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Study on Li-Fi Technology and Its Applications.

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ABSTRACT

Li-Fi technology is a milestone in the history of underwater communication. Since the number of people using wireless internet has increased, the network speed is reduced. This can be overcome by using Li-Fi technology which implements transfer of data through simple light source (LED). D-Light can produce data rates more than 10 mega bits per second, which is faster than average broadband connection. Ultrasonic sensors are used for underwater wireless communication which can be replaced by Li-Fi technology for better performance. The ultrasonic waves can be absorbed by objects present underwater whereas light cannot be absorbed. In this paper, a survey has been made regarding implementation of Li-Fi technology and its applications.

Keywords: Li-Fi technology, LED, Sensors, Ultrasonic waves

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INTRODUCTION

Li-Fi refers to Light Fidelity which was coined by Harald Haas in 2011. LED'sare used for transmission of data,so this is known as Visible Light Communication (VLC).Wi-Fi uses RF bandwidth which has more traffic so the possibility for interference is more. The equipment required by Li-Fi are already present, as light is common source of illumination which reduces the cost of implementation. The transmission of data through illumination can be obtained by taking fiber out of fiber optics and transmitting data through a LED [5][8]. In Li-Fi technology, the transmitter part consists of microcontroller which converts data signal into binary 0's and 1's where 0 represents OFF and 1 represents ON of the LED [2][7]. The transmitted signal is received and amplified to remove noise and then regenerated into desired signal.

The frequency ranges used by Li-Fi is between 400THz to 800THz [11][12]. Li-Fi uses visible light spectrum to obtain high data rates of 500 mbps practically and can reach upto 10Gbps. Parallel transmission is done using array of LED's or by using red, green, blue LED's which has different frequency range to obtain high data rates[8]. Transmission of data underwater is not possible using Wi-Fi since radio frequency cannot pass through water. Wired underwater communication tends to limited exploration. Important thing is all other sources may lead to absorption of transmitted signal. Whereas light cannot be absorbed by the objects. We place a high efficiency LED lamp underwater and a photodiode in the receiver end which is a sub marine or other underwater vehicles to receive the information [10]. The paper description is as follows, Section 2 consists about the literature survey and the survey concludes at section 3.

LITERATURE SURVEY ON Li-Fi TECHNOLOG AND APPLICATIONS

Rahul R Sharma et al. (2014) described the usage of gigahertz radio waves reduces the high data rates. Li-Fi uses unutilized bandwidth of visible light at a frequency band of 300THz, so that it can obtain a speed of 10 megabytes per second. Various multiplexing techniques and high speed LED's helps to obtaining a data rate greater than 100mbps. The LED consists of power amplifier which generates RF signal and electric field in the bulb vaporizes the contents of the bub's centre into plasma state which produces light. Dielectric material serves as wave guide to RF signal and help in focusing energy as shown in figure1.

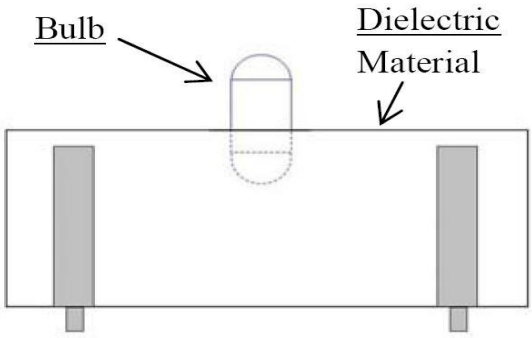

Fig.1 Li-Fi bulb

Samuel Lazar.M, and Ravi.T, (2015) described that light can travel distances without any disturbances than other signals[2]. Previous system uses acoustics as it has low absorption characteristics and electromagnetic waves can be used at higher frequency and bandwidth. The factors effecting are high attenuation and big antennas which are increasing the complexity and cost of the network with the presence of unwanted noise signal. They proposed a Li-Fi based high speed data transmission systems [2].

Jay H Bhut et al. (2014) proposed the visible light spectrum has 10,000 times more space. The LED requirement has been satisfied since they are already available in large numbers. Parallel transmission can be obtained by using an array of LED's or combination of three colours (red, blue, green) as they have different frequencies. To the voltage level of transmitter and receiver is maintained with the help of voltage regulator and level shifter. 2300 lumens of bright white light is produced by a small LED. Li-Fi can be implemented in aeroplanes since it doesn't interfere with radio waves as shown in figure 2.

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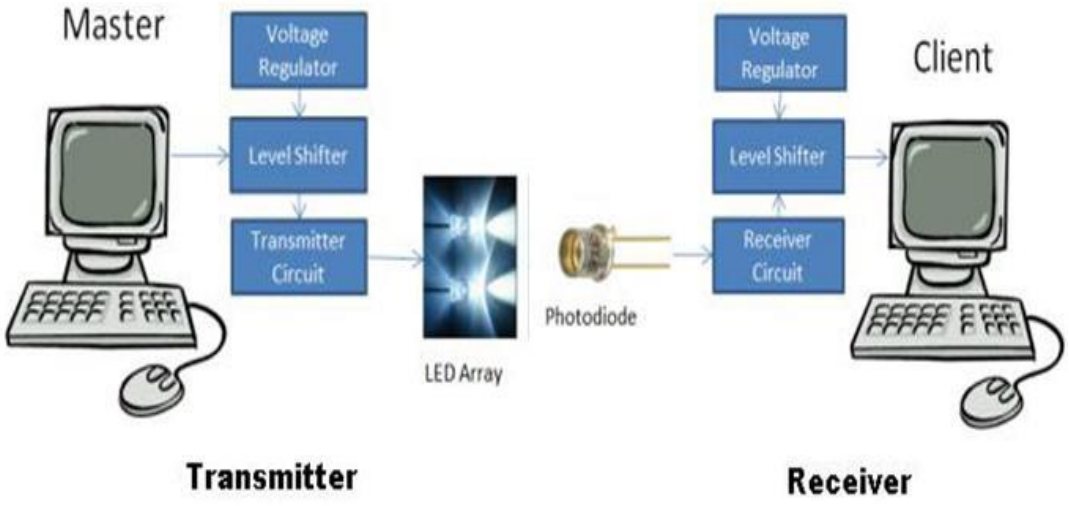

Fig 2.Transmission and reception in Li-Fi

C.Periasamy **e**t al. (2014) described that in every private institution and in public spots, Wi-Fi is used widely which causes blocking of wireless spectrum. LED can flicker at a higher rate as it's reaction time is less than 1 microsecond. The speed of data transfer using fluorescent lamps is 10 Mbps whereas if LED's are used, thedata transfer speed is 500 Mbps since it has high response time than fluorescent lamps. Pin diode, Avalanche photo diode or image sensor (shown in Figure 4) can be used in the receiving end. Using only one watt power supply, the LED all around the room can be powered. Four computers can be connected using single power LED bulb with data rates up to 150 Mbps.

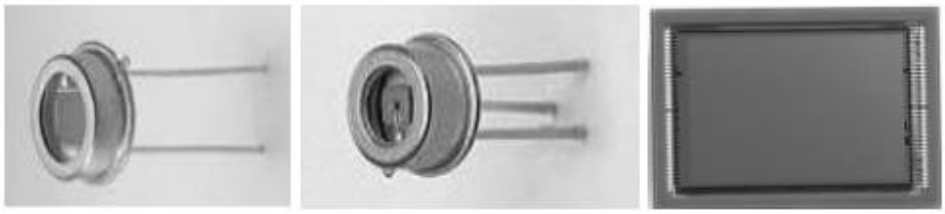

Fig 3.Pin Photo Diode, Avalanche Photodiode and Image Sensor

C Sridharan et al. (2014) described that the visible light communication can be obtained by taking fiber from fiber optic and transmitting the data through an LED light bulb. He had received 500mbps data rate with the help of standard white LED performed with a distance of 10m between transmitter and receiver.A silicon photo diode is used as it responds effectively to visible wavelength region as receiver. Li-Fi uses LED as semi-conductor device which is fixed with a unique signal-processing technology and special modulation which sends the binary signal present in its beam at a ultra-high speeds of 10,000-20,000 bits per sec to the photo detector which converts the received signal into an electrical signal and then reconstructing it into a data signal. IEEE 802.11.n family contribute only upto 150mbps and 600mbps theoretically. Light is a part of invisible, ultraviolet or visible spectrum so this can be applied with any kind of light.

Ankit Navalakha et al. (2014) proposed that doctors can get hep online as well as exchange videos and statistics of patient for getting better results. Wi-Fi is harmful to human body as it uses radio frequency spectrum. It also causes many diseases like cancer, neurological diseases etc. Li-Fi uses LED's which doesn't affect anybody and even the time taken for taking the right decision will be reduced with fast wireless communication. The property of optical current is implemented in Li-Fi technology and the controller codes the entire data into 0's and 1's. LED's flicker accordingly as on for 1's and off for 0's. The advantage is that it needs no license as it is free band.

Abhishek Kurup et al. (2014) demonstrated the simulation of Li-Fi using a simple circuit. In this circuit, the transmitter part consists of input, and timer circuit and a LED. NI Multisim 12.0 is used for simulation process.In Figure (4), the circuit consists of simple 555 timer circuit, an optocoupler and an amplifier. Virtual function generator (XFG1) is used to give input frequency. Input is converted into square waves which represents 0's and 1's. Optocoupler is used since it is not possible to simulate transmission of data between LED and photodiode. OPA656 is used to construct inverting amplifier to which the output of optocoupler is given. Thus, with this simple circuit the required output was obtained.

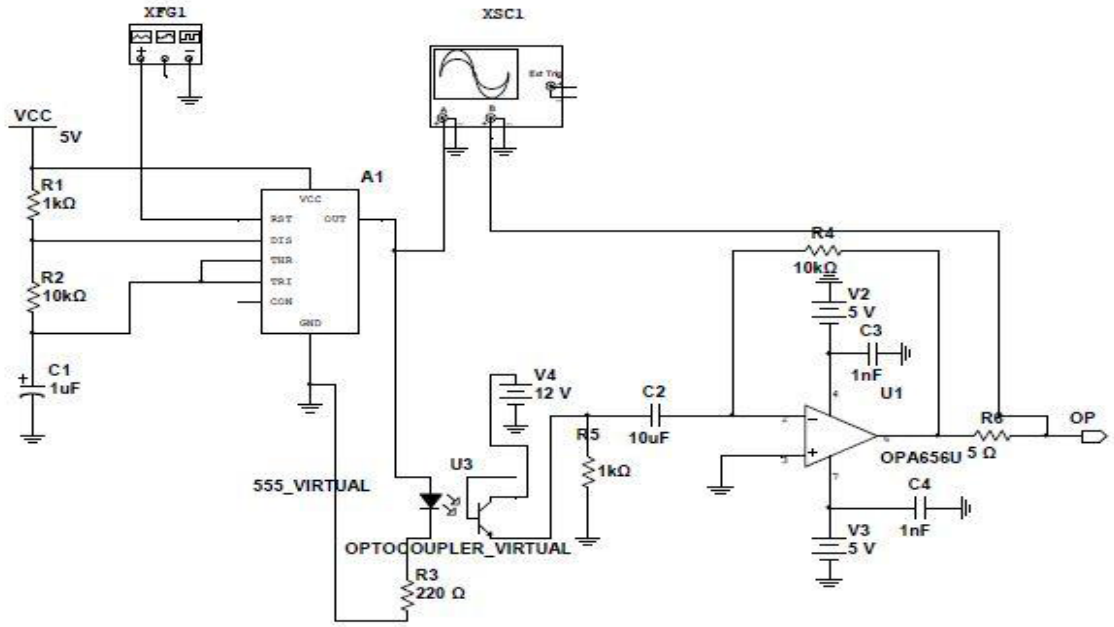

Fig 4.Circuit Diagram

R Karthika et al. (2015) explained the idea to transmit as serial data with the help of UART from one PC to another. Photo diode is used to regenerate the data then passed to PIC microcontroller which is used for toggling the LED's and for generating binary sequence into desired file, so that it can be recognized by PC software as well as android phone with an OTG. There are many opportunities like public internet access from street lights to stealth cars that can communicate through their head lights. The data stream should have proper connection with server and internet. VLC is preferred as it uses frequency more than 3THz which is not regulated by Radio Regulation Law. The high lamp life of LED is obtained with the combination of high temperature plasma and digitally controlled solid state electronics. The data rates are inversely proportional to size of LED and directly proportional to number of LED and rate of switching ON and OFF.

Akshata M Sonnad et al. (2013) described that UK scientists obtained high transmission speed with a record of 10Gbps which is 250 times higher than broadband. The basic principle is varying the intensity of LED's by varying the current at high rates. Wang Jia Juan et al proposed that illumination is reduced rapidly when the communication distance increases. They have also found a bit rate of 111.607Kbps at a distance below 1.5m and error rate increases as distance increases. He proposed Li-Fi to obtain data rates in order of MHz with a communication distance of 1m. The transmitter part contains data input which is fed into a switching control system to generate strings of 0's and 1's. Infrared germanium cylindrical detector as it demodulates received signal.

C.S.Patil et al. (2014) had studied the use of Li-Fi instead of Wi-Fi in indoor applications. A unipolar orthogonal frequency division multiplexing technique is used for modulation which provides fast ON-OFF switching of LED. The Data link layer in OSI model is divided into two sub-layers for VLC model. The two sub-layers are Optical Wireless Logic Link Control (OWLLC) and Optical Wireless Media Access Control (OWMAC). In the network, the logical links between devices are controlled and confirmed by OWLLC. OWMAC controls the

media of communication (i.e) simplex, half duplex or full duplex. They have analysed that the new LED's can flicker 1000 times faster than the normal LED's which makes them to transmit data at a far higher rate.

Dinesh Khandal et al (2014) described LED is similar to a IR remote control with higher power. Data transmission is done through illumination. The LED's are used instead of fiber in optics for sending data. Transceiver fitted LED's replace modems in room to serve both purpose of lightning the room and in transmission of data. They have explained the data transfer rate of Li-Fi technology very clearly. Considering an IR remote with data transfer rate of 10000-20000 bps and now it is replaced by an array of LED which sends thousands of the same stream at a faster rate.

Dhakane Vikas Nivrutti et al. (2013) surveyed about the implementation of Li-Fi in future. They have considered the important factors to design Li-Fi are the presence of light, LOS (Line Of Sight), and usage of LED or fluorescent lamps to obtain better performance. Li-Fi technology can be enhanced by using an array of LED's to obtain parallel transmission of data and LED's of different frequencies (i.e) coloured (red,green,blue) LED's can be used. By doing so, we can obtain a theoretical speed of 10 Gbps. There is no need for a license to use a free band in which Li-Fi is operational. The remote controlled devices used under oceans cannot be operated using radio waves but light can pass through water which allows transmission of data by Li-Fi. The data density of Li-Fi is far greater than that of Wi-Fi.

CONCLUSION

As per the survey, Li-Fi technology can be implemented to obtain high speed data transfer. Bidirectional system can be designed in order to get acknowledgements from the receiver end. Li-Fi technology can be applied in hospitals since radio waves cause harmful effects on humans. It can also be used in aviation as it doesn't interfere with radio frequencies. Ultrasonic sensors uses big antennas which increases the complexity of the network and not efficient in transmission of data with respect to speed and distance. The limitations for exploring the ocean beds can be improved using Li-Fi technology. This shows that, this is the only technology which is cleaner, greener and safe in communication system.

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