Li-Fi as a source of data: Li-Fi Technology

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Abstract—Li-Fi an acronym for Light- Fidelity. Light-Fidelity concept was brought into light by German physicist Dr. Harald Haas, as a solution for stealing of wired internet (LAN or Dongle) or wireless internet (Wi-Fi) and slow speed of internet when more devices get connected to a single router. As per IEEE 802.11n, Wi-Fi provides speed up to 150 mbps, which is insufficient for desires number of users. Li-Fi remedy this limitation of Wi-Fi where data via illumination can be used by taking the fibber out of fiber optic, sending data via an LED light bulb that varies in intensity faster than the human eye can follow. Dr. Haas called it D-LIGHT, which generate data rates faster than 10 megabits per second, which is more than average broadband connections.

Keywords— Li-Fi, Wi-Fi, Visible Light Communication (VLC)

I. INTRODUCTION

Transferring data from one place to other is most basic need in today's life. The current wireless network system which establishes connection between users and internet is very slow when increases the number of users.

Dr. Harald Haas from University of Edinburgh, UK, proposed the brilliant idea of Li-Fi and introduced Li-Fi in his 2011 TED Global talk on Visible Light Communication. He explained, "Very simple, if the LED is on, transmit digital 1; if it's off transmit 0. The LED's can be switched on and off very quickly, which gives nice opportunities data. [1]

Li-Fi plays a crucial role in relieving the heavy loads which current wireless systems face. [2] For this, adding new and utilized bandwidth of visible light to the existing radio waves for data transfer can be done.

Li-Fi in future will be such a technology where data will be transmitted through the light in a room for systems.

II. IMPLEMENTATION

Li-Fi is typically implemented using while LED light bulbs at the downlink transmitter. These devices are normally used for illumination only by applying a constant current. However, by first and subtle variations of the current, the optical output can be made to vary at extremely high speeds. This very property of optical current is used in Li-Fi setup [2].

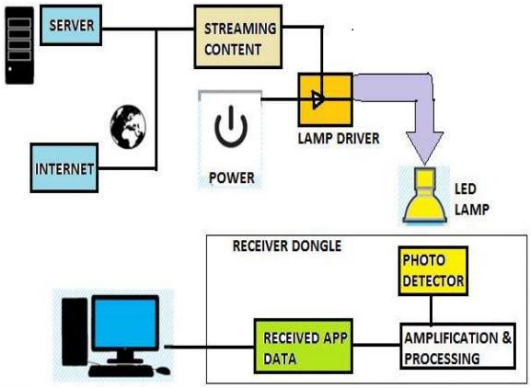
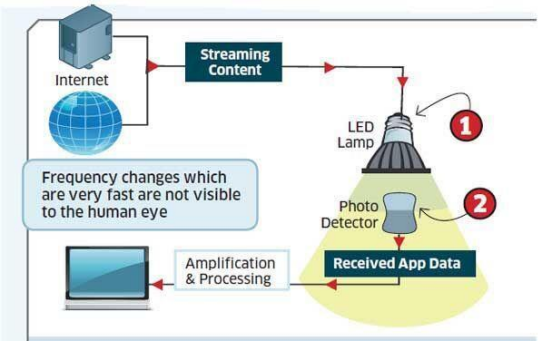


Figure 1Data transmission using LED

The LEDs (generally referred to as LEDs and found in traffic and street lights, car brake lights, remote control units and countless other applications) can be switched on and off very quickly, which gives nice chances for transmitting data. Hence all that is required is some LEDs and a controller that code data into those LEDs. All one has to do is to vary the rate at which the LED's flicker depending upon the data we want to encode. To further get an understanding of Li-Fi consider an IR remote. It sends a single data stream with 10-20 kbps speed. Transmission of data is done by single LED or multi LED through a visible light. [1] The block diagram of Li-Fi system is shown in fig.



2. Block diagram of Li-Fi system [2]

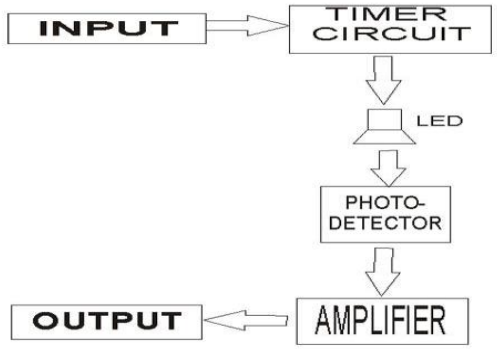
On the receiver side there is a photo detector, which convert this light into electric signals and it will give to the device which light into electric signals and it will give to the mobile or other device which connected to it. Voltage regulator and level shifter circuits are used on transmitter and receiver both side for converting or maintaining a voltage level. [3]

Further improvement can be made in this method, like using an array of LEDs for parallel data transmission, or

using mixture of red, green, and blue LEDs to alter the lights frequency with each frequency encoding a different data channel. Such advance techniques ability a theoretical speed of 10 Gbps –means you can download high definition movie in just 30 seconds. Radio waves being replaced by new method for data transmission is light waves called Li-Fi. [1]

III. WORKING

The working of Li-Fi is very simple. There is light emitting diode on one end as LED and photo detector as a light sensor on another end. The operational procedure is very simple if the LED is on, you transmit a digital 1, if it's off you transmit a 0. To build up a message, flash the LED many times or use an array of LEDs of perhaps a few different colors to obtain data rates in the range of hundreds of gbps [2].



BASIC LI-FI SYSTEM BLOCK DIAGRAM

A. Transmitter

As per the given diagram, the transmitter section consists of the input, a timer circuit, and a LED bulb. The input can be any type of data that you wish to transmit, for example voice, text etc. The timer circuit is used to provide the required time intervals between each bit. These bits i.e. 1"s and 0"s are transmitted in the form of flashes of the LED bulb.

B. Receiver

The flashes of the bulb are received by the photodiode. The photodiode then converts the light energy into electrical signals. Next these electrical signals are amplified and the output is presented.

Some LEDs and a controller that code data into those LEDs are required for the working of this technology. Just vary the rate at which the LED's flicker depending upon the data want to encode. A flickering light can be incredibly annoying, but has turned out to have its upside, being precisely what makes it possible to use light for wireless data transmission. Light-emitting diodes (commonly referred to as LEDs and found in traffic and street lights, car brake lights, remote control units and countless other applications) can be switched on and off faster than the human eye can detect, causing the light source to appear to be on continuously, even though it is in fact 'flickering'. This invisible on-off activity enables a kind of data transmission using binary codes: switching on an LED is a logical '1', switching it off is a logical '0'. Information can therefore be encoded in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. This method of using rapid pulses of light to transmit information wirelessly is technically referred to as Visible Light Communication (VLC), though it's potential to compete with conventional Wi-Fi has inspired the popular characterization Li-Fi. [6]

IV. PROBLEMS IN WI-FI

Given are some issues with radio waves:

a) Capacity: Wi-Fi has limited bandwidth and data transfer is via radio waves which are limited as well as expensive. Due to rapid growth in technologies generations like 3G, 4G things are getting out of spectrum.

b) Availability: Availability is a big concern of Wi-Fi. Devices accessing are restricted in many regions. Due to which accessing of internet is not everywhere possible.

c) Security: Radio waves can pass through walls. They can be encode, if someone is having strong knowledge with bad intensions. This will not be secure.

d) Efficiency: There are millions of cellular radio base stations consume massive amount of energy. Most of the energy is used for cooling down the stations rather than for transmission. Due to this the efficiency is just 5%.

V. COMPARISON OF LI-FI WITH WI-FI

LED's are required for transferring data with Li-Fi technology. With Li-Fi data can transferred with all kinds of light, no specific part of the spectrum is required. Also, the speed is very fat which allows downloading games, movies in few minutes. The limitation of to be in range for Wi-Fi accessing will not be an issue now. Standing anywhere and getting connected with internet will be the scenario and that too with any light presence. This technology will beat other technologies for accessing internet.

Parameter	**Li-Fi**	**Wi-Fi**
Speed	***	*
Range	*	**
Data density	***	*
Security	***	**
Reliability	**	**
Power available	***	*
Transmit/Receiver power	***	**
Ecological Impact	*	**
Device-to-device connectivity	***	***

Obstacle Interference	***	*
Bill of materials	***	**
Market maturity	*	***
• * Low ** medium ** high		

Table 1.Comparison between current and future wireless technology

VI. RECENT ADVANCES IN LI_FI

Researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates over 500 megabytes per second using a standard white-light LED [1]. With the Casio smartphones, the technology was illustrated at the 2012 Consumer Electronics Show in Las Vegas to exchange data using light of varying intensity up to 10 meters [1]. 'Li-Fi Consortium was formed in October 2011 by industry group to promote high-speed optical wireless systems and overcome with the limited amount of radio wireless spectrum. According to the Li-Fi Consortium, it is possible to achieve more than 10 Gbps of speed [1].

ADVANTAGES

- Wi-Fi is great for general wireless coverage while Li-fi is ideal for high density coverage in a confined region.
- It is believed that the technology can yield a speed more than 10 Gbps, allowing a HD film to be downloaded within 30 seconds.
- Reusability of the objects.
- Light can't pass through wall which will provided security of data.
- High installment cost but less maintenance cost.
- Monthly broadband bills will be ceased.
- License copy not required.
- Not as expensive as Wi-Fi.
- Long going LED bulbs with saves money.

LIMITATIONS

- The major issue is light not passing through objects, if the receiver stuck up then the connection would automatically break. Dr. Harald says," If the light signal is blocked, one need to switch back to radio waves".[1]
- For the Visible Light Communication (VLC) services reliability and network coverage could be main problems inspected by the companies while providing VLC.
- Li-Fi can take over Wi-Fi fully as radio frequency system will be needed for transmission of high speed data or n remote areas where trees or walls could be the obstacles.

APPLICATIONS

There are enormous applications of Li-Fi, from public internet access via street lights to automatic-piloted cars which communicate via their headlights.

Li-Fi is helpful where Wi-Fi fails to survive. As Li-Fi uses only light, it can be used safely in aircrafts and hospitals where Wi-Fi is banned.

All the street lights gives transmission of data as Li-Fi. As a result, accessing internet at any place will be possible.

Some of the future applications of Li-Fi are:

a) Education System: Li-Fi is the emerging technology with fastest speed for internet. Wi-Fi can be replaced at educational institutes and companies so people can make use of it with same speed.

b) Medical Help: Operation theatres (OT) don't allow Wi-Fi due to radiation concerns as it is hazardous to patient's health. To resolve this make OT tech savvy, Li-Fi can be used to accessing internet and to control medical equipment.

c) Airline: Airlines Wi-Fi. Ugh. The passengers on planes get low speed internet by paying high rate. Wi-Fi is not allowed as it may interfere with the navigating system of the pilots. Li-Fi will provide high speed internet and removes the overhead present inside the airplane.

d) Underwater Applications: Underwater vehicles are operated from large cables which supply power and allows to communicate with pilots. But for larger areas it fails. If light – submerged, high powered lamp replaces wires then it will be free to explore. Li-Fi also work underwater where Wi-Fi fails.

VII. CONCLUSION

Every light source in homes and offices could potentially be a "Li-Fi" within 20 years. When this technology becomes feasible like the Wi-Fi, then human life will be awesome on earth. This is the technology that could start to touch every aspect of human life within a decade. When practically established this system, every bulb can be a Wi-Fi hotspot to transmit wireless data. For the increase in number of users and their devices for wireless network, the airwaves will get congested which will be difficult to get reliable and high speed internet signal.

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