

Li-Fi: A Full-Fledged Wireless Communication Technology

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Abstract - Wireless communication has made great progress throughout the last century, since the first wireless signal was sent in 1880. Since then the number of users has increased and so has the number of devices using it. The current wireless communication systems use RF spectrum, which is getting congested. So, we are consolidating a review paper on Li-Fi technology which uses visible spectrum light to transmit data both securely and efficiently and hence using 50% less power consumption as its source is an LED. With better promised speeds, it proves to be an option for adapting 5G technology as well. Comparatively, Li-Fi offers a better alternative than Wi-Fi.

Key Words: Li-Fi, Wi - Fi, Light Emitting Diode (LED), Visible Light Communication Technology (VLC), Photo detector, 5G

1. INTRODUCTION

There are around 5 Billion mobile phones being served by 1.4 Million Radio waves base stations transmitting over 600TB data on an average monthly basis. Currently RF spectrum is the only popular means available and hence is crowded with devices such as microwave ovens, video devices, radar systems, radio navigation and many more. With the increase in wireless data traffic, we need an efficient, fast & secure way to overcome the problems that we faced with the previous technologies. The brightest alternative is Li-Fi. The term LI-FI, basically known as light fidelity is a 5G visible light communication system which in turn proves to be the modern archetype for optical wireless technology to cater unprecedented connectivity within a sectarian data centric environment. Li-Fi is a bidirectional, high speed and wholly networked wireless communication, using visible light which can be considered as a good accompaniment tor radio communication i.e. (Wi-Fi or Cellular network) or, it can even serve as a replacement against the technologies that are being used today for data broadcasting [8]. Li-Fi is an archetype of Optical Wireless Communication that can transmit data at a very high speed. The concept of Li-fi was Proposed by Prof. Harald Hass, a German scientist, along with Dr. Gorden Povey and Dr. Mostafa Afgani at the University of Edinburgh, Haas streamed high-definition video of blossoming flowers from a normal table LED lamp and projected it onto a screen behind him. During the event he repeatedly blocked the pathway of light to

demonstrate that the lamp was the origin of incoming data where he achieved 10Mbps transfer rate and thereby coined the term Li-Fi. [7]. In the present-day scenario, IEEE 802.15.7 is introduced to standardize the visible light communication for connecting devices via visible light spectrum. A physical layer (PHL) and medium access control (MAC) sublayer for short-range optical wireless communications. Optical Wireless Communication is optically transparent media using light wavelengths from 10000 nm to 190 nm are defined.

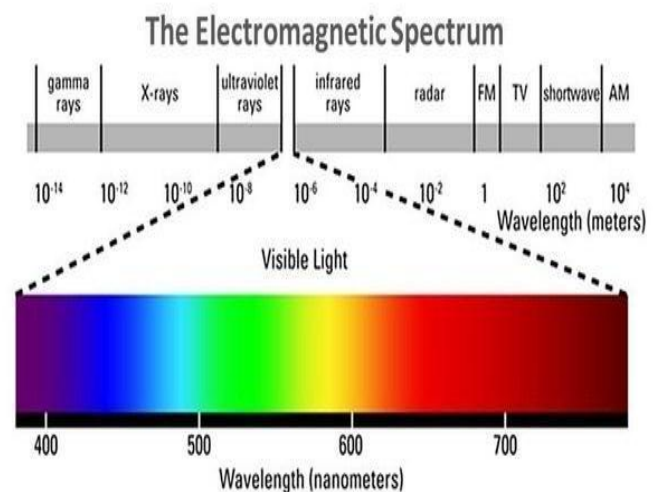


Fig -1: Visible light spectrum [2]

- Visible light on the other hand is everywhere, and also has a wide spectrum as shown in fig1. [8]
- Gamma rays are a biological hazard to a human body due to high penetration power.
- X-Rays will increase risk of cancer in the human body.
- Ultra-violet rays lead to skin cancer as well as eye damage including cataracts and eyelid cancers.
- Infrared Rays increase the internal temperature of the eye which lead to corneal ulcers, retina burns etc.

2. Architecture of Li-Fi

Architecture of Li-Fi consists of a number of LED bulbs or lamps including wireless devices such as mobile phones or laptops.

2.1 Working of Li-Fi:

In Li-Fi systems, visible light is modulated using techniques like pulse position modulation or frequency shift keying. At receiver's end, demodulation using pulse position modulation. So, it forms a six-step process:

- a) Read data from Sender
- b) Apply Modulation
- c) Data transmission using Light source
- d) CMOS/CCD
- e) Demodulation
- f) Received Data

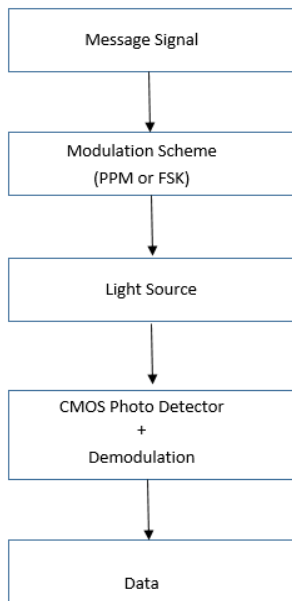


Fig-2: Flow of Data transmission in Li Fi

Li-Fi is based on a unique solid-state lighting system to create a binary code of 1s and 0s where LED's can toggle on and off very quickly where binary "1" is sent when LED is ON and "0" is when LED is OFF. Data can be ciphered by varying the flicker rate of the LED. Human eye cannot perceive the rate at which LED alters the state from ON to OFF therefore the output appears consistent. Thus Li-Fi is a Visible Light Communication (VLC) using visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. [5].

The signal is transmitted from a circuit consisted of PCB housing a micro controller to manage LED functions, powered by a 9V battery. At receiver side, an NPN photo-transistor sensor is fitted and can detect lights up to 1050 nm, which is obviously higher than visible spectrum range, which then passes it through a Schmitt trigger to clean up and square the signal.

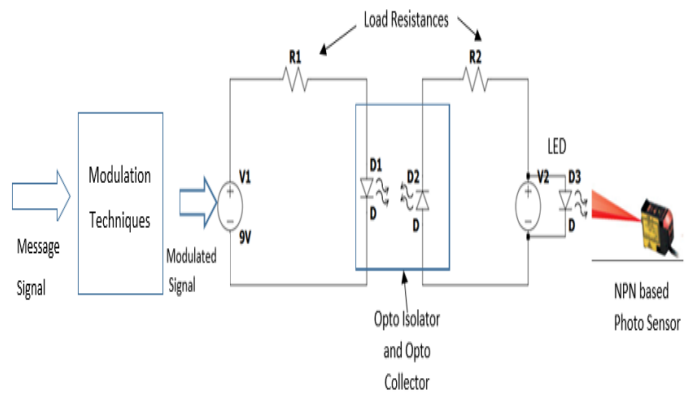


Fig-3: Circuit Diagram Representation

2.2 Application of Li-Fi:

1. Vehicular communication system:

Li-Fi produces an intelligent transport system (ITS) used to facilitate communication and facilitate information sharing between vehicles and units located along roadsides. All this information has the primary aim of preventing accidents on the highway. One such example is the Vehicle to Vehicle system [10], that allows vehicles to communicate with one another. This is achievable using Li-Fi as source and camera as receiver.

2. Internet Outreach:

Li-Fi technology allows devices, for example computers, to be connected to the internet. Li-Fi makes the net surfing cheaper and faster. Statistics say three billion, eight hundred and ninety million people are still unable to access the internet [11]. But Li-Fi will reduce this number significantly among the people especially in rural and remote areas.

3. Sub-aquatic communication:

This mode of information is very important to naval officers and divers; we know that Wi-Fi uses radio waves which is not suitable for underwater communication. This is because radio waves cannot propagate through water. Acoustic systems (like underwater telephone communication) have always been limited by some factors like strong signal attenuation, low data rates, small available bandwidth etc. Li-Fi makes underwater communication easier and faster with relatively higher bandwidth.

4. Smarter Grid:

Smarter power plants develop a more reliable, affordable and sustainable electric power system. Smart power plants & Smart grid stations are having special industrial facilities with special capabilities to produce electric power with

excellent operational flexibility, high energy efficiency and fuel flexibility. These power plants are facilitated by fast, interconnected data systems for monitoring which can be readily achievable with Li-Fi.

5. Pipeline management:

Intelligent Li-Fi systems can be used to monitor oil and gas pipelines against the activities of vandals as well as detecting defects or blockage along pipelines and to communicate such anomalies to appropriated / quarters for urgent and stringent actions to be taken to avert damage.

6. Sensitive area tracking:

Retail stores have a rich atmosphere especially Casinos [13] and other places like them need reliable video monitoring for providing a secure environment to the customers. Li-Fi has a great application in fields where we need cameras and security equipment.

7. Green information Technology:

In present days, fossil fuels are responsible for the source of energy but the fossil fuel emission is harmful. source of concern due to their negative impact on the environment and climate change. By using Li-Fi, we can save lots of energy with the evolution of Li-Fi, a large number of incandescent lamps will be replaced by LED bulbs. In this process we can save lots of energy like reduction in the amount of energy that is used in the production of incandescent lamps and operational energy will be saved by replacing Wi-Fi. [12]

8. 5G candidate Technology:

There are many strengths of Li-Fi mentioned in the literature including speed, security, safety, and many more.

9. Li-Fi Based Indoor Navigation System

By using visible light data is sent to led. Arduino software and hardware uses internal navigation system. The data which we send is used as a trans receiver from which led and photodiode are in the same line of sight (LOS). here light is identified using a photodiode and the data is send to Arduino. this entire system is faster than Wi-Fi. [14].

2.3 Difference between Li-Fi & WIFI

Li-Fi and Wi-Fi both works similarly by transporting data in an electromagnetic spectrum (EM). But Li-Fi transmit data using visible light i.e. LED Bulbs and Wi-Fi transmits data through radio waves/ radio frequency which is a traditional way of approach for data transmission developed using Copper wire connected to a router hub. Also, Wi-Fi provides a single bandwidth. Li-Fi

provides individual bandwidth to each user provided, each user accesses it using an individual light source.

3. ADVANTAGES OF LI-FI

Large number of places are present that need li-fi like technology.

- a) There are many places that contain equipment's that are sensitive to any kind of interference for example hospitals military areas or air planes Li-fi technology can be successfully used here, as it only uses light to transmit data.[1]
- b) A led can be turned "ON" & "OFF" 10 billion times a second so the data transfer speed can reach upto 10 to 20 Gb per second. [1]
- c) Once again adding to its side benefit Li-Fi offers more privacy and security than Wi-Fi because the signal is easily obscured by opaque structures and light does not penetrate through walls whereas in case of Wi Fi radio waves can pass through any wall. [6] Li-Fi Internet is accessible only to the users within the place and cannot be contravened by users in other rooms or buildings.
- d) Li-fi is completely environment friendly as no harmful rays are emitted through the system.
- e) Li- Fi uses light and therefore they are unimpeded by radio interference. Li-Fi is intolerant to any kind of interruption. [3]
- f) Li Fi technology can prove to be very useful in traffic control applications like in highways where cars can have LED based headlights as well as backlights, and they can communicate with each other and prevent accidents. [6]
- g) While Wi-Fi is anticipated on the availability of a microwave signal, Li-Fi can presumptively turn any lamp into a network connection. Every street lamp would be a free data access point meaning that high-speed data transmission could be available everywhere. [6]
- h) Li-Fi can be beneficial in electromagnetic sensitive areas such as in aircraft, gas installations, nuclear power plants and other places as it does not cause any interference. Thus Li Fi can be used in places where radio waves are problematic. [9]
- i) Wi-Fi does not function under water at all, but light does so it can be used for communication and hence undersea explorations are possible now with Li Fi technology. [6]

4. ISSUES WITH LI-FI

There are some serious drawbacks regarding the li-fi technology they are mentioned below:

- The main component of Li-Fi systems is a light source example LED bulb, CFL or any electric light source, due to this factor we need an electricity supply.
- Now, availability of electricity depends upon the area & locality.
- To get a constant internet connection we must always be needing to keep the lights switched 'ON', since load is inversely proportional to frequency so with increase of load will lead to overheating of power station and in order to keep the power station from overheating we need a much better cooling system, Thus the cost of keeping these light sources 'ON' is very high.
- Li-fi is unable to penetrate through the thick & opaque surfaces¹ which limits the range of data communication in Li-Fi technology. Since the light rays can cover a short distance usually (5m-10m),^[1] thus limiting the data transfer range of the Li-Fi to a very small place.
- Since the Li-fi is only limited to a small place so we need to install li-fi equipment in every room that will certainly increase the cost & consumption of electricity and resources.

5. FUTURE SCOPE

Researchers are working around the world to overcome the limitations of Li-Fi (i.e. low reliability, short range and inability of visible light to penetrate through the walls). Number of companies are also working on how to commercialize Li-Fi including Apple. Light is everywhere and free to use, if this technology becomes mature, each LI-FI bulb can be used to transmit wireless communication. The next will be LI - FI, WLAN for the B2B market with high added value on specific business cases and could grow towards the mass market. In the coming days Li-Fi can be an alternative solution for augmented virtual reality. [15]

6. CONCLUSION

Data transfer through Li-Fi is a next generation technology which holds the capability to provide an easier, faster & more secure communication system. Li-Fi is a technology which has a prospect to replace Wi-Fi as it has a problem of restricting access to mobile devices in sensitive areas like underwater submarines, airplanes, hospitals etc.[1] As Wi-Fi has loopholes and limitations, Li-Fi can be considered as a technology which has given wireless communication a broad edge over its wired communication. Li-Fi is a full-fledge wireless communication technology that leaves users with no room for any excuse to the outdated cabled communication. But a lot of research work & improvements are needed to be done in order to overtake the Wi-Fi technology, since there is no infrastructure to operate the Li-Fi network yet, so this may lead to a wastage of lots of resources like electricity. But this technology if

developed completely can reduce the EM effect that harms/disrupts the functioning of equipment in sensitive areas and provide High speed data transfer.

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