Visible Light Communication (VLC) and LiFi

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Abstract — This paper deals with the emerging technology of Visible light communication and LiFi. There is a description about the working and structure of this new technology. Along with the introduction of theoretical concept the practical system has been implemented in order to acquire the firm knowledge about the need to change the present day technology to realize the favourable or unfavourable impacts of the existing Wi-Fi and the emerging LiFi technology. VLC (Visible Light Communication) and LiFi provide a new dimension to the wireless technology. For efficient working of this technology proper modulating techniques are required to control the dimming of light and also to avoid the flickering of light perceptible to the human eye. Since these technologies require high switching speed, the employment of LED as a source of light is highly encouraged. But, since LED has a technical design that produces incoherent light, intensity modulation provides a viable option for its development. This paper also mentions some basic applications of LiFi technology.

Keywords *—* **VLC:Visible Light Communication , LiFi: Light Fidelity, Giga MIMO, GigaShower, Pulse Width Modulation.**

I. INTRODUCTION

Visible Light Communication (VLC), of which Light-Fidelity (LiFi) forms a subset, is a method of data communication that employs light with constant illumination as a medium for transferring data. But, the mere flashing on and off of light (as in the case of Morse code) cannot be termed under VLC due to non-proficient exploitability of the source of light. To achieve a constant source of illumination the flashing off and on of the light needs to be so quick that it becomes impossible for the naked eye to differentiate it from that of a constant light source. The ordinary bulbs that we use are not capable of such high speed switching which brings us to make use of the LED bulbs that can flicker quick enough to appear to be emitting constant light. Moreover, the transference of data does require the LEDs to be turned on all the time. It is also possible to transfer the data by dimming the glare of the light to such an extent that it hardly seems to be switched on and emitting light. LEDs are semiconductor diodes and hence, the light

output is directly proportional to the forward current. Thus, reduction in forward current of LEDs can aid their dimming. Pulse Width Modulation is another method used to minimize the glare of light by moderating the time and relative duration of the pulses.[1]
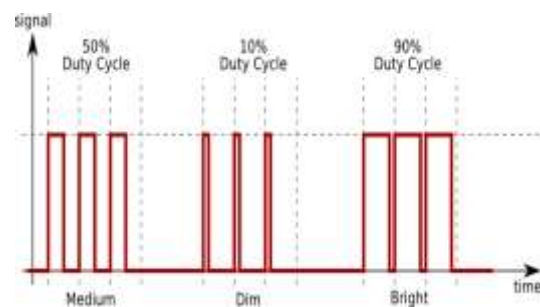

Fig 1: Pulse Width Modulation [2]

II. LIFI

Analogous to Wi-Fi, LiFi (Light-Fidelity) is a wireless system for data communication that makes use of light instead of Radio frequency for the purpose of data transmission. LiFi comes under the category of Optical Wireless Communication (OWC) that employs high speed VLC in application. The term LiFi was first cast by Professor Harald Hass[3], professor of Mobile Communication in the University of Edinburgh[4], in the year 2011 in TEDGlobal. The high speed flashing on and off of light is utilized for data transmission by the LED bulbs. For the establishment of LiFi network LED light source and light sensor or photo-detector is necessitated. When the LED light source initiates to glow the photons emitted by it will be detected by the photo-sensor. The intensity of the light falling on the photo-sensor in a regular dim and bright manner will correspond to either binary 1 or binary 0. The information received by the photo-detector or the photo-sensor needs to undergo the process of amplification and is then fed to the accessing device (mobiles, computers etc.).
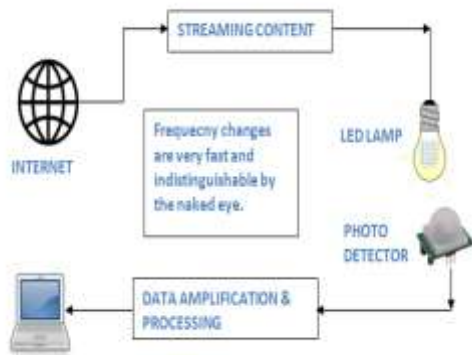
Fig 2: The LiFi System

III.PHYSICAL IMPLEMENTATION OF VLC CIRCUIT

Unlike the systems in trend that work in radio-frequency or microwave band, the visible light is tooled to transfer the data in the form of 1's and 0's that pass through the medium. Hence this factor increases the reliability as well as the accuracy in transmission. The transmission takes place under 400nm to 700nm range of wavelength of EMW.
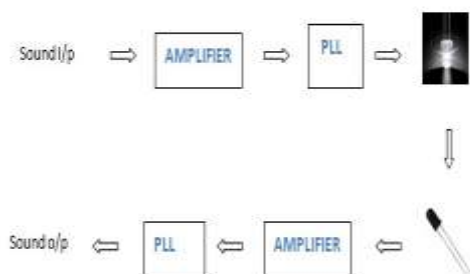

Fig 3: Physical implementation of LiFi

The circuit is designed in such a way that the signal will be fed to the amplifier where signal acquires the gain of 1000. This can be achieved by using the IC3130 as a non inverting amplifier. Afterwards, the amplified signal is passed through the loop–lock circuit where the analogue signal is processed into corresponding PWM (Pulse width modulation) signals with different duty cycles which does switching of the LED. This transmitted digital signal is received by the PIN Photo Diode at the receiver side. Because the received signal is weak, it is feed to the amplifier in order to attain the signal suitable for processing. Eventually, the signal again passes through the loop-lock circuit where it is converted into analogue form to be realized in the physical world, through the speakers.

IV.GIGA SHOWER AND GIGA MIMO

The VLC consortium (VLCC) in Japan was the first to implement the technology of LiFi which makes use of IEEE 802.15 and 802.15.7 for personal and industrial use respectively. For improvising on speed, models such as Giga Shower and Giga MIMO can be used.

A. Giga Shower

A model which proffers its service in only one only direction making use of several channels covering a wide range of area, thereby being able to provide the service to multiple users at the same time . This infers that this model can be employed when the usage of uplink channel is obsolete. This model can be used for selling commodities in which the media server which is connected can be accessed through Wi-Fi for payment procedures.[5]
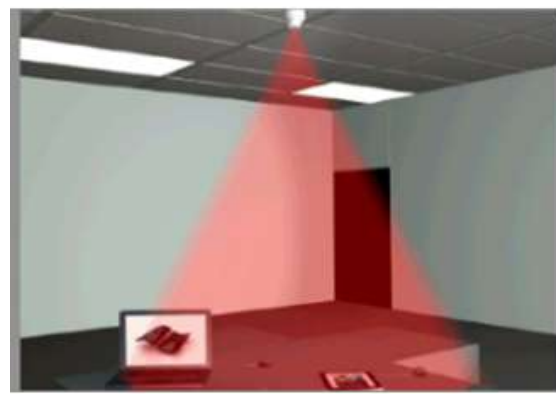

Fig 4: GigaShower[6]

B. Giga MIMO

MIMO stands for Multiple Input and Multiple Output. As the name suggests, this model makes use of multiple channels facilitating bi-directional data transfer, unlike Giga Shower that provides unidirectional data transfer facilities. This model can replace the conventional system of Hot-spot by providing bidirectional data transference service to a large audience through Visible Light Communication.[5]
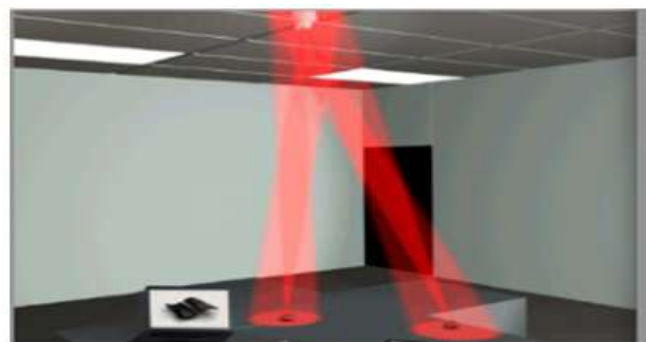

Fig 5: Giga MIMO [6]

V. ADVANTAGES AND DISADVANTAGES OF LIFI OVER WIFI

A. ADVANTAGES

- *Band-width availability*: With the rapid increase in the population of the world the band width of the Radio frequency seems to be getting exhausted. LiFi which uses light for data transmission instead of Radio frequency consists of a frequency of band that is nearly ten thousand times that of the frequency spectrum of Radio. Thus, LiFi has more than sufficient band width, so much so that even if more than double the current population were to transmit data there would still be enough spectrums left for consumption. In other words, the band-width available for LiFi is almost non-exhaustible.
- *Effect on health*: It is proven by scientists that excessive exposure to Radio Frequency Fields can cause carcinogenic diseases to human beings. Not only human beings but also the animals are affected by the radiations. LiFi, on the other hand does not lead to such health hazards.
- *Security*: The Radio Frequencies can pass through opacity and obstacles and hence are exposed to imperceptibility. This is not the case in LiFi as the light cannot pass through opaque substance. They can be confined and are difficult to intercept.
- *Speed*: Due to more than sufficient availability of band-width for LiFi the speed of data transmission never seems to be an issue. Data transmission via LiFi takes place at very high speed.

B. DISADVANTAGES

- *Power usage*: For the transmission of data the high power LEDs need to be kept on all the time thereby utilizing most of the energy.
- *Permeability through walls*: The medium used for transmission of data in LiFi is light which cannot pass through opaque substances like wall and thereby limiting its range.
- *Interference*: The light from one source can interfere with the light from a different source which can lead to disruption of the network and damage the data transmission proficiency.
- LiFi works on the principle of Line-of-sight. When setup outdoors, the LiFi apparatus would have to face changing environmental conditions.

VI. APPLICATIONS OF LIFI

- *V2V:* V2V is Vehicle to vehicle communication. This system uses LiFi to communicate the vehicles on road for the purpose of safety. The mere honing of horns creates unnecessary noise. V2V lets the drivers know what step needs to be taken for each of the drivers communicating through the light emitted by the LED headlights and backlights of the respective vehicles. The messages like changing of lane, overtaking etc. can be done between the vehicles to avoid accidental damages.
- *Under-water communication*: Water can easily sponge up radio waves and limit the distance upto which radio waves can travel under travel thereby leading to weakening of signals after covering a particular distance. LiFi, on the other hand, has the ability to perforate lager distances under water.
- *Communication in airplanes*: We are always asked to switch off our mobile and tablet devices or to put them in flight mode so that the radio signals emitted by these cellular devices can interrupt the signaling of airplanes and there by lead to accidents. But, in case of LiFi that makes use of light as a medium of data transfer can handy as light does not interrupt the signaling between airplanes. LiFi, thus, can assure both comfort and safety of the passengers.
- *Sensitive information*: Places like Police-stations and hospitals where the information stored or shared can be sensitive calls for a system like LiFi as light, unlike RF signals, cannot penetrate the walls.

VII. CONCLUSION

The technology of LiFi that forms a subset under Visible Light Communication (VLC) seems to be a prominent technology for usage. This technology can very well compensate the problems we are facing using RF signals. Not only that, this technology has wider applications and can improve the quality of performance wherever employed. GigaDock is a one of the beneficial wireless docking solutions which includes wireless charging of gadgets with high speed.[6]

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