

Next Generation Communication Li Fi Technology

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Abstract

Li fi is a method of transmitting data wirelessly using LED (= light-emitting diode). Li fi is known as light fidelity. It is a cheap wireless-communication system, which is the optical version of wi fi. In this method data is transmitted by the light, so its speed is same as the speed of light. This technology is first demonstrated in the context by German physicist Harald Haas in his TED Global talk on Visual Light Communication.

The LED bulb will hold a micro-chip that will process the data. Intensity of light can be manipulated to send data by tiny changes in amplitude. This technology uses visible spectrum of light, a part of the electromagnetic spectrum that is still not greatly utilized. There for the technology transfers thousands of streams of data simultaneously, in parallel, in higher speeds with the help of special modulation, using a unique signal processing technology.

Li-Fi has the advantage of being able to be used in sensitive areas such as in aircraft without causing interference. However, the light waves used cannot penetrate walls. This is the major problem coming across the implementation of this technology. A possible solution of this problem is the replacing all the lights by the LED lamps. The lamp generates the data signal as well as it is also used for the lightening. But size of the lamp is larger than conventional bulbs. Research on reducing the size is going on.

This paper describe method of transmitting data through li fi technology, various component used, the advantages of this technology over the other presence method of data transmission, the difficulties faced during implementation and their possible solution.

1. Introduction

A method of transmitting data wirelessly using LED (= light-emitting diode) known as Li Fi technology. Li-Fi is also known as the light fidelity. The definition of Li Fi given as “Li Fi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow”. Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. In this method data is transmitted by the light, so its speed is same as the light. LI-FI technology has the potential to change how we access the internet, stream videos, receive emails and much more.

1.1 History

The technology truly began during the 1990's in countries like Germany, Korea, and Japan where they discovered LED's could be retrofitted to send information. This type of light would come in familiar forms such as infrared, ultraviolet, and visible light. This type of light rays carries some energy. So the researchers think that why not this energy can be used for the data transmission. With this thought journey of Li Fi starts. Several projects were carried out for this .But the project is facing early challenges such as finding ways to get devices to receive data from affixed light sources.

German-born Haas sits in his office in Edinburgh University. Several of the university's faculties, led by the informatics department, are involved in his project, called D-LIGHT; the university, a sponsor, owns the intellectual property. Haas coined the term Li-Fi in 2011 in the context of a talk presenting the new technology at the TED (Technology Entertainment and Design) Global conference. There he gave his first live demonstration of how we might rely upon light bulbs for cell phone service, 3G data, and wireless networks in the home. The word quickly entered common parlance as an instantly recognizable alternative to Wi-Fi.

1.2 Need of Li-Fi Technology

When we talk about Li-Fi then one question arises that "why we need Li-Fi?"

Now a day we are seeing that human need more fast data transmission to save the time. For increasing the speed if we go for the wire lines it will cost higher and we have to fix our systems. But today we need a wireless network so that we can use it freely from any place inside its range. So a possible solution is the using mobile networking. But it cannot be used for the local networking.

For local networking one option of Wi-Fi is also available. But one of the major problems that present it is the already limited spectrum available for communications. The remaining free spectrum has to be used to its maximum potential, spread spectrum technology presenting itself as a suitable means of increasing performance. Splitting up of the environment into a number of small cells also increases the overall accessible bandwidth of the communication system, but also increases the cost as more cell sites are required. So it becomes costly. Security is also one of the major issues. There are many proxy server such as hotspot, tor are available which can easily crack the Wi-Fi system and provide the unauthorized browsing to the user.

Some health issue are also related with Wi-Fi. Researchers are going on to find the effect of Wi-Fi to human health. So to prevent all of these problems we need Li-Fi technology. It promotes high-speed optical wireless systems and to overcome the limited amount of radio-based wireless spectrum available by exploiting a completely different part of the electromagnetic spectrum. The consortium believes it is possible to achieve more than 10 Gbps, theoretically allowing a high-definition film to be downloaded in 30 seconds. It uses the light as carrier so it is cheaper than

other wireless network. It also provides the security because it feeds the data only which is authorized to access.

2. Components Required

For the generation and transmission of light signal various components are required. They are as follows

2.1 Emitter Assembly

It is a light emitting plasma device. Mechanical assembly contains ceramic resonator and quartz bulb. Ceramic resonator channels the RF (radio-frequency) energy into the bulb resulting in powerful light emitting plasma. The bulb contains halides needed to generate the plasma.

2.2 RF Driver

It generates radio frequency used to couple with the light emitting plasma device. It consists of power amplifier (PA) assembly that uses an LDMOS device to convert electrical energy into RF power. The PA is designed for ruggedness and efficiency. The RF driver also contains control circuit for digital and analog lighting controls.

2.3 Power Supply

Generally it is the component that converts AC power into DC power. Li-Fi system requires a DC input up to 28 volt. On this place a DC power source can also be used.

2.4 Connection sequence

Emitter Assembly \Rightarrow RF driver \Rightarrow Power Supply

3. How Li-Fi works

When power source is connected to the RF driver then it generates the radio frequency which is amplified by the power amplifier and it is coupled with the emitter assembly, so it generates light emitting plasma.

Solid-State Power Amplifier is used in the RF driver to create and amplify the RF energy. Process of light generation in all LIFI systems can be understood by the following steps-

- An RF circuit is established by connecting an RF power amplifier to a ceramic resonant cavity known as the "puck".
- In the center of the puck is sealed quartz bulb that contains materials consistent with metal-halide lamps.

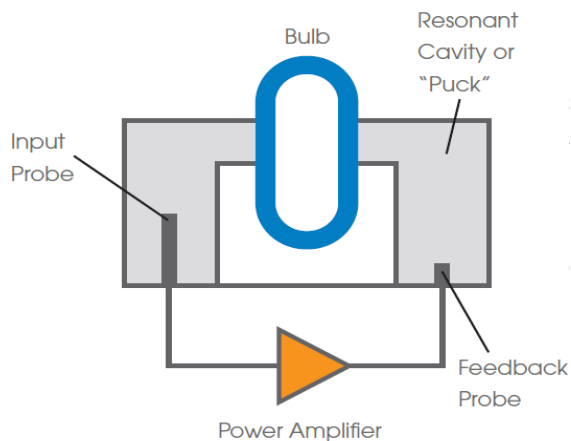


Fig 1 Assembled RF circuit

- The puck, driven by the power amplifier, creates a standing wave confined within its walls.
- The electric field is strongest at the center of the bulb which ionizes the gasses inside the bulb (purple glow).



Fig. 2 Emitting RF rays

- The ionized gas in turn heats up and evaporates the metal-halide materials which form a bright plasma column within the bulb (blue to bright white light).
- This plasma column is centered within the quartz envelope and radiates light very efficiently.
- In the back side of the bulb, a highly reflective powder is used to reflect nearly all of this light in the forward direction.

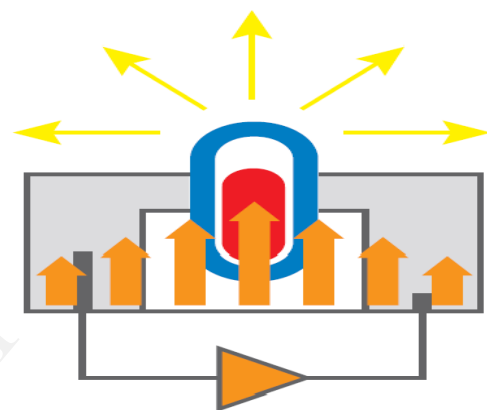


Fig. 3 Emitting plasma column

3.1 Process

The lamp driver is connected to internet server that is the source of data. Lamp driver convert this data in to RF energy and it is applied to the Led lamp. Lamp generates the light which contains the data. It is received by the receiver that is the photo detector. Then this light signal detected is amplified and processed and extract the data. In this way the Li Fi technology works.

3.2 Transmitter

This is the general process of transmitter. It can be explained by the following points:-

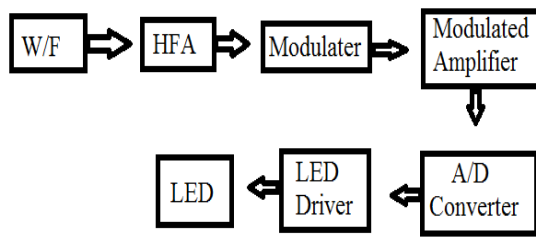


Fig.4 Block diagram of transmitter

- High frequency amplifier amplify the high frequency signal i.e. carrier frequency.
- Modulator is a AM modulator.
- Modulator gives the output that is directly proportional to the amplitude of the message signal.
- Modulated amplifier amplify the output of the modulator i.e. AM modulated signal.
- It gives the desired power for the transmission of signal.
- A/D converter converts the AM signal into equivalent Digital signal.
- So we get a digital signal whose amplitude is directly proportional to the amplitude of the message signal.
- LED driver drives the LED according to the signal coming from primary stages.

3.3 Receiver

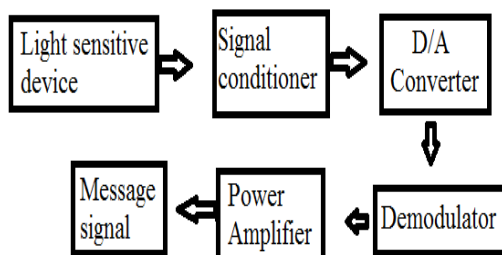


Fig.5 Block diagram of receiver

Process of receiver can be explained by the following points:-

- Light sensitive device is the device that senses the light. It may be LDR,

Photo Diode, Photo Transistor, IR Sensor.

- Signal conditioner condition the signal to bring it to desired level. It may be attenuator or amplifier.
- D/A converter again convert this signal into analog signal.
- Demodulator extracts the message signal from the received signal.
- Power amplifier increases the power level of the message signal.

4. Environmental Condition

The lamp performance is stated for the following environmental conditions:

Table 1. Environment condition table

	MIN	MAX	UNIT
Operating Temperature	-45	40	Centigrade
Storage Temperature	-40	100	Centigrade
Humidity		5% to 95% RH, Non Condensing	

4.1 Effect of Temperature

- At ambient temperatures higher than 45 C, the driver temperature can exceed its recommended limits which will impact its long term reliability.
- At ambient temperatures lower than -40 C, start time becomes longer and can exceed the specification for the system.

5. Implementation

5.1 Is it a proven technology?

After all of these theoretical parts a question arises that “is Li Fi a proven technology?”

Yes, this is already proven.

Harald Haas demonstrated his invention using an ordinary table lamp that successfully transmitted data at speeds exceeding 10Mbps using light waves from LED light bulbs to a computer located below the lamp. To prove that the light bulb was the source of the data stream, he periodically blocked the beam of light, causing the connection to drop.

5.2 Problem in implementation

To implement this technology it is suggested that the ordinary bulbs should be replaced by the Li Fi lamps which will generate light emitting plasma. But initially available Li Fi lamp has the bigger size. So work on minimizing the size is started and now we have the small circuit which can be used for generation of light signal.

5.3 Implementation in daily life

The next high-speed data networking connections could be powered by a simple light bulb. Whilst older filament bulbs aren't quite up to the task, due to the speed at which light has to flicker, the new LED-based lights are. The technology works by creating a flicker that is indiscernible to the human eye but can be picked up by a photo detector, which can pick up the stream of binary which is created by a blinking bulb. The ones and zeros are then compressed in order to up the throughput of the data even more. It transmits the data in the format of digital signal.

Due to the fact that every household and business use light bulbs, it's possible that Li-Fi, as it's dubbed, will become the communications technology of the future. Companies intending to supply the new technology are already popping up and it's these that have adopted the name Li-Fi, so as to make it sound attractive to potential buyers, who will automatically connect the term to the word Wi-Fi.

This technique is also known as Visible Light Communications (VLC) in the research community and the concept has been around since about 2003. VLC could do away with the need for radio masts and that it is faster, cheaper and safer than other types of communications technology.

Casio's Picapi Camera iPhone app claims to be the world's first app to use visible light communication technology. Casio are using flashing dots (red, green, blue) from a display, or even flashing coloured lights (e.g. on a Christmas tree) to convey small amounts of

data (8 bits) which are received via the camera and then translated into codes relating to specific information content.

6. Benefits of Li-Fi technology

- Wide spectrum over the visible wavelength range.
- High speed data transmission.
- Extremely high color fidelity.
- Instant start-time.
- Dynamic Dark - Brightness modulation of lamp output to enhance video contrast.
- Easy thermal management.
- Trouble-free integration into existing light engine platforms.
- The system has unique advantages in that it can be used in areas where radio frequency is not desirable.
- The system also benefits from an existing lighting infrastructure and therefore does not require huge investments.
- It also offers greater security by keeping the internet signal inside the room in which the light is being used.
- Li-Fi was developed as an alternative to carrying data on radio frequencies, which are becoming increasingly crowded with the growth in smart phone and tablet PC use.
- The light emissions are harmless to humans and can be transmitted even if the light source is dimmed or reflected around the room.

7. Applications of Li Fi:

- It Can be used in the places where it is difficult to lay the optical fiber like hospitals. In operation theatre Li Fi can be used for modern medical instruments.
- In traffic signals Li Fi can be used which will communicate with the LED lights of the cars and accident numbers can be decreased.
- Thousand and millions of street lamps can be transferred to Li Fi lamps to transfer data.

- In aircraft Li Fi can be used for data transmission.
- It can be used in petroleum or chemical plants where other transmission or frequencies could be hazardous.
- It can be used in offices to access and transfer the data from one to another employ.
- It can be used in e learning system to secure that the student cannot use other data at the time of study.

7.1 Some Points of Li Fi

- The light used to transmit the data is called D-light by Harald Hass, the inventor of Li Fi.
- In future data for laptops, Smartphone's, and tablets can be transmitted through the light in a room by using Li Fi
- Security would be a snap—if you can't see the light, you can't access the data.

8. Li Fi Technology At a Glance

- The LED bulb will hold a micro-chip that will do the job of processing the data.
- The light intensity can be manipulated to send data by tiny changes in amplitude.
- This technology uses visible spectrum of light, a part of the electromagnetic spectrum that is still not greatly utilized.
- In fact the technology transfers thousands of streams of data simultaneously, in parallel, in higher speeds with the help of special modulation, using a unique signal processing technology.
- Digital information can easily be converted by a small device in the light fitting into minute variations in light, even at very low levels of light and transfer to other devices many times faster than the data coming into the building.

9. Conclusion

Li Fi is the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The increasing demand for higher bandwidths, faster and more secure data transmission as well as environmental and undoubtedly human friendly technology heralds the start of a major shift in wireless technology, a shift from RF to optical wireless technologies. The possibilities are numerous and can be explored further. If this technology can be put into practical use, every bulb can be used something like a Li Fi hotspot to transmit wireless data.

10. References

- [1] Borregas Avenue Sunnyvale, "Data reliability", *Luxim*, USA, September 24, 2010.
- [2] Ignacio Mas and David Porteous, "A Light transmission World", QCGAP, USA, January 11, 2012.
- [3] Gordon Povey, "Visible Light Communications", *wordpress*, UK, June 29, 2012.
- [4] Dr. Joseph Schwartz, "Next generation optical wireless communication solution", IPMS, Germany, September 1, 2012.