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FLIP-OFDM for Optical Wireless Communications

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Abstract:

Whether you're using wireless internet in a coffee shop, stealing it from the guy next door, or competing for bandwidth at a conference, you've probably gotten frustrated at the slow speeds you face when more than one device is tapped into the network. As more and more people and their many devices access wireless internet, clogged airwaves are going to make it increasingly difficult to latch onto a reliable signal. But radio waves are just one part of the spectrum that can carry our data. What if we could use other waves to surf the internet? One German physicist,DR. Harald Haas, has come up with a solution he calls "Data Through Illumination"—taking the fiber out of fiber optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. It's the same idea behind infrared remote controls, but far more powerful. Haas says his invention, which he calls D-Light, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. He envisions a future where data for laptops, smartphones, and tablets is transmitted through the light in a room. And security would be a snap—if you can't see the light, you can't access the data. Li-Fi is a VLC, visible light communication, technology developed by a team of scientists

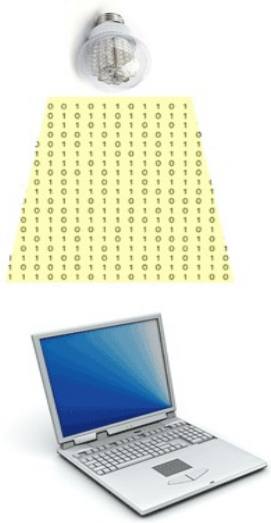
Introduction

In simple terms, Li-Fi can be thought of as a light-based Wi-Fi. That is, it uses light instead of radio waves to transmit information. And instead of Wi-Fi modems, Li-Fi would use transceiver-fitted LED lamps that can light a room as well as transmit and receive information. Since simple light bulbs are used, there can technically be any number of access points. This technology uses a part of the electromagnetic spectrum that is still not greatly utilized- The Visible Spectrum. Light is in fact very much part of our lives for millions and millions of years and does not have any major ill effect. Moreover there is 10,000 times more space available in this spectrum and just counting on the bulbs in use, it also multiplies to 10,000 times more availability as an infrastructure, globally. It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eyes cannot notice, so the output appears constant. More sophisticated techniques could dramatically increase VLC data rates

1.What is LiFi?

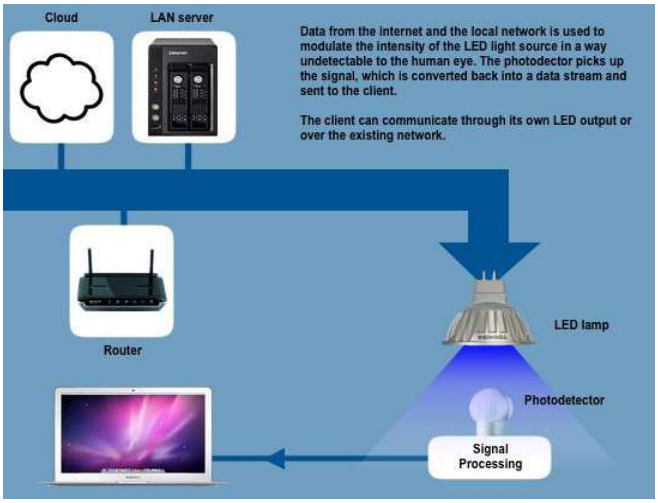
LiFi is transmission of data through illumination by taking the fibre out of fibre optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is the term used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s.The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. In this busy world, high speed data transferring is highly desirable. a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The concept of Li-Fi is currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. Wi-Fi (Wireless Fidelity), which uses 2.4-5GHz RF to deliver wireless Internet access around our homes, schools, offices and in public places. We have become quite dependent upon this nearly ubiquitous service. But like most technologies, it has its limitations. While Wi-Fi can cover an entire house, its bandwidth is typically limited to 50-100 megabits per second (Mbps). This is a good match to the speed of most current Internet services, but insufficient for moving

large data files like HDTV movies, music libraries and video games. The more we become dependent upon the cloud‘ or our own media servers‘ to store all of our files, including movies, music, pictures and games, the more we will want bandwidth and speed. There fore RF based technologies such as today‘s Wi-Fi are not the optimal way.



II. Working of LiFi

A new generation of high brightness light-emitting diodes forms the core part of light fidelity technology. The logic is very simple. If the LED is on, a digital 1 is transmitted. If the LED is off, a digital 0 is transmitted. These high brightness LEDs can be switched on and off very quickly which gives us a very nice opportunities for transmitting data through light. The working of Li-Fi is very simple. There is a light emitter on one end, for example, an LED, and a photo detector (light sensor) on the other. The photo detector registers a binary one when the LED is on; and a binary zero if the LED is off. To build up a message, flash the LED numerous times or use an array of LEDs of perhaps a few different colors, to obtain data rates in the range of hundreds of megabits per second. The data can be encoded in the light by varying the flickering rate at which the LEDs flicker on and off to generate different strings of 1s and 0s.The LED intensity is modulated so rapidly that human eye cannot notice, so the light of the LED appears constant to humans . 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'.



A.How it is different?

Li-Fi technology is based on LEDs for the transfer of data. The transfer of the data can be with the help of all kinds of light, no matter the part of the spectrum that they belong. That is, the light can belong to the invisible, ultraviolet or the visible part of the spectrum. Also, the speed of the internet is incredibly high and you can download movies, games, music etc in just a few minutes with the help of this technology. Also, the technology removes limitations that have been put on the user by the Wi-Fi. You no more need to be in a region that is Wi-Fi enabled to have access to the internet. You can simply stand under any form of light and surf the internet as the connection is made in case of any light presence. There cannot be anything better than this technology.

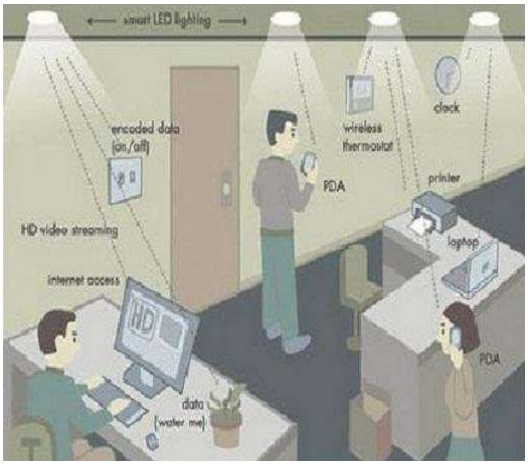
B.Uses in Various Areas

Can be used in the places where it is difficult to lay the optical fiber like hospitals. In operation theatre LiFi can be used for modern medical instruments. In traffic signals LiFi can be used which will communicate with

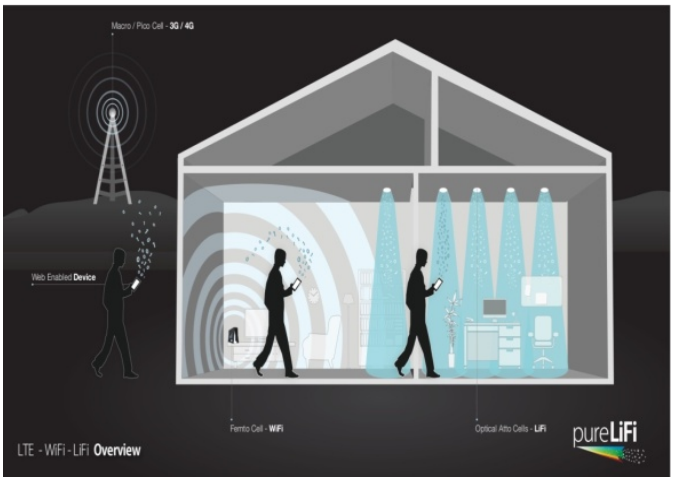
the LED lights of the cars and ccident numbers can be decreased. Thousand and millions of street lamps can be transferred to LiFi lamps to transfer data. In aircraft LiFi can based for data transmission.It can be used in petroleum or chemical plants where other transmission.

III. System model and working

The LED is on, digital 1 is transmitted , if it's off 0 is transmitted. The LEDs can be switched on and off very quickly, which gives nice opportunities for transmitting data. So what we require are some LEDs and a controller that into those LEDs. We have to just vary the rate at which the LED's flicker depending upon the data we want to encode successfully. It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s.The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. The microcontroller will encode the data to be transmitted using Manchester Algorithm. Then encoded data will be sent to the MOSFET. MOSFET is a switching device, so according to the gating signal applied, it will turn ON and OFF. So the LED lamp will blink accordingly. The data to be transmitted is encoded as zeroes and ones. The LED will turn ON when '1' is to be transmitted and LED will turn OFF when '0' is to be transmitted. Since MOSFET and LED are semiconductor devices, it can be switched ON and OFF quickly. So very high data rates can be achieved.



IV.Existing wireless technology



Bandwidth:

The visible light spectrum is plentiful unlicensed and free to use.

Speed High:

It is Very high data rates can be achieved due to low interface, high device bandwidths and high intensity optical output.

Low cost: Requires fewer components than radio technology.

Environment:

RF transmission and propagation in water is extremely difficult but Li-Fi works well in his environment.

Control:

Data may be directed from one to another.There is no need for additional Security such as pairing for RF interconnection such as bluetooth.

V. Experimental setup and result

The components are assembled and program was burned in the PIC microcontroller. The program is done using the software Mikro C. Mikro C is a powerful development tool for PIC microcontrollers. It is designed to provide the programmer with the easiest possible solution for developing the application for embedded system without compromising the performance of the controller. the datas transferred through led is detected by a photodiode and it is decoded .Java

program is developedtomakeaninterface to sent images. The testing is done and it is possible to transfer images effectively using LiFi. Instantly taken photos are sent using light of an LED as carrier.

A.Modulation Techniques Used in LI-FI

OFDM (Orthogonal frequency-division multiplexing)

Orthogonal frequency-division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. OFDM is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method. A large number of closely spaced orthogonal sub-carrier signals are used to carry data on several parallel data streams or channels. Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phaseshift keying) at a low symbol rate, maintaining total data rates similar to conventional single-carriermodulation schemes in the same bandwidth.

B.OOK (On-off keying)

On-off keying (OOK) denotes the simplest form of amplitude-shift keying (ASK) modulation that represents digital data as the presence or absence of a carrier wave. In its simplest form, the presence of a carrier for a specific duration represents a binary one, while its absence for the same duration represents a binary zero. Some more sophisticated schemes vary these durations to convey additional information. It is analogous to unipolar encoding line code. It is very easy to generate and decode but is not very optimal in terms of illumination control and data throughput.

PWM (Pulse-width modulation)

Pulse-width modulation (PWM) is a technique used to encode a message into a pulsing signal. Although this modulation technique can be used to encode information for transmission, its main use is to allow the control of the power supplied to electrical devices, especially to inertial loads such as motors. Pulse Width Modulation transmits the data by encoding the data into the duration of the pulses. More than one bit of data can be conveyed within each pulse.

PPM (Pulse-position modulation)

Pulse-position modulation (PPM) is a form of signal modulation in which M message bits are encoded by transmitting a single pulse in one of possible required time-shifts. This is repeated every Tseconds, such that the transmitted bit rate is bits per second. It is primarily useful for optical communications systems, where there tends to be little or no multipath interference.

SIM-OFDM(Sub-carrier Index Modulation OFDM)

Sub-carrier Index Modulation OFDM is a technique which adds an additional dimension to the two dimensional amplitude/phase modulation technique i.e., Amplitude Shift Keying (ASK) and Quadrature Amplitude Modulation (QAM). SIM uses the sub-carrier index to convey information to the receiver. Unlike the traditional OFDM technique, the SIM-OFDM technique splits the serial bit stream into two bit sub-streams of the same length.

VI. SCOPE AND CHALLENGES OF LI-FI TECHNOLOGY

- LI-FI requires Line of Sight.
- If the apparatus is set up outdoors, it would need to deal with changing weather conditions.
- If the apparatus is set up indoors, one would not be able to shift the receiver.
- The problem of how the receiver will transmit back to the transmitter still persists.
- Light waves can easily be blocked and cannot penetrate thick walls like the radio waves can.
- We become dependent on the light source for internet access. If the light source malfunctions, we lose access to the internet.

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VII.Applications of lifi

Education System:

LI-FI can replace WI-FI in educational institutions and provide faster internet speeds. All the people can make use of the same speed as has been designated.

Medical Applications:

WI-FI is not allowed operation theaters because they can interfere with medical equipments. Moreover, their radiations pose risks for patients. LI-FI uses light and hence can be used in place of WI-FI.

Internet access in aircrafts:

The use of WI-FI is prohibited inside airplanes because they can interfere with the navigational systems of the plane. The users get access to very low speed internet at high rates. Thus, LI-FI is a safe alternative to WI-FI in

aircrafts since it uses light and can provide faster internet access.

Disaster Management:

In times of natural calamities such earthquakes, LI-FI can be used as a powerful means of communication since it uses light which unlike RF is not obstructed by walls or other such things.

Radio broadcast:

A large amount of power is required by radio masts in order to broadcast and this makes them quite inefficient. LEDs on the other hand require very low power to operate and this means that LI-FI .

Advantages of LI-FI

- Li-Fi can solve problems related to the insufficiency of radio frequency bandwidth because this technology uses Visible light spectrum that has still not been greatly utilized.
- High data transmission rates of up to 10Gbps can be achieved.
- Since light cannot penetrate walls, it provides privacy and security that Wi-Fi cannot.
- Li-Fi has low implementation and maintenance costs.
- It is safe for humans since light, unlike radio frequencies, cannot penetrate human body. Hence, concerns of cell mutation are mitigated.

Disadvantage of LI-FI

- Light can't pass through objects.
- A major challenge facing Li-Fi is how the receiving device will transmit back to transmitter.
- High installation cost of the VLC systems.
- Interferences from external light sources like sun, light, normal bulbs, opaque material.

Conclusion

The possibilities are numerous and can be explored further. If his technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The concept of Li-Fi is currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals. One of the shortcomings however is that it only work in direct line of sight.

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