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A Study on Li-Fi Technology and its Various Applications

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I. INTRODUCTION

Li-Fi (Light Fidelity) is a high speed, wireless communication using visible light. It is categorized under optical wireless communications. Transmission of data takes place through LED bulbs whose intensity varies.

The word Li-Fi was first coined by Harald Haas at the University of Edinburgh. This technology has vast applications where the use of Wi-Fi is limited or banned. It also reduces the health effects of using electromagnetic waves. Unless light is seen, data can't be hacked and so data transmission is secure. Data transmission is in terms of Gbps.

II. LITERATURE SURVEY

Li-Fi or Light fidelity is another wireless communication technology based on Visible Light Communication technique. It uses LED sources as a transmitter of data over the visible light spectrum, IR and UV. It is a new and efficient alternate of Wi-Fi as it serves higher bandwidth.

Many companies have taken up projects on Li-Fi technology. Companies like Phillips, Samsung, Signify, LVX etc. are currently working on this technology. According to a recent study, the maximum number of patents on Li-Fi has been submitted by Samsung. Oledcomm has been working on to merge big data and Li-Fi together to simplify tasks.

Oledcomm has developed a ceiling lamp- Li-Fi Max which offered internet connectivity to 16 users at the same time at a speed of about 100Mbps.

Pure Li-fi – the creator of Li-Fi has been working with Apple Inc. to introduce Li-Fi in iPhones. They have also introduced Li-Fi-X, a portable hotspot and dongle to enable internet browsing and connectivity in a confined space using Li-Fi.

III. HOW LI-FI WORKS?

- As light is present everywhere it will be useful if we use it to transmit data. Li-fi can be used exactly for this purpose.
- Digital data transmission takes place using LED bulbs with varying intensity controlled by varying currents.

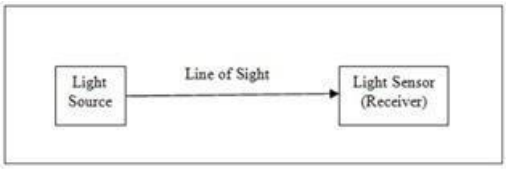

Fig 1: Data communication using Li-Fi

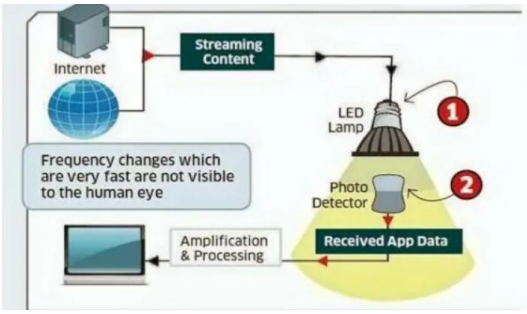

Fig 2: Working of Li- Fi technology

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The working is very simple as shown in figure below,

- There is a light emitter (LED) at one end. When the LED is on, a digital '1' is transmitted. When the LED is off, a digital '0' is transmitted.
- This is received by a photo detector at the other end.

This refers to a single bit data transmission. An array of LED's can be connected so that a large amount of data transmission takes place. Speed depends on the rate of variation of LED intensity. The main factors include, Line of Sight (LoS), Presence of light, Illumination.

3.1 Features of Li-Fi

A. Capacity

Li-Fi provides with greater Bandwidth. Li-Fi also provides with greater data density compared to that of Wi-Fi. The data density is about 1000 times than Wi-Fi. This is due to less interference of light than RF waves. Due to this output speed is also very high.

B. Efficiency

The system would be of low cost as it requires minimum number of components. No additional power input is required for this technology as LED illumination is already efficient.

C. Safety

It eliminates health hazards caused by RF waves. Use of light cannot interfere with any electronic circuitry and hence the technology is safe.

D. Security

Data theft or hacking is negligible compared to Wi-Fi since the range of data transmission is confined to a certain area.

3.2 Advantages of Li-Fi

- Li-Fi can be used around highly inflammable areas like Petrol bunks, aircrafts etc. as there wouldn't be any interference with inflammable objects.
- It can be used for underwater communication as light passes through almost all liquid media.
- Li-Fi provides an environment which is free from electromagnetic waves and thus creates a healthy environment.
- Li-Fi technology provides safety, security, fast and efficient communication.
- The Electromagnetic free environment created by Li-Fi can be used for hospital applications.

3.3 Applications of Li-Fi

The internet users are increasing day by day, as a result of which there is a heavy load on RF spectrum. Li-Fi Technology reduces this load. Even the usage of LED bulbs has grown over the years and this gives an advantage to incorporate light as a medium. Few applications are,

1. Smart Lightning: Any light source including street lights can be used to provide Li-Fi hotspots.
2. Communication in Electronic Gadgets: Short range data transfer with high speed can be achieved through Li-Fi in electronic gadgets.
3. Vehicle to Vehicle (V2V) Communication: This is most important real time application that can be implemented using LiFi. Using vehicle headlights data can be transmitted and thus vehicle to vehicle communication can be achieved.

3.4 Application of Li-Fi technology in Various Fields

A. LI-FI communications applied to telepresence robotics

Fig 3: Two robots VLC unidirectional communication

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The method by which data is transmitted using light waves is called Visible Light Communication (VLC). and can be used to transmit data in one direction, as shown in the block diagram of Figure 1, while the LI-FI technology includes a VLC restricted class and allows both duplex communications and routing, as with WI-FI communications, so multiple devices can connect to the network at the same time.

The ***transmitter*** controller module includes instructions about the modulation, channel and digital transmitter definitions. If the robot also transmits analog data, they are converted to binary data before entering in the transmitter controller modules.

The ***receive controller*** module includes blocks for demodulation, channels and definition of reception parameters.

In the case of using LI-FI technology for fast communications between two robots meeting, or between a robot and a fixed station, the communications are duplex, and the simplified diagram of the entire communication system is illustrated in Figure 4.

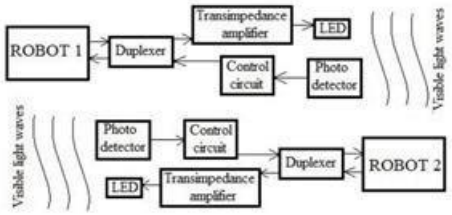

Fig 4: Two robots Li-Fi communication technology

B. LI-FI for monitoring covid-19 patients in hospital

Covid-19 is an infectious disease due to newly discovered coronavirus. Monitoring patient's temperature, Heartbeat, pressure, respiratory condition is very essential and should optimize to improve the covid-19 patients' survival. At present in most of the Hospital monitoring the patients is done either manual or Wi-Fi Wireless devices which are used for transferring the medical data must be highly reliable and secure. Whereas devices that uses Wi- Fi can interfere with one another which results to the connection loss.

At present we are using Wi-Fi services in and around campus covering the distance from 10 to 100-meter distance to connect computers, Laptops, mobiles etc. In order to overcome this best solution for these issues is Li-Fi.

In this, a simple communication protocol is proposed to bridge energy harvest sensors and Li-Fi. This proposed model can be used as a real time monitoring system in the hospitals for covid-19 patients by using Light Fidelity technology techniques instead of wireless technology to avoid radio waves for causing frequency interference with the human body.

IV. ARCHITECTURE

The covid-19 patient in Isolation ward needs ultimate care and continuous monitoring. These patients are monitored by using Li-Fi instead of Wi- Fi which cause interface to certain biomedical instruments. The temperature sensor, heartbeat Sensor and pressure sensor have been attached to these patient's body. Each patient is sensed by these corresponding sensors.

The analog signals produced from each sensor are converted into digital form and these digital signals get stored in microcontroller. From the microcontroller the data is transmitted to the receiver with the help of light which acts as a medium from simple white LED to the photo detector placed at the receiver. The receiver includes a Universal Asynchronous Receiver Transmitter (UART) which can be attached to a LiFi module and is located in the room. Then the data obtained is forwarded to the suggested model, via Li- Fi technology, so that the doctor can directly obtain information of every patient wherever he wants.

4.1 Benefits of using LI-FI in Hospital

Li-Fi can be easily used in many hospital applications, thanks to the non- interference of Li-Fi with radio frequency equipment. Without the need for cords, Li-Fi will be used to track and record patient gestures and vital signs in real time.

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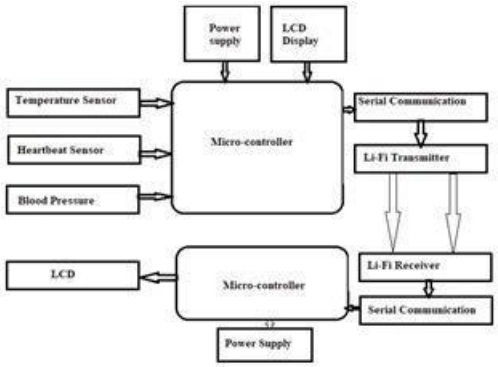

Fig 5: Block diagram for Li-Fi technology in hospital

4.2 Virtual and Augmented Reality

Li-Fidelivers higher speeds, lower latency and wireless interference-free communications that allow digital virtual / augmented reality to solve technology challenges.

4.3 Li-Fi in Pharmacies and the Pharmaceutical Industry

In hospital pharmacies, particularly in the pharmaceutical industry, Li-Fi will be used by pharmacists directly in the unit to receive and screen electronically approved prescriptions.

Li-Fi can be used to track prescribed drugs in the unit in real time so that the ward nurses and other healthcare professionals can check the status without calling or going directly to the unit.

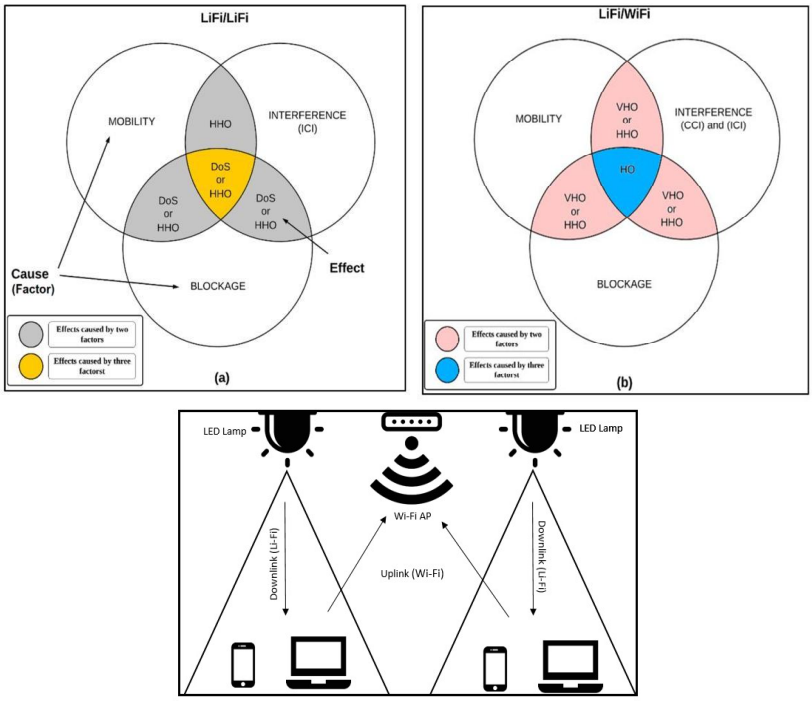

Fig 6: Illustration of Hybrid Li-Fi technology

4.4 LI-FI: Illuminating the Future of Internet

Hybrid Li-Fi System

VLC is best suited for broadcast applications as it encounters a number of disadvantages in its optical uplink transmission. The main limitations encountered are the interference between the optical and downlink transmission. Also an immobile transmitter finds it difficult to locate its receiver. To overcome this issue a combination of Li-Fi and Wi-Fi can be used; the hybrid Li-Fi systems which can help commercialize this native communication system.

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An Experimental Investigation on Communication Interference and Mitigation during Disaster Using Li-Fi Technology

Existing methods for Post-Disaster Communication- Rescue and Evacuation:

Run for a corner during a disaster is not conceivable. Early warning can be eventually limiting the hazard caused by the disaster. Disaster deteriorates infrastructure in affected areas like power cut, the collapse of antennas and buildings. A healthy communication system is necessary for an act in an emergency. Three aspects, which take in action, are

1. Execution of the action plan,
2. Locate and Rescue affected people and
3. Perform disaster relief operation

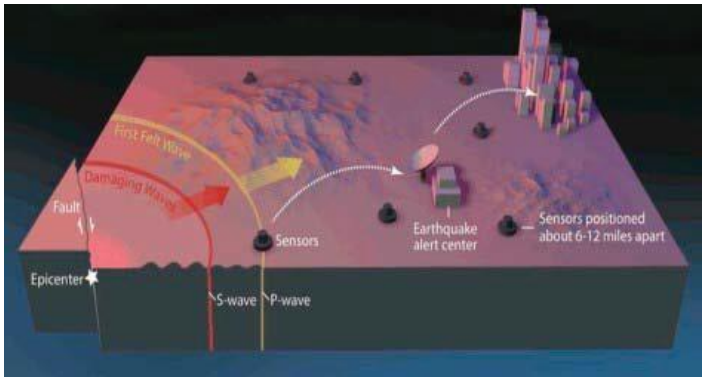

Fig 7: Illustrating communication using Li-Fi technology during disasters.

To achieve communication during disasters they used different technologies such as

1. MRV Based Communication
2. Satellite Based Communication
3. MANET Based Communication
4. Ad-hoc Based Communication
5. Wireless Balloon Based Communication etc.

Here we are proposing a methodology to use Li-Fi technology.

Radio waves are reinstated by Light-based for communication visible spectrum pretence sizable part in our spectrum. Using this visible range, data can be transmitted and received. When deteriorating during a disaster. This never shuts off because of the use of visible light spectrum. The visible spectrum is chose due to its less harmful effects compared to other waves in the spectrum. The range is 780nm to 375nm, which is less dangerous to humans as well in high power applications. The visible portion of the electromagnetic spectrum is used to transmit information. The switching of Light is fleeting that cannot reveal to the human eye. The habitude of RF becomes subsided as LIFI has breakthrough over 10,000 times greater. Light plays a dominant role in our prosaic life. Channel this to transmit data is conducive. LIFI extended under the concept of visible light for wireless communication. The size when considering with radio spectrum is 2500 times the larger one which, makes it support multiuser and mobility. The compound traffic is 60% more than the last year this increase in demand of 12000 times larger. The bandwidth requirement will be larger in the future 667 times shortfall when compared to the current situation. Reuse of the frequency in the spatial band can be the solution for this shortfall. However, the LIFI approach is a very successful method for the spectrum crunch.

V. CONCLUSION

Light-based technologies are considered as promising solutions to continue the trend towards higher frequencies in the electromagnetic spectrum. Given that the need for higher transmission speeds and more reliable wireless communication systems, we argue that light based wireless communications systems are inevitable, meaning it is not a question if we will witness a mass-market deployment of these system, it is only a question of 'when' will see the mass market uptake. The existing standardization activities within IEEE 802.11bb primarily hold the answer to the latter question. In conclusion, VLC, OCC, FSO and Li-Fi are of the utmost importance to accomplish spectrally efficient, robust, reliable, high-speed and secure wireless connectivity requirement of the fourth industrial revolution.