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Light Fidelity (Li-Fi) Technology

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ABSTRACT: Whether you are vying for bandwidth at a conference, using wireless internet at a coffee shop, or stealing it from the person next door, you may become irritated with the poor speeds you experience when multiple devices are linked to the network. In order to address this problem, German physicist Harald Haas developed a novel technology known as "data through illumination," which entails data transfer using LED lights that change in intensity more quickly than the human eye can see. He claims that the light emitting diode's potential and intensity are the foundation of this technology. This study examines the design and operation of a Li-Fi based system and evaluates its efficacy in comparison to current wireless network technologies.

KEY WORDS: Li-Fi, Wi-Fi, VLC (Visible light communication), LED (Light emitting diode), RF (Radio frequency)

I. INTRODUCTION

All of us rely on the internet, either directly or indirectly, to meet our everyday needs. We can't imagine a day in our lives when we aren't "connected" to the internet. Data sharing is one of the many uses for the internet that we engage in. We share a lot of data in the current context, thus having a strong data sharing capacity is essential.

Professor Harold Haas of the University of Edinburgh in the United Kingdom proposed the concept of "Data through illumination," a novel kind of wireless network technology, in 2011. And in order to put this into practice, he sent data through LED lightbulbs using fiber optics. Even though the idea of light modulation is not particularly novel, Haas wants to advance the situation by making communication possible with inexpensive LED lights. With Li-Fi technology, an LED beam with a limited range can assist us in connecting to the internet. We would be able to send data using this technology even when driving. Although there are many different network topologies, as the network spectrum grows, new ones are also forming.



Fig. 1: Li-Fi environment

Li-Fi, or 5G Visible Light Communication systems, is a novel technology that uses visible light for communication instead of radio waves, which are employed in numerous conventional communication technologies. Similar to Wi-Fi, LEDs in Li-Fi technology serve as a medium for high-speed communication [5]. Transmitting data through light bulbs

and other similar lighting equipment can significantly reduce the amount of electricity used. Unlike Wi-Fi, which uses radio waves as a carrier, Li-Fi uses visible light. Since visible light cannot pass through walls, wireless networking, or Wi-Fi, is regarded as a secure method of transmitting data. At the downlink transmitter, we install LED lamps [1]. We can alter the yield quickly if the LED current is changed at a very rapid pace. This is the Li-Fi's guiding principle. The Li-Fi operates in a very straightforward manner: when the Driven is turned on, a computerized 1 is transmitted, and when it is turned off, a digital 0 is transmitted. We can encode and transmit different types of data by varying the pace at which the LEDs flash.

II. WORKING TECHNOLOGY OF LI-FI

In his TED Worldwide talk on VLC, Harald Haas, a professor at the University of Edinburgh in Great Britain, presented this wonderful notion. "Very simple that a digital '1' is transmitted if the LED is on, and a digital '0' is transmitted if the LED is off," he or she said in explanation. The LEDs provide excellent open gateways for data transmission since they can be turned on and off fast. Thus, a few LEDs along with a controller that programs data into those LEDs are necessary. All we need to do is adjust the LEDs' flicker rate according to the data that has to be encoded.

This technology, which uses a variety of LEDs for parallel information transmission or mixes of red, green, and blue LEDs to adjust the light's frequency so that each frequency encodes data from different channels, may be improved further. With these developments, potential download speeds of up to 10 Gbps are possible, meaning that a full HD movie could be downloaded in under 30 seconds.

Fantastic! But this technology's advantages frequently go beyond its lightning-fast data rates and the world's shrinking bandwidths. Li-Fi is typically used safely in hospitals and airplanes, which are vulnerable to radio waves' interference because it only uses light. This can even function underwater, an area where Wi-Fi is totally ignored, opening up countless possibilities for military operations.

Imagine being able to download a movie from your lamp at work or access the public internet by simply hovering under a street bulb. There's a new technology on the block that has the potential to both literally and figuratively 'shine light on' how to address the growing demand for high-speed wireless online connectivity. Light waves take the role of radio waves in a brand-new data transmission technique known as Li-Fi. Because LEDs flicker on and off more quickly than the human eye can see, it appears as though the light source is always on. Even though flickering lights might be very bothersome, they have a benefit in that they allow us to use light to transmit data instantly. Light-emitting diodes, or LEDs for short, are ubiquitous in traffic and street lighting, automobile brake lights, remote control units, and a plethora of other applications. Because they can be turned on and off more often than the human eye can perceive, the light source appears to be on all the time even though it is actually "flashing." This subtle on/off function enables a type of binary unique code data transmission. A logical "1" is displayed when the LED is switched on, and a logical "0" is displayed when it is turned off. Thus, by altering the pace at which the LEDs flicker on and off to produce distinct guitar series of 1s and 0s, information may be encoded inside light. Technically speaking, this method of transmitting data wirelessly using rapid heartbeats is known as Visible Light Communication (VLC); in fact, Li-Fi, a popular characterization, was inspired by VLC's ability to challenge traditional Wi-Fi.

A. "A potential solution to the global wireless spectrum shortage" is visible light communication, or VLC.

Visible light communication is the basis for the technology of Li-Fi (Light Fidelity), which is often a quick and inexpensive optical version of Wi-Fi (VLC). VLC is typically used as a data communication channel. For lighting and information transmission, it uses visible light at wavelengths of around 800 THz (375 nm) and 400 THz (780 nm). It uses brief bursts of light to facilitate communication, and data is transferred wirelessly. The essential elements of this communication system consist of:

1. An extremely bright white LED that serves as both a communication source and
2. The receiving element is a silicon photodiode that exhibits strong response to a distinct wavelength range.

LEDs may be turned on and off to create 1s and 0s digital guitar strings. Typically, data is encoded into the light and used to change the pace at which the LED flickers to create a new data flow.

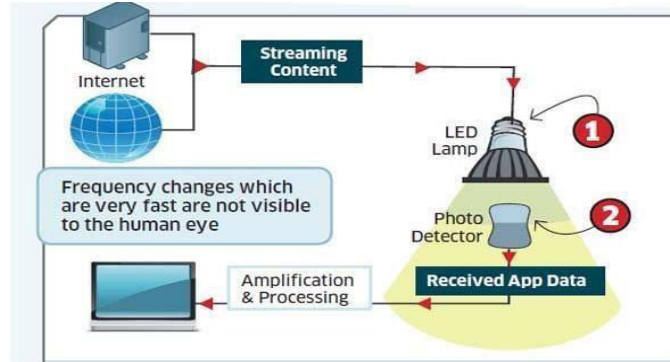


Fig. 2: Data transmission using LED

By explicitly employing data signals to modulate the LED illumination, it can be utilized as a communication source. To the human sight, the LED output seems continuous because of its rapid dazzling rate. By employing LED arrays for parallel information transmission, where each LED broadcasts a different information stream, data rates can even be enhanced. Although there are many alternative light devices like fluorescent light, radiant light, etc., there are reasons to lean toward LED as the light source in VLC.

III. COMPARISON BETWEEN LI-FI & WI-FI

For visible light communication technology to be used in high-speed wireless transmission, Li-Fi is required. The resemblance to Wi-Fi led to the acquisition of the moniker.

| | LI- FI | WI- FI |
|----------------------|------------------------|----------------------|
| SPEED | 1-3.5 Gbps | 54-250 Mbps |
| RANGE | 10 meters | 20-100 meters |
| IEEE STANDARD | 802.15.7 | 802.11b |
| SPECTRUM RANGE | 10000 times than WI-FI | Radio spectrum range |
| NETWORK TOPOLOGY | Point-to-Point | Point-to-Multi Point |
| DATA TRANSFER MEDIUM | Use light as a carrier | Use radio spectrum |
| FREQUENCY BAND | 100 times of THz | 2.4 GHz |

Table 1: Comparison between Li-Fi and Wi-Fi

IV. APPLICATIONS OF LI- FI

A. Health Technologies:

The radio waves that your Wi-Fi transmits can be extremely damaging to patients, as they can interpret medical equipment. Thus, Li-Fi technology allows you to utilize the internet in running rooms. Medical technology would no longer be able to keep up with those other whole wireless worlds. Due to radiation concerns, operating rooms have not allowed Wi-Fi up until recently, and there is a dearth of specifically designed options.

B. Airlines:

Passengers agree to pay an additional amount of cash for the in-flight dial-up service on airlines. Li-Fi may only offer "high-speed" transmission service, which is distinct from other wireless signals on the board and may be interruption-free.

1. Light is used by Li-Fi instead of radio frequency communications.
2. Wi-Fi does not function where Li-Fi does under the sea, under the water.
3. There are approximately 19 billion lightbulbs in the world; it would be beneficial to replace them with data-transmitting LED bulbs. We estimate that VLC is ten times less expensive than Wi-Fi.
4. Another advantage is security because light cannot pass through walls.

C. Street Light:

Headlights and backlights made mostly of semiconductor diodes are features of cars, and these devices connect with one another to prevent accidents by exchanging data. The traffic signal will alert the car and turn it on. Issues like the lack of radio frequency bandwidth might be resolved with Li-Fi.

V. ADVANTAGES OF LI- FI

A. Capacity:

Since light is a kind of energy that may be freely chosen, it can encompass the majority of the electromagnetic spectrum.

The visible light spectrum is ten thousand times larger than the radio wave spectrum.

B. Efficiency:

Li-Fi data bits can be sent in parallel, which results in increased efficiency.

C. Availability:

Since there is light everywhere in the world, people can work on the internet while flying.

D. Data rate:

More than 10Gbps may be obtained, which might hypothetically allow a high-quality movie to be downloaded in 30 seconds. This results in simple and quick communication.

E. Cost:

Li-Fi has a well-organized cost since it uses LEDs.

F. Bandwidth:

The main selling feature of Li-Fi is that it can transfer 10,000 times as much data as Wi-Fi.

VI. RECENT ADVANCEMENT

A. Li-Fi for smart cities:

The development of smart settings may be aided by the low-complexity of li-fi technology, which uses LED lighting to transport data and offers high-speed connections that can be sourced from street lights.

B. Topology will be most important in the future:

Worldwide research publications suggest that although future networks will be speedier, capacity issues may still arise. It also indicates which topology—the aesthetics of the transmitters supplying the network signal—will become more crucial in light of conferencing demand in densely populated areas.

C. Enhanced networking and dependable connectivity within a Li-Fi network:

Li-Fi is a fully networked, high-speed, bi-directional broadband wireless technology designed to replace current Wi-Fi technology. Optical at-to-cell refers to a Li-Fi access level's ability to serve many users concurrently within its insured coverage area.

D. Light offers incredibly fast wireless internet to consumers:

Wireless web connectivity is typically available in classrooms, cars, and store windows. Li-Fi has the potential to be seven times faster than Wi-Fi and allow for the download of an entire HD movie in a matter of seconds.

VII. CONCLUSION

Since there are many possibilities, exploration can be conducted. If this technology is applied, each lightbulb may serve as a sort of Wi-Fi hotspot, facilitating the wireless transmission of data. This would help us move closer to a more environmentally friendly, secure, and prosperous future. Li-Fi is currently gaining a lot of attention due to its potential to provide a reliable and effective substitute for Wi-Fi that is based on radio waves. The airways have become more congested due to the increasing number of people using wireless internet with several devices, making it harder to receive a reliable, fast connection. This could address problems like the lack of radio-frequency bandwidth and enable

the web in places where traditional radio-based remote access is prohibited, such hospitals and airplanes. But one of the flaws is whose sole piece of work is in plain sight?

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