

Light Fidelity Technology Technique and Parameters: A Review Paper

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Abstract

The process of increasing the speed of the internet in the present time is of great interest to researchers. In this paper we reviewed the Light Fidelity (Li-Fi) technology, which is the future of communications that will provide solutions to the problems of bottlenecks. This technology has the ability to transfer data rate at very high speed of up to 100 times faster than Wi-Fi technology. The focus of this paper is on the definition of Li-Fi and the applications, benefits, disadvantages of Li-Fi technology and the future uses of this technology as compared to the existing ones such as Wi-Fi technology, where the abundance of technology for Wi-Fi offers a larger package, a better work efficiency and a greater security of data transfer technologies currently exist.

Keywords: light fidelity (Li-Fi), Wi-Fi technology, Light emitted diode (LED), Optical wireless channel.

1. Introduction

Communication systems are one of the complementary parts of human life. Nowadays, there are a lot of techniques and tools used in telecommunication systems [1]. One of the most promising and modern methods of communication systems discovered in 2011 by a team led by Dr. Hess at the University of Edinburgh in the United Kingdom, where the start of this work dates back to 2004 [2].

Due to the increase in data exchange, the increase in the number of users and the development of communication systems, the technology of Wi-Fi is no longer able to meet the ends. Therefore, it has suffered from many difficulties and challenges relative to capacity and data security, so alternative solutions have to be considered to overcome these challenges [3].

A Li-Fi is a technique that can be considered as a Wi-Fi light-based technique rather than a radio wave, which is used to send and receive data. Instead of using modems in Wi-Fi technology, a lamp LED will be used to transmit and receive data, and for indoor lighting. This is called parallel communications [4].

Li-Fi uses optical spectrum while Wi-Fi uses radio waves spectrum where Li-Fi employs the optical wireless communication to make the communication process. Li-Fi uses IEEE 802.15.7 standard. Li-Fi works in simple method by using LED light it works in two modes LED ON, digit 1 transmit, LED OFF digit 0 transmit, it works at high frequencies so that the eye looks like a continuous light [5].

The Li-Fi is a modern type of optical wireless communication system (OWC) and is complementary to wireless radio communications, which have attracted great attention in the recent period because of its advantages, including the ultra-high speed of data transmission at a very low cost and satisfy the need of the market to increase the number of users [6].

2. Light Fidelity System working principle

Li-fi is an alternative for Wi-fi that transmits data using the spectrum of visible light. A simple working principle for Li-Fi is like a LED light bulb work ON-OFF at a very high frequency invisible to the human eye as shown in figure (1). Under the term, “Data through illumination” the intensity variation is at high rate according to current passing [7].



Figure (1) Li-Fi bulb [7]

The data modulate on optical carrier by using modulation technique called On-Off (OOK) and it includes intensity modulation as it shown in figure (2) [8].

Li-Fi is a part from optical wireless communication systems (OWC), the increase data will be performed by transmitting data in parallel form using a range of LEDs. Each LED works individually to send and receive data [9].

3. Li-Fi System Architecture

Li-Fi is the future of optical wireless communications, which is characterized by its low cost, license free and its ability to transmit data at a very high bit rate. It uses visible light at frequencies ranging from 400THz to 800THz as optical carrier [10].

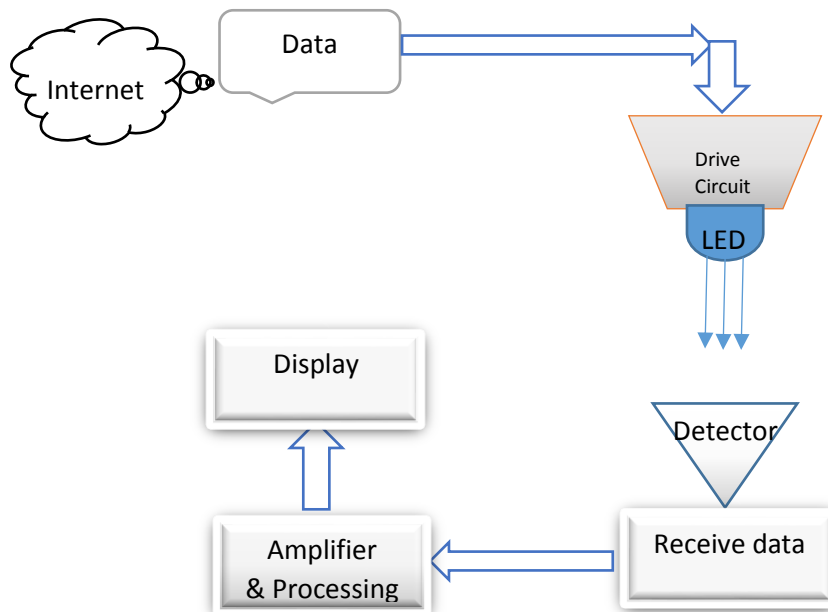


Figure (2) Block Diagram of Li-Fi Technology

4. Main Parts of Li-Fi Systems

The main parts of the Li-Fi system can be considered into two parts:

4.1 Optical transmitter high brightness (LED) as emitter

There are two type of optical transmitter that depend in manufacturing on semiconductor materials: [11]

- i) Light Emitting diodes (LEDs)
- ii) Laser diodes

The optical transmitter manufacturing from semiconductor materials has many benefits like small size, low cost, and high reliability. There are two types of light source : one is the coherent Laser diode LD and the other is the non-coherent light emitted diode (LED). The output spectrum range from ultraviolet UV up to infrared IR while the LD has more spectral range in the Li-Fi technology and we use LED as the optical source

4.2) Optical detector works a receive of optical data (PIN) [12]

PIN represents the main part of the optical receiver and consist the essential elements of the receiver circuit where the responsivity of the detector is very important [13].

5. Li-Fi transmitter components

The main parts of transmitter is shown in figure (3) [12]

- 1- Bulb
- 2- RF power amplifier (PA)
- 3- Enclosure
- 4- Print circuit board (PCB)

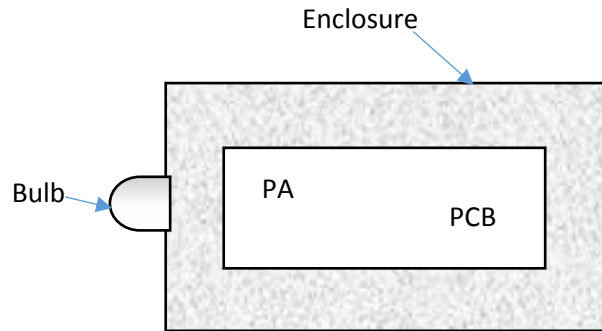


Figure (3) Li-Fi transmitter parts [3]

Bulb is the main part of Li-Fi transmitter and it represents the emitter it consists of LED mounted on insulator materials which is used as waveguide for the radio energy emitted from power amplifier. RF power amplifier is a concentrator of electrical field on the LED which operate to heat the bulb to plasma state and emitted the light at high intensity.

6. Li-Fi Receiver Components

The optical receiver circuit shown in figure (4) consist of the following parts:

1. Optical amplifier

Typically, there are two classifications for the optical amplifiers when we come to the gain medium, there are semiconductor and fiber optic amplifier, and when we come to the amplification mechanism, there is the linear and nonlinear optical amplifier. Used to boost up the weak signal.

2. Detector: the photo detector convert the incident light into electrical signal. Photo detectors currently in use and under investigation for optical communications. The detector is an essential component of an optical fiber communication system and is one of the crucial elements which dictate the overall system performance. Its function is to convert the received optical signal into an electrical signal. Therefore, when considering signal attenuation along the link, the system performance is determined at the detector. Improvement of detector characteristics and performance thus allows the installation of fewer repeater stations and lowers both the capital investment and maintenance costs.

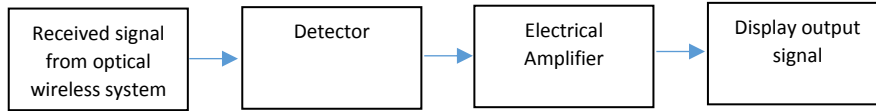


Figure (4) receiver circuit of Li-Fi system

7. Advantage of Li-Fi over Wi-Fi Technology.

- 1- Capacity: Li-Fi optical wireless communication technology offer a high bandwidth reach 10000 times of that of the Wi-Fi, and also can transmit in parallel form at very high rate [14]
- 2- Efficiency: li-fi technology consume low power and therefore becomes more efficient than Wi-Fi.
- 3-Security: As part from optical wireless communication the Li-Fi technology provides a high secured data of data from Wi-Fi technology.
- 4- Availability: Li-Fi technology available in different positions because the light exist in all locations.

8. Limitations of Li-Fi Technology

- 1- The existence of light in the transmitter location.
- 2- The alignment of the transmitter and receiver must be in a line of sight

9. Applications of Li-Fi

- 1- The li-fi technology can be used in different application like hospitals because it is safe for use [15].
- 2- Li-Fi can use millions bulb LED in the streets to provide transmitted data.
- 3- It can be used in communication under sea as an alternative to the Wi-Fi technology which can't be used in communication under water.
- 4- The Li-Fi technology can be used in airports easily and without any hazard.
- 5- Light Fidelity (Li-Fi) can be used in petrol and chemical factory because it's safe and less hazard.
- 6- Li-Fi Can be used to minimize accidents due to the possibility of making contact between vehicle lighting and traffic signals to regulate traffic and reduce congestion and accidents.

10. Comparisons of Li-Fi with Wi-Fi Technology

In this paragraph, a comparison was made between Li-Fi and Wi-Fi technology in many respects [14].

Table (1): Li-Fi, Wi-Fi Comparison Technologies

| Parameters | Li-Fi technology | Wi-Fi technology |
|------------------------|----------------------------------|------------------|
| Data transmission rate | > 1 Gbps | 150 Mbps |
| Carrier of data | Optical wave (light) | Radio wave |
| Bandwidth | > 10000 times greater than Wi-Fi | Less than Li-Fi |
| Cost | Cheaper | Expensive |
| Operate frequency | In THz range | 2.4 GHz |
| Range | 10 m | 20-100 m |
| IEEE standard | 802.15.7 | 802.11b |
| network | Point to point | Point to point |

11. Conclusions

The concept of Li-Fi at this time has received a lot of attention because it is considered a future technology which will be an alternative to Wi-Fi technology. What is more interesting is the use of LED as a means of lighting in homes, government departments and public streets, which prompted us to pay attention to this technique significantly to get high-speed data rate, clean systems environment-friendly, reliable, low-cost systems that can be used in all aspects of life at airports and chemical plants as a safe and low risk technology .

CONFLICT OF INTERESTS.

- There are no conflicts of interest.

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تقنية الضوء الدقيق: المعاملات التقنية ورقة مراجعه

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الخلاصة

في وقتنا الحاضر عمليات زيادة سرعة نقل البيانات لاقت اهتمام كبيراً من قبل الباحثين لتلبية الزيادة الكبيرة بعدد المستخدمين وكثرة تبادل البيانات. في ورقه المراجعة هذه قمنا بمراجعة تقنية نقل البيانات عبر الضوء المرئي والتي تعتبر تكنولوجيا المستقبل والتي ستوفر الحل لجميع الاختناقات بسبب امكانيتها العاليه لنقل البيانات بسرعه عاليه جدا تصل الى 100 مرة أسرع من تقنية Wi-Fi. تم التركيز بهذه الورقه على تعريف هذه التقنية وتطبيقاتها ومنافعها وكذلك معوقاتنا لكي يتم تجاوزها والتي تعتبر البديل لتقنية Wi-Fi الموجوده.

الكلمات الدالة: تقنية الضوء الدقيق، تقنية Wi-Fi، الثنائي الباعث للضوء القنوات اللاسلكيه الضوئيه.