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DATA TRANSMISSION BY LIGHT FIDELITY

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Abstract - Li-Fi Stands for Light-Fidelity. It is a New Technology and was proposed by The German Physicist Herald Haas in 2011. Li-Fi Provides Transmission of Data Through Illumination and sends Data Through an LED Light Bulb That Varies in Intensity Faster than Human Eye can't Detect. In This Paper, We will be discussing The Technology in Detail and also how Wi-Fi can be replaced by Li-Fi. Wi-Fi is Useful for General Wireless Coverage within Buildings while Li-Fi is ideal for High-Density Wireless Data Coverage in Confined Areas where There are no Obstacles. Li-Fi is a Wireless Optical Networking Technology that uses Light Emitting Diodes (LEDs) for Transmission of Data. Li-Fi refers to Visible Light Communication (VLC) Technology that uses as Medium to Deliver High-Speed Communication in a Manner Similar to Wi-Fi. Li-Fi Provides Better Bandwidth, Efficiency, Availability and Security than Wi-Fi and has already Achieved High Speeds in the Lab. In this paper, we will give a Detailed Study on Li-Fi Technology, Its advantages, and Its Future Scope.

Keywords – Light Fidelity; LED; Illumination; Wireless Fidelity; VLC; Bandwidth;

INTRODUCTION

Professor Harald Haas came up with the Idea of Data Transmission through Light, and he coined this Technology as "Light Fidelity (Li-Fi)". He is a Chair Professor of Mobile Communications at The University of Edinburgh, and The co-founder of PureLiFi along with Dr. Mostafa Afgani.
Professor Hass helped start a company to market it PureLiFi, formerly PureVLC, is an Original Equipment Manufacturer (OEM) firm set up to Commercialize Li-Fi products for Integration with existing LED-Lighting Systems.
Professor Haas promoted this Technology in 2011 at TED Global Talk, He used a Table Lamp with an LED Bulb to Transmit a Video of a Blooming Flower that was then projected onto a screen. During the Talk, He Periodically Blocked the Light from The Lamp with his Hand to show that The Lamp was indeed The Source of The Video Data. Li-Fi can be regarded as Light-based Wi-Fi, i.e. Instead of Radio Waves, it uses Light to Transmit Data. In place of Wi-Fi modems, Li-Fi would use Transceivers fitted with LED Lamps that could light a room as well as Transmit and Receive Information. It makes use of The Visible Portion of The Electromagnetic Spectrum which is underutilized. Li-Fi can be considered better than Wi-Fi because there are some limitations to Wi-Fi. Wi-Fi uses 2.4 – 5 GHz Radio Frequencies to Deliver Wireless Internet access and its Bandwidth is limited to 50-100 Mbps. With the increase in the number of Wi-Fi Hotspots and Volume of Wi-Fi Traffic, The Reliability of signals is bound to suffer. Security and Speed are also important concerns. Wi-Fi communication is vulnerable to hackers as it penetrates easily through walls. Li-Fi Provides Better Bandwidth, Efficiency, Availability and Security.

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WORKING

Li-Fi makes use of Visible Light through overhead Lighting for The Transmission of Data. This is Possible through the use of a Visible Light Communications(VLC) system for Data Transmission. A VLC system has two qualifying components:

1)Device Containing a Photodiode/Solorcell in order to Receive Light Signals.

2)Light Source equipped with a Signal Processing unit for The Transmission of Signals.

The VLC Light Source can be in the form of a Fluorescent Bulb or a Light Emitting Diode(LED). LED Light Bulbs are The Most Optimum VLC Light Source, however, since a Robust Li-Fi System requires extremely High rates of Light Output. Fluorescent Bulbs emit Light in a much wider band of Wavelengths, which makes it a Relatively Less efficient Light source than LED. On the other hand, LED is a Light source that emits light in a very narrow band of wavelengths, making it a more efficient Light Source.

LED is also a Semiconductor, which implies that it can amplify Light intensity and switch rapidly. This is an important quality to look for in a VLC Light Source because LiFi relies on the constant Stream of Photons emitted as visible light for The Transfer of Data. When The Current applied to the Light source is varied slowly, the Light source dims up and down, which makes it unsuitable as a Source of Light, not for the Li-Fi system, but as a Device for Household illumination. To Strike a balance between VLC Light Source and Household illumination, this current, as well as the optical output, is Modulated at extremely High Speeds, making it detectable by The Photodiode Device and converted back into Electrical current, but unperceivable by the human eye. Once these signals are Received and Demodulated, they can now be converted into a continuous stream of binary data that contains Videos, Images, Audio, Text, or Applications that are readily-consumable on any internet-enabled device.

Because Li-Fi Technology is still in its relative infancy, there is still much room for growing innovation. One proposed innovation to the existing Technology includes creating a Bidirectional communication system similar to conventional broadband and Wi-Fi. This can be done by Interchanging Visible Light and infrared Light from a Photodetector, allowing connected mobile devices to send back data to the Light Source for an uplink. Another proposed innovation is the re-engineering of the multi-colored RGB LEDs to send and receive data on a wider range of signals than the single-colored phosphor-coated white LEDs.

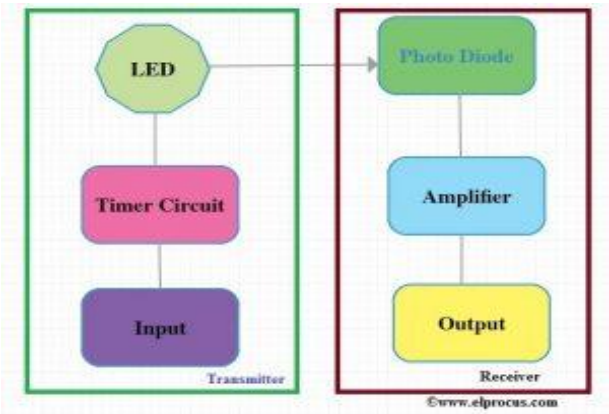

Fig.1 Li-Fi Block Diagram

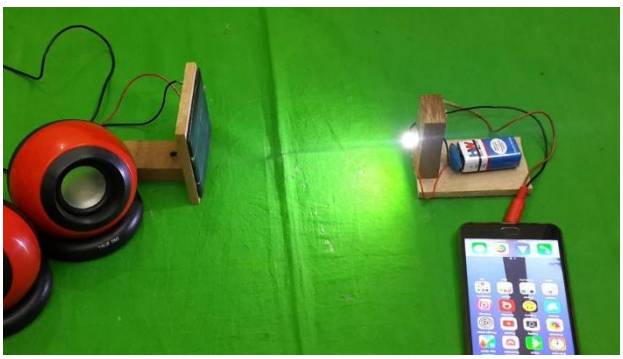

Fig.2 Li-Fi Live Model

COMPONENTS

1) Light Emitting Diode (LED)-

A Light-Emitting Diode (LED) is a Semiconductor Light Source that emits light when current flows through it. Electrons in the Semiconductor recombine with electron holes, releasing energy in the form of Photons. The Colour of the Light (corresponding to the energy of the Photons) is determined by the energy required for electrons to cross the band gap of the Semiconductor. White light is

obtained by using multiple Semiconductors or a layer of Light-emitting phosphor on the semiconductor device.

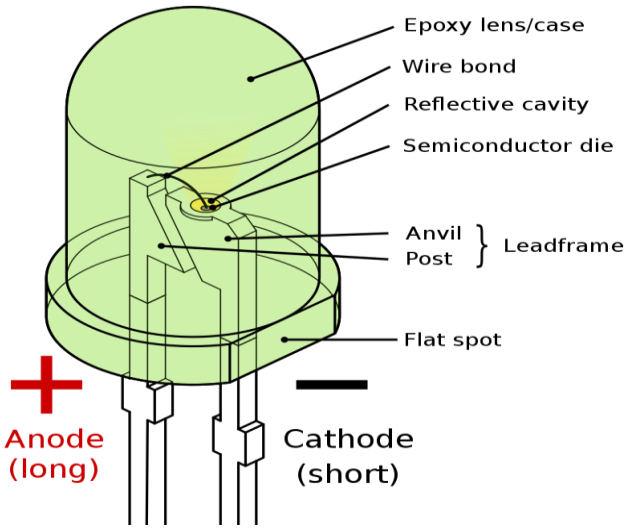

Fig.3 Light Emitting Diode (LED)

LEDs have many advantages over incandescent light sources, including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Unlike a laser, the light emitted from an LED is neither spectrally coherent nor even highly monochromatic. However, its spectrum is sufficiently narrow that it appears to the human eye as a pure (saturated) color.

2) Solar Panel

A Solar Panel works by allowing photons, or Particles of Light, to knock electrons free from atoms, generating a flow of electricity. Solar Panels actually comprise many, smaller units called PhotoVoltaic Cells. (Photovoltaic simply means they convert Light into Electricity.) Many cells linked together make up a Solar Panel.

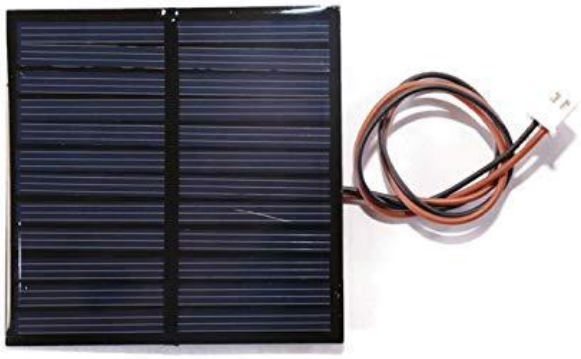

Fig 4.Solar Panel

3) PAM 8403 Sound Amplifier

The PAM8403 is a 3W, Class-D Audio Amplifier. It offers low THD+N, allowing it to achieve high-quality Sound Reproduction. The New Filterless architecture allows the device to drive the speaker directly, requiring no low-pass output filters, thus saving system cost and PCB area. With the same numbers of external components, the efficiency of the PAM8403 is much better than that of Class-AB cousins. It can extend the battery life, which makes it well-suited for portable applications. The PAM8403 is available in the SOP-16 Package.

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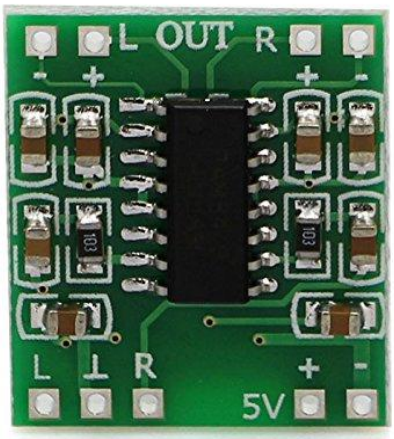

Fig 5-PAM 8403

4)4 OHM, 3 WATT Speakers

A Small Audio Speaker that is ideal for Radio and Amplifier Projects and is small enough to fit in Robot Projects.

Features: Power Rating: 3W,

Impedance: 4 ohm,

Diameter: 50mm/5cm approx.

Fig.6 4 ohm, 5 watt Speakers

5) AUX Cable

The AUX (Auxiliary) Portable cable is a cable with 3.5mm jack on both ends. Basically, it has two normal size earphone jacks on both ends. It's very useful for playing music from your smartphone to an amplifier like Car Stereo, or like, in this case, a Home Theatre. It consists of three wires RBG, Where Red is for right audio, Blue is for left audio and Green is for Ground.

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Fig.7 AUX Cable

CIRCUIT DIAGRAM

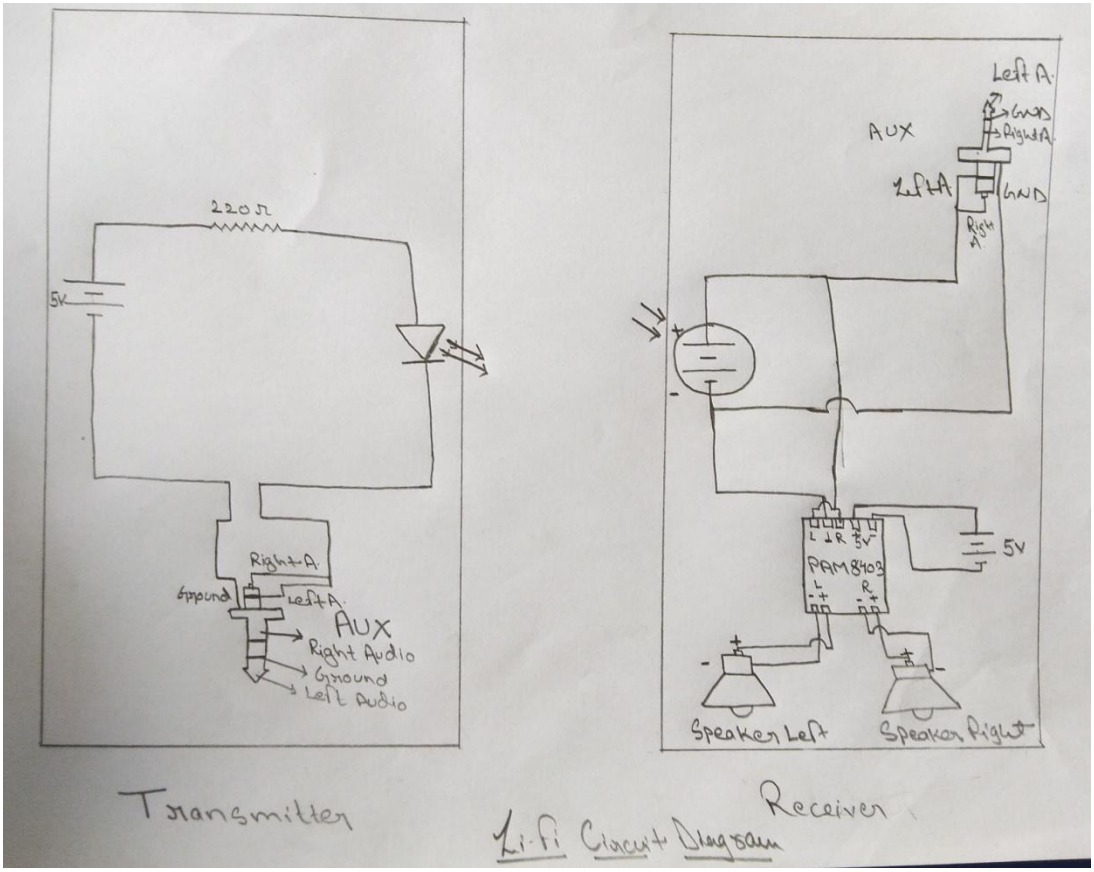

Fig.8 Li-Fi Circuit Diagram

COMPARISON BETWEEN Li-Fi AND Wi-Fi

PARAMETER	**Li-Fi**	**Wi-Fi**
Speed	High	High
Spectrum	10,000 times broader than WI-FI	Narrow Spectrum
Data Density	High	Low
Security	Highly Secure	Less Secure
Reliability	Medium	Medium
Bandwidth	High	Low
Transmit/Receive Power	High	Medium
Ecological Impact	Low	Medium

Device to Device Connectivity	High	High
Obstacle Interference	High	Low
Bill of Materials	High	Medium
Market Maturity	Low	High
Latency	In microseconds	In milliseconds

APPLICATIONS OF Li-Fi

(1) Medical and Healthcare Due to concerns over radiation, operating rooms do not allow Wi-Fi and even though Wi-Fi is in place in several hospitals, interferences from computers and cell phones can block signals from medical and monitoring equipment. Li-Fi solves these problems. Lights are an essential part of operating rooms and Li-Fi can thus be used for modern medical instruments. Moreover, no electromagnetic interference is emitted by Li-Fi and thus it does not interfere with any medical instruments such as MRI scanners.

(2) Li-Fi can be used for communications between the LED lights of cars to reduce and prevent traffic accidents. LED headlights and tail-lights are being implemented for different cars. Traffic signals, signs and street lamps are all also transitioning to LED. With these LED lights in place, Li-Fi can be used for effective vehicle-to-vehicle as well as vehicle-to-signal communications. This would, of course, lead to increased traffic management and safety.

(3) Street lamps can in the future be used to provide Li-Fi hotspots and can also be used to control and monitor lighting and data

(4) Li-Fi can also be used in situations where line of sight makes a difference, such as in-vehicle to vehicle communication as previously discussed as well as in indoor GPS systems.

(5) Li-Fi can find application in the new smart class technology which is quickly becoming imperative for progressive schools and colleges in the world. Using this technology, teachers show the class a 2D/3D animation on a large screen.

(6) Li-Fi is extremely useful for applications in which communications must be hidden. These involve various military and defence-based communications as well as communications in hospitals.

(7) Laptops, tablets, Smartphone's and various other mobile devices can interconnect with each other using Li-Fi, much like they interconnect today using Wi-Fi. These short-range links provide very high data rates as well as increased security.

FUTURE SCOPE

Li-Fi provides a great platform to explore the grounds of transmission of wireless data at high rates. If this technology is put into practical use, each light bulb installed is potential and can be used as a Wi-Fi hotspot to transmit data in a cleaner, greener and safer manner. The applications of Li-Fi are beyond imagination at the moment. With this enhanced technology, people can access wireless data with the LED's installed on the go at very high rates. It resolves the problem of the shortage of radio frequency bandwidth. In various military applications, where RF-based communications are not allowed, Li-Fi could be a viable alternative to securely pass data at high rates to other military vehicles. Also, LEDs can be used effectively to carry out VLC in many hospital applications where RF-based communications could be potentially dangerous. Since light cannot penetrate through walls, it could be a limitation to this technology. Nevertheless, given its high rates of data transmission and applications in multiple fields, Li-Fi is definitely the future in wireless communication.

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LIMITATIONS OF LI-FI

(1) The main problem is that light cannot pass through objects, so if the receiver is inadvertently blocked in any way, then the signal will immediately be cut out. If the light signal is blocked one could switch back over to radio waves.

(2) The High installation cost of the systems can be complemented by large-scale implementation of VLC through adopting this technology will reduce further operating costs like electricity charges, maintenance charges, etc.

(3) We still need Wi-Fi and we still need radio frequency cellular systems. You can't have a light bulb that provides data to a high-speed moving object or to provide data in a remote area where there are trees, walls, and obstacles.

CONCLUSION

Li-Fi is the most ideal solution for effective data transmission due to its basic building block; Light. Inexhaustible, accurate, fast, safe and cost-effective, Li-Fi could potentially be the successor of Wi-Fi upon further development. Its working centers around the principle of varying the electrical signal based on the required output. Its applications range widely from toys to communication and can find uses in critical fields like military and medicine. Further research on Li-Fi is gaining pace in recent times which will potentially resolve the many unsolved mysteries of the world.

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