph.D. students and published 330 journal and conference papers. His research area includes Optical Communications, Optical Amplifiers, Free Space Optics, Visible Light Communications, and Optical Networks.