

Visible light communication through LEDs

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Abstract- Li-Fi stands for Light-Fidelity. Li-Fi technology, proposed by the German physicist—Harald Haas, provides transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. This paper focuses on developing a Li-Fi based system and analyzes its performance with respect to existing technology. Wi-Fi is great for general wireless coverage within buildings, whereas Li-Fi is ideal for high density wireless data coverage in confined area and for relieving radio interference issues. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and has already achieved blisteringly high speed in the lab. By leveraging the low-cost nature of LEDs and lighting units there are many opportunities to exploit this medium, from public internet access through street lamps to auto-piloted cars that communicate through their headlights. Haas envisions a future where data for laptops, smart phones, and tablets will be transmitted through the light in a room.

Index Terms— Li-Fi, Wi-Fi, high-brightness LED, photodiode, wireless communication.

Do you know more than 1.4 million cellular radio towers i.e called as a base station and we also have more than 6 billion cellular mobile phones. And these mobile phones emit more than 700 tetra bytes of data every month. Nowadays wireless communication has become a utility like electricity and water every day. We use it every day, we use it in everyday life, and it can be in our private life or in our professional life. An annoying flickering light can give you a headache but the same light can be used as a medium for communication between two sources or many more. Light Emitting Diode, commonly known as LEDs which are found in almost everywhere. It can be in our traffic and street light or our home and office light. It can be in car's headlight, aircraft, trains, metro and countless other appliances.

I. ISSUES

The currently used for communication between two or more sources is through are LAN and WI-FI. But

these two Technologies have a lot of limitations such as LAN connection is not feasible at all places and it is not mobile. Same is the scenario with WI-FI technology, although it is mobile and can be accessed through distances, but the security issue arises.

- **Capacity:** The way we transmit wireless data using electromagnetic waves in particular radio waves. These radio waves are limited as well as expensive to use and most important the radio waves have certain limited bandwidth (range).it is because of this limitation that doesn't cope with the demand of wireless data transmission than the number of bytes and data we used every month. We are simply running out of spectrum.
- **Efficiency:** These 1.4 million cellular radio tower or base station consume lots of energy and most of these energy is not used to transmit the data or radio waves but it is used for cooling the base station or towers. Moreover, the efficiency of this base station is just 5%.
- **Availability:** Then there is another issue that we all are familiar of that we have to switch off our cell phones and devices during flight and even in hospitals due to security issues.
- **Security:** These radio waves can penetrate through walls. They can be intercepted and somebody can use your data if he has some bad intention.

What are the requirements for visible light communication?

There is no such extra requirement for LI-FI communications since it is transferring data through illumination. We just need to replace these inefficient incandescent bulbs and florescent tube lights with LEDs. As we know LEDs are semiconductor devices

and because of their unique devices these are used in various applications.

With the rapid development of modern solid-state lighting, light-emitting diodes (LEDs) are increasingly used in a wide range of display, signaling and illumination applications. Some of the advantages of LEDs over incandescent or fluorescent tube lights are stated below:

- Long lifetime i.e. it can last for almost 20 years
- LEDs are high in energy efficiency. Moreover, research is carried on whether LEDs can have an efficiency more than 100%.
- They are not at all expensive, etc.

These are some of the advantages of LEDs over other bulbs.

VLC mostly used for indoor communication. The most important requirement is of light source with ability of very fast on-off switching. A novel modulation technique like unipolar orthogonal frequency division multiplexing (U-OFDM) is used. Visible light is constant beam of photons emitted from light source when constant current is applied. When the current varied at very high speed, light output varies accordingly which is detected by photo detector (PD).

These variations in light are impossible to follow by human eyes. Hence we feel constant lightning from light source. VLC is much simpler than complex RF communication like IR, which is limited in power because of its hazardous effects.

Li-fi technology uses VLC. It is similar to Wi-Fi technology with RF communication. The term Li-fi was first coined by Harald Haas, a German physicist. Li-fi operates in the range of terahertz and it is free from the spectrum license.

Problems and solution:

- **Capacity:** As we know light is the part of electromagnetic spectrum.

Gamma ray-they are too dangerous for a human body.

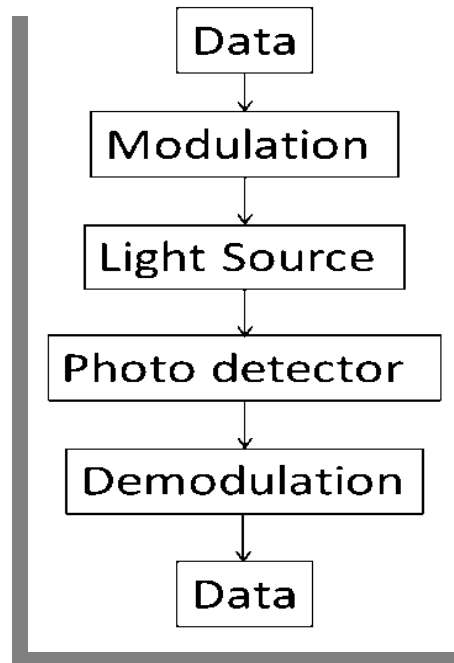
X-rays and UV-rays -they are used for medical purposes and are even sometimes harmful to human body if contact for long period.

Infrared rays- due to eye safety, it can be used only in low power.

Issues of radio waves have been mentioned already above.

And in the middle of the electromagnetic spectrum is visible spectrum. It's light. This visible light have created us, created life on earth and have been for million million years. So inherently it's safe to use.

If we compare visible light spectrum with radio

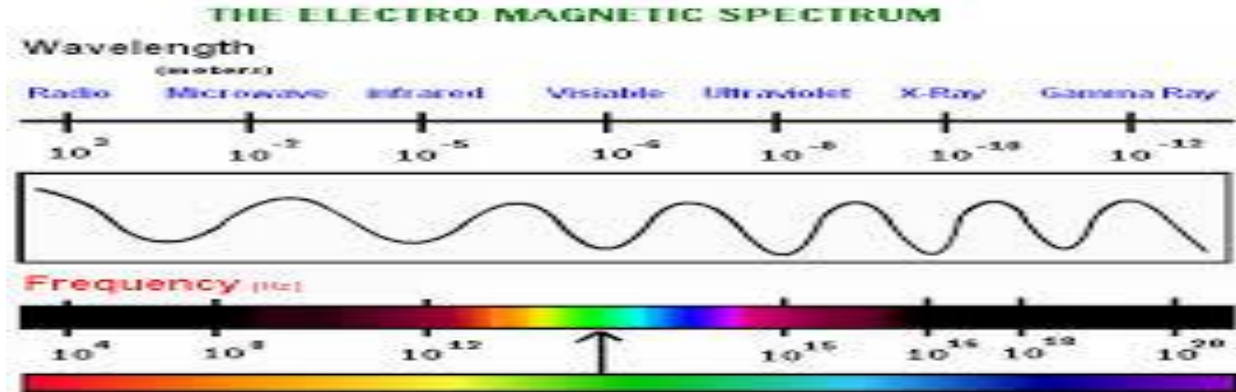


spectrum then guess what, we have 10,000 times more spectrum than radio.

- **Infrastructure:** For the communication through visible light we just need LEDs. There are 1.4 million base station present worldwide and when we multiples with the 10,000 times more spectrum then we need 14 billion LEDs. We just need to change the inefficient incandescent light bulbs with LEDs.

- **Efficiency:** LI-FI is a concept based on data through illumination. Data is send and received through illumination i.e. it is highly energy efficient. Data is send and received free of cost.

- c) **Cheaper Internet in Aircrafts:** The passengers travelling in aircrafts get access to low speed internet at a very high rate. Also Wi-Fi is not used because it may interfere with the navigational systems of the pilots. In aircrafts Li-Fi can be used for data



- **Security:** Unlike radio waves which can penetrate through walls and have a high percentage of data being leaked, as you know light doesn't penetrate through wall. So if I have a light here then no one will be able to read your data on the other side of the wall. **There is data where is light.**

APPLICATIONS

There are various applications of LI-FI, from public internet access through street lamps to auto-piloted future made cars that will communicate through their LEDs headlights and RED Lights.

a) Education systems: Li-Fi is the technology which provides the future fastest speed internet access. So, it can replace Wi-Fi at institutions such as school and college level and at companies.

b) Medical Applications: In Operation theatres (OTs) do not allow Wi-Fi due to radiation concerns. Usage of Wi-Fi at hospitals interferes with the mobile and pc which blocks the signals for monitoring equipments. So, it may be hazardous to the patient's health. To overcome this and to make OT tech savvy Li-Fi can be used to accessing internet and to control medical equipments. This can even be beneficial for robotic surgeries and other automated procedures.

transmission. Li-Fi can easily provide high speed internet via every light source such as overhead reading bulb, etc. present inside the airplane.

d) Underwater applications: Underwater ROVs (Remotely Operated Vehicles) operate from large cables that supply their power and allow them to receive signals from their pilots above. But the tether used in ROVs is not long enough to allow them to explore larger areas. If their wires were replaced with light — say from a submerged, high-powered lamp — then they would be much freer to explore. They could also use their headlamps to communicate with each other, processing data autonomously and sending their findings periodically back to the surface [1]. Li-Fi can even work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military operations.

e) Disaster management: Li-Fi can be used as a powerful means of communication in times of disaster such as earthquake or hurricanes. The average people may not know the protocols during such disasters. Subway stations and tunnels, common dead zones for most emergency communications, pose no obstruction for Li-Fi. Also, for normal periods, Li-Fi bulbs could provide cheap high-speed Web access to every street corner.

f) Applications in sensitive areas: Power plants need fast, inter-connected data systems so that demand, grid integrity and core temperature (in case of nuclear power plants) can be monitored. Wi-Fi and many other radiation types are bad for sensitive areas surrounding the power plants. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. This can save money as compared to the currently implemented solutions. Also, the pressure on a power plant's own reserves could be lessened. Li-Fi can also be used in petroleum or chemical plants where other transmission or frequencies could be hazardous.

g) Traffic management: In traffic signals Li-Fi can be used which will communicate with the LED lights of the cars which can help in managing the traffic in a better manner and the accident numbers can be decreased. Also, LED car lights can alert drivers when other vehicles are too close.

h) Replacement for other technologies: Li-Fi doesn't work using radio waves. So, it can be easily used in the places where Bluetooth, infrared, Wi-Fi, etc. are banned.

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