REVIEW ON Li-Fi

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***Abstract* - Li-Fi is an emerging technology that uses LED's as transmitters and Photodetectors as receivers. It uses visible spectrum (380nm to 750nm) for data transmissions and light as medium of communication. Li-Fi is capable of overcoming WiFi technology restrictions such as radiofrequency interference, media barriers and security concerns Li-Fi has high speed and broader spectrum for communication. It can be used as alternative to WiFi. Li-Fi technology is thoroughly examined in this paper along with its benefits and limitations.**

INTRODUCTION

Technology is the main factor which influences the overall development socially and economically. LiFi is the advanced version of wireless communication method which helps in fast data transmission. Harald Haas came with this concept in 2011 to tackle the limitations of other wireless technologies [1]. Because of its potential to offer a new spectrum for data sharing research into visible light communication as a solution has accelerated.

Li-Fi has unique capability to encode data at speed of Giga bits per second. That's why it is emerged as integral components of 5G networks, as well as IOT era [2]. Li-Fi is 1Gbps faster than Wi-Fi which in turn 100 times slower than Li-Fi. Li-Fi has frequency range of 430-790THz and wavelength range of 380-750nm [3].

Li-Fi is classified as an optical wireless communication system that utilizes Light Emitting Diode (LED) bulbs with adjustable intensities to transmit data based on these variations. Digital communication occurs through this method. This technology is useful in locations where Wi-Fi access is either limited or not allowed, and it also removes the potential health risks associated with electromagnetic waves. Data transmission is secure since it cannot be intercepted unless light is present. Li-Fi concentrates on enabling data transfer between two endpoints using LED technology. It is utilized in multiple areas such as home automation, hospitals, underwater applications, aviation, power plants, various industries, the defense sector, education, and the Internet of Things. In most of these fields, Li-Fi provides superior performance and efficiency when compared to Wi-Fi.

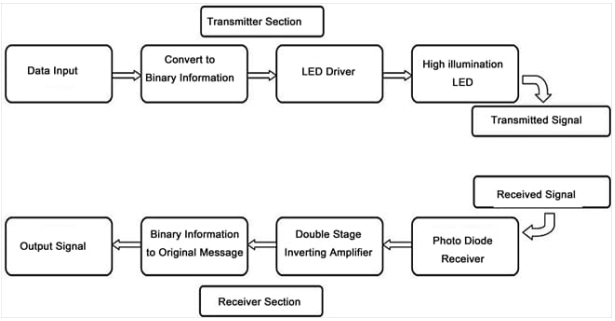

Fig.1 Li-Fi System

LITERATURE REVIEW

Home automation based on LI-Fi technology transfers data using LED which enables use to operate household appliances through an android app that is linked to the cloud it offers high security effective and fast communication. Li-Fi is also very useful in vehicle, aircrafts and undersea environments where radio based systems are less reliable [4].

Arduino boards can be used in the construction of the connectivity modules. In most of the home automation scenarios communication range is ten meters. Home automation system is implemented using KNX ,which is most widely used home automation standards world wide. [5].

Li-Fi based internet of things system enables simultaneous illumination and communication using LED and phototransistors. Environmental monitoring can be done using Wi-Fi and HTTP protocol ,a DHT11 sensor gathers temperature and humidity data, which is then stored in cloud. Data is transmitted via pulse position modulation at 2KHz over a 1m distance [6].

Light Fidelity advanced in lower energy usage, increased bandwidth, and resistance to signal jamming it offers safe command and control, naval communication and quick data sharing in emergency situations. The IEEE 802.11bb standards adoption and the hybrid networks combination of Li-Fi with RF systems represent important advancements towards real world implementation. In addition, LiFi's potential for cooperation with quantum technology makes it a vital component of secure communication in next generation [7]

Li-Fi helps visually impaired people navigate indoor spaces, the system utilises Li-Fi to provide precise, actual location data. Zigbee based switch system helps user detect obstruction in their surroundings even in dynamic situations, the system showed over 90% accuracy with a positioning error of less than 30cm. [8]

Compared to conventional Wi-Fi Li-Fi offers vary speed better security and energy efficiency by using visible light for wireless data transmission. The system design uses ON-OFF keying and pulse width modulation to modulate photodiodes for reception and LED for transmission. Because Li-Fi doesn't interference with electromagnetic signals, it can be used in smart homes, health care, IOT etc. [1]

Li-Fi based medical monitoring system and use of LiFi technology for image transmission during surgery achieving effective signal processing and data transfer, as well as guaranteeing communication stability and dependability, are some of the obstacles and issues LiFi technology faces in the medical domain. MIMO (Multiple - Input Multiple - Output) modulation technology used in medical domain to enable the application of Li-Fi. [9]

An Arduino controlled working prototype that uses LED's for transmission and LDR sensor for reception shows how useful the system is. For scalability and compatibility, the system adheres to widely used building automation protocols by using building automation standard. White LEDs offer an affordable solution for low data rate requirements, while high brightness and RGB LEDs allow for faster, wider connectivity. [10]

Light Fidelity based home automation system with arduino transmitter processes and sends out the visible light signal from the white LED bulb when a working push button is pressed. The Arduino receiver than receive and processes the signal and turns the linked household appliances ON or OFF. The transmitter and receiver can communicate upto 41cm, and the system was constructed easily accessible components. [2]

Integration of Li-Fi into V2V communication are set out, with a focus on how it can enable real time data transmission that is essential for safety and autonomous driving applications it uses photo detectives and LED bulbs to transmit and receive data. Implementation techniques for incorporating Li-Fi in to V2V communication system, such as automatic collision avoidance systems and sensor based distance measuring. It promises affordable way to reduce traffic accidents and improve communication in smart doors.[11]

Internet of things uses wireless networks to install a large number of sensors for monitoring environmental, system, and physical factors without demanding a lot of infrastructure wireless sensor networks (WSNs) facilitate a wide range of applications, including monitoring and effective rooting with integrated communication potential. The intelligent health care system uses variety of sensors to gather health data in real time and send it to a central server for medical analysis. LED's can be combined with light fidelity technology to transmit data wirelessly. [12]

Li-Fi based solution for effective and safe IoT device control in smart home automation system is Li-Fi IoT. Based on testing light intensity, distance, and device angle experimental results demonstrate improvements in data transfer speed, energy efficiency and security utilizes AES encryption. In order to improve Li-Fi's performance range in low light conditions and increase it's potential for wider range of wireless communication applications, future research will investigate nano technology.[13]

Wi-Fi and Li-Fi has similar characteristics, light fidelity is a new wireless communication technology that offers incredibly fast data transfer rates and full bidirectional networking. It has draw backs, including a restricted interior coverage range the requirement for line of sight between the transmitter and receiver and susceptibility to interference from ambient light. These issues can be solved by combining Li-Fi with hybrid wireless technology as a solution to these issues. Integration of Li-Fi with Wi-Fi and cellular networks in a number of areas, such as satellite communication, the industrial internet of things (IIoT), and Vehicle- to- Everything (V2X) connectivity. Since light travels at a speed that is significantly faster than conventional transmission techniques, L-Fi has the potential to revolutionise data accessibility and communication effectiveness in a verity of industries particularly in future scenarios that need for dependable and quick
connectivity. [14]

Vehicle- to- Vehicle (V2V) communication will continue to be one of the most potential use cases in upcoming 6G networks. These systems need ultra low latency and very large data rates, which are still difficult to accomplish with existing technologies. Recently, Vehicular Visible Light Communication (VLC) has become a feasible way to satisfy these exacting standards. Blind interference alignment for vehicular visible light communication using the idea of a reconfigurable photo detector that produces linearly independent channel responses.
Reconfigurable photo detectors may be easily installed in cars. [15]

An environment friendly green optical wire less communication technique called visible light communication combines communication and illumination to save energy and less carbon emissions. [16]

Tests are conducted to determine how well the system can send text and image data quickly with interruption. Based on the findings, Li-Fi technology can be a good substitute for conventional wireless communication system in some situations where high speed data transfer and security are crucial, such indoor communication. AI can be combined with LiFi technology that is more intelligent and effective. [17]

Li-Fi and VLC provide Industry 4.0 with potential connectivity options that allow for high-speed, interference-free data transfer in factories and warehouses. Where RF connection might not be dependable, these technologies support automated systems, mobile robots, and sensors. However, their widespread outdoor and industrial deployment is still constrained by environmental issues and lack of standards.[18]

A straight forward exponential attenuation model is used to assess under water wireless optical communication performance over a range of water types in contrast to slow incandescent bulbs, LED light respond quickly, which makes them ideal for data transfer compared to current under water communication system this approach is more useful and efficient. [19]

In order to replace infrared laser communication to replace infrared laser communication in automated guided vehicle in Li-Fi based communication system is developed AGV mobility is restricted by the need for perfect alignment for laser systems more mobility and increased durability are made possible by the use of LED'S with the wider beam the system prevents obstruction induced signal blockages and works well in RF sensitive situations. [20]

Bluetooth and Wi-Fi both use radio waves to transfer data, but they are limited by spectrum congestion and RF interference. Li-Fi system for indoor audio communication that uses photo registers and LED'S as optical transmitter and receivers. It address to RF scarcity problems. [21]

A low cost visible light communication system for intelligent transportation system is developed uses photo diode based receiver and embedded transmitter to send real time traffic information to cars via traffic signals to give drivers helpful information, such accident alerts or traffic updates the received optical signal is digitalised and decoded. [22]

The research on Li-Fi technology for data transmission using LED-based visible light for vehicle-to-vehicle communication in an effort to lower traffic accident. It uses white LEDs to transmit many kinds of data ,including text, video, audio and ultrasonic sensors to identify vehicles in vicinity. In order for

microcontrollers to compute and send data via LED lights-which are picked by a photodiode in the receiving vehicle-the system transforms sensor signals from AC to DC. The CPU analyses the received light, transforms it into voltage ,and then displays it on an LCD.[23]

A study on Li-Fi offers simplified method to assist novice researchers in comprehending

And experimenting with a Li-Fi audio signal transmission system that uses reprogrammable modules.[24]

By employing Li-Fi to continuously provide doctor's patients physiological data(such as temperature, pulse, and saline levels),the system fills a significant healthcare gap real time health monitoring-improving response times and perhaps saving lives. ARM and PIC microcontrollers were used to construct the system, which showed effective real-time data transfer, enhanced portability, and user friendliness while maintaining cheap prices.[25]

Cryptographic protection can be used for safe data transfer and duplex Li-Fi communication system between two PCs. High power LEDs are used to transmit data, two Arduino Uno boards (one for transmission and one for reception) are used receive data, BPW40 phototransistors are used as photodetectors. The Arduino IDE is used to program the Arduino boards in C, and they are then uploaded over USB. Data encoding, transmission, and reception are managed by this software. The transmission is a 12V LED that is powered by a BD139 transistor. Since Arduino can only output 5V,an extra 12V source is required. To analyse light signals from the phototransistor , the receiving circuit employs a comparator design with an LM393 operational amplifier. A 2N2222 transistor molds the signal for the Arduino, and a potentiometer modifies light sensitivity.[26]

According to Li-Fi transmission principle Li-FI uses a

power amplifier stage to modulate the current and voltage for powering the LED light transmitter, as well as a pre-amplifier(LM741) to enhance microphone signals. The ATmega328P micro controller supports TWI and SPI interfaces and controls UART communication through digital pins. It is Programmed using Arduino software and ordinary USB COM drivers. A photodiode or solar panel is used by the receiver to gather light signals. After that these signals undergo two stages of amplification those are power amplifier for both voltages and current gain and preamplifier for voltage gain. Signals identified using LDR. The resistance of LDR decreases in the presence of light, resulting in the presence of light, resulting in insufficient base voltage to turn on the transistor. Signal detection is made possible by current being redirected through the LDR.[27]

The technology makes use of LI-Fi to allow for wireless communication in both directions between street lights and automobiles. Even while cars are moving, data is transferred between them via LED headlights and taillights as well as transceivers based on streetlights. The cars vibration sensors identify collisions or unexpected motions. When activated, they transmit alarm information to neighbouring streetlights, automobiles, and emergency services. Two cars and two streetlights are used in the implementation, LEDs are used for transmission, photodetectors are used for reception, and Arduino UNO controllers are used and control the data flow in each unit. Through constant, lowlatency connectivity, in-car LCD screens show information about traffic conditions, accidents, or road alerts, giving drivers real-time awareness and improved safety[28]

COMPARISION BETWEEN LI-FI AND WI-FI

Sl.No	Feature	Li-Fi	Wi-Fi
1	Full form	Light Fidelity	Wireless Fidelity
2	Speed	1Gbps	100Mbps-1Gbps
3	Spectrum	Visible Light Spectrum	RF Spectrum
4	Medium of data Transfer	Light	Radio Spectrum
5	Security	Very High(light doesn't leave room)	Moderate

CONCLUSION

Li-Fi technology is sowing promise in addressing a number of issues that contemporary wireless systems confront, most notably the scarcity of radio frequency spectrum. Li-Fi provides a new method of data transmission by utilising infrastructure already present in residences, work places and public areas. Since Li-Fi offers a quick, safe and energy efficient substitute for traditional Wi-Fi interest in it has been raising quickly. Data transmission rates using LED based system have been shown to be substantially faster than

those of conventional wireless networks. The technology is intrinsically more secure because light is used for communication and any attempt to intercept the signal necessitates direct line of sight.

The integration of Li-Fi in smart home equipment is one promising area of development. Business are investigating machine to machine (M2M) communication, which allows communication which allows commonplace appliances like lights, refridgerators and washing machines to share data using Li-Fi system based on LED's. Manufacturers will need to incorporate appropriate chips and firmware in to their devices in order for this to become widely used, allowing for proper communication with home automation systems.

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