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Performance Enhancement of Networking with Visible Light Communication in Customer Service

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ABSTRACT: -

Visible Light Communication is the short range optical wireless communication technology used in LEDs for communication and illumination. The visible light communication (VLC) refers to the communication technology which utilizes the visible light source as a signal transmitter, the air as a transmission medium, and the appropriate photodiode as a signal receiving component.

In Visible Light Communication, communication and illumination occurs simultaneously [17]. The technology uses transmitter, receiver, modulators and demodulators for communication. Visible light communication is a new broadband transmission technology that

uses standard off-the-shelf visible light LED luminaries to transmit broadband data streams.

VLC uses white Light Emitting Diodes (LED), which send data by flashing light at speeds undetectable to the human eye.

In this paper the detailed investigation of VLC research, it was found that not a lot of research has been done to develop this technology for commercial use. But because research into VLC is relatively new, the possibilities are wide open.
A lot of research is being done to make this technology available for commercial use in various fields, including Internet access and vehicle-to-road communication using traffic signal lights.

Keywords: -

Visible Light communication, LED, Wireless fidelity (Wi-Fi)

1. Introduction: -

Visible light communication (VLC) is a data communications medium which uses visible light between 400 and 800 THz (780–375 nm). VLC is a subset of optical wireless communications technologies.

The idea of using light as a communication medium was implemented by Alexander Graham Bell in 1880 with his invention of the photo phone, a device that transmitted a voice signal on a beam of light.

The visible light communication (VLC) refers to the communication technology which utilizes the visible light source as a signal transmitter, the air as a transmission medium, and LED (Light Emitting Diode) as a signal receiving components which achieves high data rates compare to other wireless technologies like WIFI, BLUETOOTH, WI-max. While using wireless internet, if one or more devices are connected to network, then bandwidth of network goes down at slow speed. To overcome this deficiency of bandwidth we can use light to transfer the data.

The characteristic of short transient time in turning the light on/off processes was further investigated. A high-speed wireless communication system, which is embedded in our LED lighting system, was built.

With the invention of LED (Light Emitting Diode), the idea of using light as a communication medium has started again

The visible light communication is accomplished with LED (Light Emitting Diode). The intensity of light cannot catch by human eye. LED's are low cost and bidirectional which gives 300THz bandwidth whereas RF (Radio Frequency) gives 6GHz. It also gives low complexity network transfer rates up to 10GB/S.

One major advantage of VLC is that we can use the infrastructure around us without having to make any changes to it. LEDs' ability to transfer information signals over light (light which is between 400THz to 800THz of frequency and whose wavelength is between 400nm to 700nm) makes it a very good communication medium.

VLC = Illumination + Communication

The visible light is the form in which the electromagnetic radiation with wavelengths in particular range is interrupted by human brain. The visible spectrum covers the wave lengths from 380 nm to 750 nm. Visible light communication (VLC) is an evolving communication technology for short range applications. Exploiting recent advances in the development of high-power visible-light emitting LEDs, VLC offers an energy-efficient, clean alternative to RF technology, enabling the development of optical wireless communication systems that make use of existing lighting infrastructure.

1.1 Characteristics of Visible light communication: -

Characteristics: -

- ***Efficiency: -***

VLC provides efficient way of communication due LED which require negligible power and less complexity. It is inexpensive because of the use of already available visible light sources. In case of RF communication, complexity and cost is very high.

- ***Security*: -**

VLC is secure because of two main reasons: VLC signal is defined closely to lightning area i.e. line of sight communication and other is signals cannot be transmitted through solid things like walls.

- ***Safety*: -**

VLC uses light as a carrier. Light is the source of life. Hence, there has no health hazard. While in case of RF, it is proved to be hazardous for all living things.

- ***Unlicensed use*: -**

As VLC uses visible spectrum which is free. Hence, there are no licensing issues.

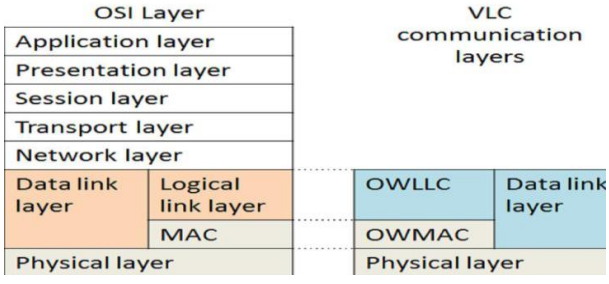
- ***High data rates*: -**

VLC inherits high data rates from optical communication.

2. Literature Review

Many of researchers working to develop light-emitting diode (LED) lighting system. Using LED technology can achieve lower power consumption and long lasting fluorescent lamp system [1]. Fluorescent bulbs last for10,000 hours, convert from 20% to 25% of their energy to light. A disadvantage of fluorescents bulbs, however, is that they require mercury vapor to work efficiently. While this doesn't make them unsafe to operate, the bulbs cannot be disposed of with regular household garbage due to the toxicity of the mercury. Also, there is a potential health risk if a bulb breaks. While light-emitting diode (LED) is

very efficient which uses 6-8W electricity, no mercury, Turns ON instantly and energy saving will be 50-60% [4]. LEDs have excellent characteristics such as low power consumption, small size/high density, high speed response, low cost, long life, and excellence in visibility. Because of the fast response time of LEDs, LEDs can be intensity modulated (blinked) much faster than the human eye can perceive. This blinking can be used to communicate digital data, at bit rates greater than 100 Mbps. An LED can also sense light in a narrow bandwidth slightly lower than but overlapping with its illumination frequency, thus the LED can also be used as a visible light communication receiver [2]. The system has a low complexity and uses LEDs to achieve bidirectional communication avoiding the use of photo detectors. Bidirectional communication is obtained by temporal separation of transmitter and receiver signals. To achieve bidirectional communication using a time domain multiple access (TDMA), devices must be synchronous. The system uses single LEDs for transmission and reception using an On-Off Keying modulation; the result is a low-power system for low data rate applications [3].
For any communication the two basic parts are sender and receiver. In VLC, a LED bulb is used as sender. The sender signal is controlled either by fast ON/OFF switching of LED or by color of light. This flickering is not good for eye safety; hence a dimming scheme LED illumination or modulation is used control brightness. The photo diode is used as a receiver to detect this signal. Following fig. 1shows open system interconnection (OSI) model for VLC [4].



The essential layers in VLC OSI model is Physical Layer (PHY) and Data Link Layer (DLL). These are important for sending and receiving the light signal. The Media Access Control (MAC) and Physical layers are same for both transmitter and receiver part. [5]

2.1 Comparison Between IR WIFI and LI-FI

Parameter	IR	WIFI	LI-FI
Spectrum Used	IR	RF	Visual Light
Standard	IEEE 802.11	IEEE 802.11	IEEE 802.15
Range	5 meters	Not more than 150 meters	Based on Light Intensity
Data Transfer Rate	1-5 mbps	10-30 mbps	1 gbps
Power Consumption	Low	High	Low
Cost	Low	High	Low
Security	Less	Less	More than WIFI

3.Methodology

Visible light communication (VLC) is a data communications medium which uses visible light between 400 and 800THz (780–375 nm). VLC is a subset of optical wireless communications technologies.
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. Low rate data transmissions at 1 and 2 kilometers (0.6 and 1.2 mi) were demonstrated. Reasonable Optical near Joint Access achieves full Ethernet speed (10 Mbit/s) over the same distance thanks to larger optics and more powerful LEDs.

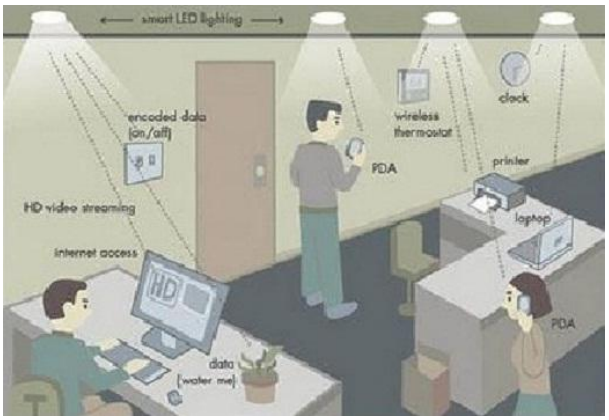
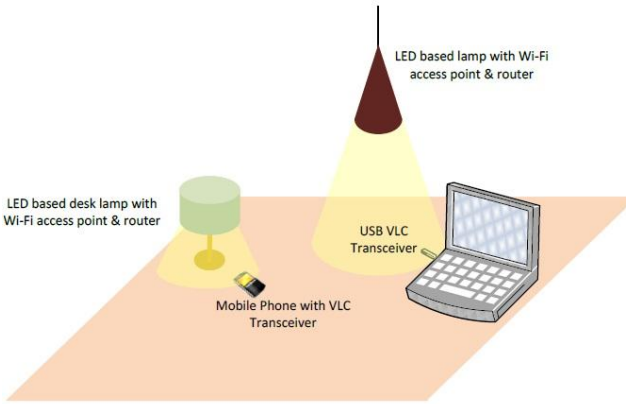


Fig. 1 Boston Smart Lighting office [6].

Specially designed electronic devices generally containing a photodiode receive signals from 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 or a spatial awareness of multiple light sources.

VLC can be used as a communications medium for present computing, because light-producing devices (such as indoor/outdoor lamps, TVs, traffic signs, commercial displays and car headlights) are used everywhere. Using visible light is also less dangerous for high-power applications because humans can perceive it and act to protect their eyes from damage.



3.1 Challenges

- *Transmitter equalization*

Analogue equalization techniques can be used to compensate for the rapid fall-off in response of the white LEDs at high frequencies. It is possible to use an array of LEDs, each driven using a resonant technique with a particular peak output frequency to achieve this. Careful choice of a number of different frequencies allows the overall response to be 'tuned' to that desired.

- *Receiver equalization*

Transmitter equalization has the disadvantage that the drive circuits for the LED (which often involve currents of several hundred milliamps) need modification, and in atypical coverage area there may be a number of sources, making the modifications potentially costly. In addition,some of the signal energy used is not converted into light, thus reducing the energy efficiency of the emitter. Equalization at the receiver allows complexity to be at the receiver only. A simple first-order analogue equalizer is shows there is substantial improvement in data-rates. More complex approaches are likely to yield higher data rates.

Multipath DistortionWhen the transceivers are equipped with wide beam, the copies of the same signal from different paths arrive the destination with different amount of relay, because each path has different length from source to destination. This creates a problem called multipath distortion [14].

Interference from sunlightThis problem is also associated with a wide transmission beams. In visible light, this becomes more critical since the ambient light could be very strong. The cost will be increased by equipping a receiver good enough for distinguishing such low signal when encountering high signal attenuation [14].
Lights onto use VLC, the lights completely need to be on. The lights are on in the vast majority of industrial, commercial and retail environments when the area is occupied. The lights are usually on for illumination hence VLC transmission power comes free as it is already used.During daylight in domestic environments we do tend to switch off lights [13].

- *Line of Sight (LOS):*

LOS is a definite advantage because the signal will be stronger. Visible light signals can be reflected but does not penetrate most of objects in our daily life which can be a security advantage and perhaps a

coverage disadvantage [15] [16]. However, if you look under the table you can still see despite there being no line of sight from light sources.

3.2 Applications

These are the following Applications which can use in future

- *Healthcare*

In hospitals any RF application like Wi-Fi is banned because of its hazardous effects on human health, it may affect the working of medical instruments. In this situation, Li-Fi which uses light as medium will be best solution for communication in hospital campus.

In Hospital medical equipment requires isolation from Electromagnetic Interference

(EMI) or Radio Frequency Interference (RFI). VLC does not emit EMI or RFI. So it does not interfere with medical instruments and also it does not interfere with MRI scanners. Hence VLC provides equipment and staff communications with no EMI and RFI problems [7].

- *Defense*

With established RF application it is not possible to communicate without proper instruments. As light is available everywhere, VLC communication is possible. Like RF jammer, VLC communication has no such barrier

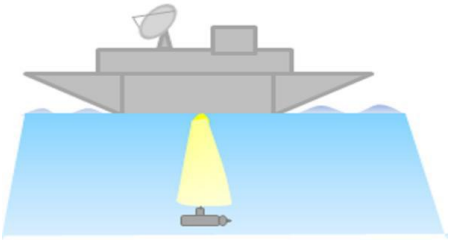
- *Aviation*

Radio is undesirable in passenger compartments of aircraft. LEDs are already used for illumination and can also be used instead of wires to provide media services to passengers. This reduces the aircraft construction costs and its weight.

- *Underwater Communications*

Visible light can support high speed data transmission over short distances in this environment. This could enable divers and underwater vehicles to talk to each other.

VLC is an excellent alternative for high speed underwater communication compared to RF transmission, which is still extremely difficult, and acoustic communication which results expensive and have limited data rate. Several systems have been proposed for wireless sensor networks, remotely operated vehicles and diver communication applications [13, 14].



Underwater communication with VLC

- *Vehicle & Transportation*

Many cars already LED lamps. Traffic signage, traffic lights, and street lamps are adopting the LED technology so there are massive applications opportunities here [12].

This allows the deployment of smart traffic systems based on VLC where vehicles can communicate with each other about speed, routes and destinations of themselves to avoid traffic accidents and share traffic information which is unknown in advance for traffic management; and some infrastructures could share valuable information with passing vehicles to help drivers and ensure road safety [11].

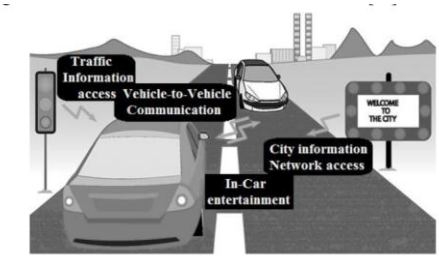


Fig. 3. VLC for transport information systems [10].

- *Location Based Services(GPS)*

Each visible light information source can be uniquely identified, so the location of any VLC device can be identified quickly and accurately.

4.Conclusion

We presented the concept of VLC in which communication takes place by visible light signal. We explained the benefits of VLC over current RF solutions including ability, efficiency, security and safety. These benefits enable a new and wider range of VLC applications from hospital, military applications, Underwater Communications, Aviation etc.VLC gives the advantage of a using an unregulated, unlicensed part of the electromagnetic spectrum.VLC have many challenges but apart from it is ready for implementation. It is greener, safer and brighter option for radio waves.

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