LED Lamp Based Visible Light Communication in Underwater Vehicles

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***Abstract*— Wi-Fi technology becomes more popular today. Every public spots and private offices have wifi because of this wireless spectrum is blocked very frequently. Due to maximum utility RF interferences are getting more common to overcome this problem light fidelity (Li-Fi) technology was introduced in the year 2011. Li-Fi is similar to other wireless communication which uses the communication medium as light. Visible light is use to transfer data between the system instead of radio signals. Li-Fi uses LED light source to transmit the data wirelessly this method is widely called as VLC (visible light communication). A stream of data transmitted in the way of pulses of light that cannot be detected by the naked eye. This paper speaks about the new vlc technology over the existing wifi technology and the challenges of new Li-Fi technology.**

Keywords—Li-Fi, Wi-Fi, Visible Light Communication, Wireless communication, Light Emitting Diode, Data Encryption and Data Decryption, Light Sensor, Data Transmission.

I. INTRODUCTION

Li-Fi is a visible light communication which is used for high speed communication. The name Li-Fi is due to the similarity of the working of Wi-Fi except light source instead of radio waves. The Li-Fi technology was first proposed by Harald Hass a German physicist, number of industry groups and companies combined form the Li-Fi association to promote the high speed wireless communication using VLC technique to overcome the shortage in spectrum distribution for the purpose of high speed wireless communication. The technology is demonstrated for the first time in los Vegas using a pair of smart phones up to the distance range of 10 meters.

The data is send in the way of light rays that has been generated using LED light source the intensity of the light source as been increased by reducing the amplitude of the digital data that as to be transmitted.

II. PRINCIPLE OF LI-FI TECHNOLOGY

The important segment of the Li-Fi technology is the high power Led lights, led can be turned on & off quickly because the reaction time of the led is lesser than 1 microsecond which cannot be detected by the human eye this will appear to be continues beam of light. This change from on state to off state in high frequencies enables the data transmition. On states '1' and off states '0'the data can be encoded and modulation techniques can be done faster than the human eye can detect it. A photo detector can be used to receive the transmitted data from the light source and generates the original data. This method continuously receives the pulses of light and decode into the stream of data is referred as VLC (visible light communication).

A. Devices used in visible light communication

The components used into the Li-Fi communication purposes are Led lights or florescent light source and the photo detector. The light intensity of the Led and florescent bulb can be controlled by regulating the current applied to the light source. The usage of florescent lamps will help in generating the 10mb/s speed of data transfer but led light source provides the transmission speed of 500mb/s which is more faster response than that of florescent light so led lights are preferred to perform the visual light communication.

Figure.1. Devices used in visible light communication

The device which used for reception is pin diode or avalanche photo diode or image sensor as shown in figure 4 below

Figure.2. Pin Photo diode, Avalanche photodiode and Image Sensor

Figure 2, shows that different kind of photo diode used for VLC technologies to transfer data from point to point system, and the converter to desire data transmission.

B. Construction and Working of LI-FI Technology

Li-Fi is performed using the power led bulbs for downlink transition. A constant power source has been given to the system. By change in the input of power supply the optical data transition can be achieved. The variation in the intensity of the light source carries the high speed data working of Li-Fi shown in fig-3. The Led light which has been placed above the system is connected to the driver module which drives the led light source based on the data transmitted through it. The data has been transmitted in form of light beam. The receiver segment that has been placed in the table detects the changes in the light beam and separates the data from the light source and generates the electrical signal based on the intensity of the light fall on it. The converted signal was transmitted to the computer or other electronic devices.

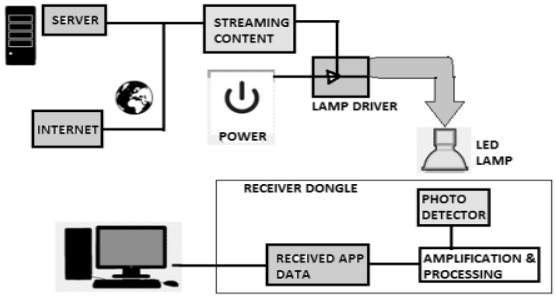

Figure.3. Working of Li-Fi

C. Issues on communication

Other than the advantages of the Li-Fi technology it faces more challenges. Li-Fi needs line of sight transmission limit. It cannot penetrate any obstacles so even a person stand between the receiver and the light source can stop the function of Li-Fi system which results in failure of system [10]. An important challenge is how to transmit the data from reception side to transition side or vice-versa. When the Li-Fi system is placed outdoor then the system should face the changes in climatic conditions and in indoor the receiving device cannot be shifted around the places.

Other than that when we compare in the terms of power consumption the Li-Fi requires only the 1 watt of power supply we can power the led all around the room. Using a single power led bulb we can connect four computers to the online with transfer rate of 150mb/s. The speed of the data transitions getting higher to Gbs by several research works. While comparing the efficiency, speed and power consumption the Li-Fi technology is more effective than that of Wi-Fi that used widely now a days.

The Li-Fi technology possess both positive side and negative sides by several improvements we can clear all the problems faced by Li-Fi can be fixed and make the Wi-Fi technology as the past way of transitions technique. The Li-Fi provides more frequency allocation than the Wi-Fi does, any led bulbs can be used to connect to the internet so this technology sure it may be widely popular in terms of speed, efficiency and cost.

D. Theoritical Analysis

In an ordinary inverting amplifier the input voltage is applied to a resistor, and the amplifier generates an output voltage in response to the current that flows through the input resistor to the virtual ground at the negative op-amp input. A current-to-voltage amplifier is an inverting amplifier with the input current I in applied directly to the negative op-amp input. Since no current flows into the op-amp input, the output voltage must be Vout = Itin X -Rf. The ideal low frequency gain of a current-to-voltage amplifier is

This gain has the units of impedance, and it is often called a trans-impedance. The current-to voltage amplifier is called a trans-impedance amplifier in figure.4.

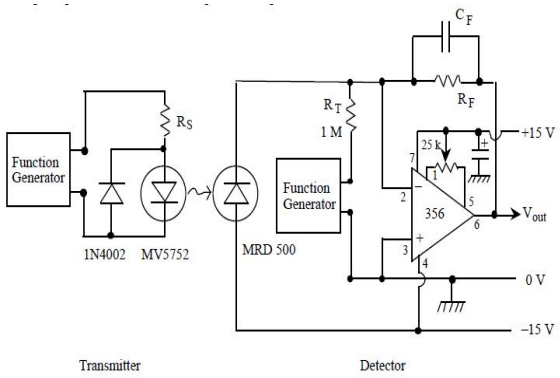

Figure.4. Light Transmitter and photodiode detector

The sensitivity Sl (in units of mA/(mW/cm2)) is defined as the photocurrent per unit light intensity incident on the photodiode. It is a function of the light wavelength l. Thus for light intensity N (in mW/cm2) the photocurrent I (in mA) is given by

The sensitivity at any wavelength l is given on the data sheet in terms of the peak sensitivity at 800 nm times a correction factor called the relative spectral response, or RSR:

E. Methodology

- Li-Fi is a new paradigm for optical wireless technology to provide unprecedented connectivity within a localized data-centric environment.
- The increasing demand for higher bandwidths, faster and more secure data transmission as well as environmental and undoubtedly human friendly technology heralds the start of a major shift in wireless technology, a shift from RF to optical technologies.

- You have a light on one end (an LED in this case), and a photo detector (light sensor) on the other. If the LED is on, the photo detector registers a binary one; otherwise it's a binary zero.
- Flash the LED enough times and you build up a message. Use an array of LEDs, and perhaps a few different colors, and very soon you are dealing with data rates in the range of hundreds or megabits per second.

III. SIMULATION STUDY

A. *LED output with Software*

For historical reasons, illumination engineers have also retained a cousin of the lumen, the candela. These will which is the same as the lumen per steroidal, measures luminous intensity in a particular direction. Both the candela and the lumen are best illustrated by imagining a standard candle as an isotropic source of light. The candle emits a total of 4π lumens which is l lm/sec or 1 cd in all directions. Place a mirror right behind the candle. The luminous flux is still 4π lm, but the luminous intensity is now 2 cd in front of the mirror (and 0 cd behind).

We now rewrite the last equation as a relation between radiant and luminous intensities:

Relative response of any LED can be drive using above status of luminous intensity.

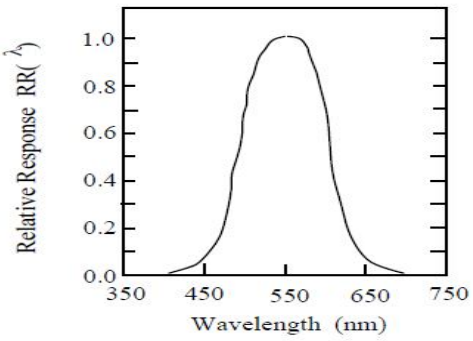

Figure.5. Relative response of adjusted human eye

Suppose now we place our photodiode a distance d from the LED, and we want to find the intensity H (mW/cm2) at the photodiode. We first find J in milli candela on the LED data sheet. The data sheet will give the dependence of J (mcd) on the diode current and on direction. We then convert J(mcd) to J (mW/str), using Equation and RR(l) for the appropriate wavelength. (For our LED, RR(635 nm)=0.2.) Finally we divide J (mW/str) by d2 to get H (mW/cm2).

Below figure.6 shows the hardware module of prototype which consists of two PIC16F877A microcontroller with sensor module which reacts with more light energy also with intensity of LED lumination.

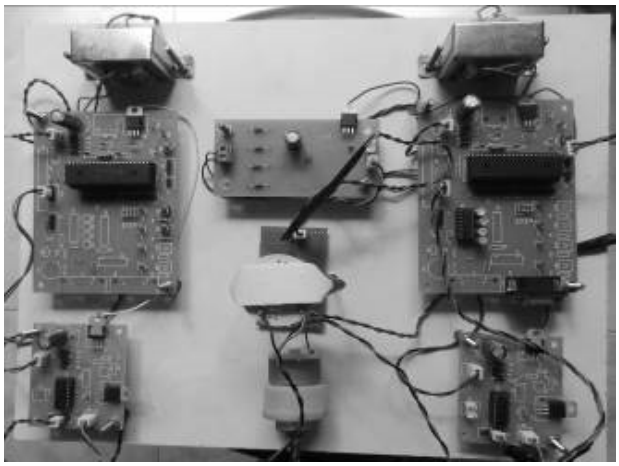

Figure.6. Hardware working kit

IV. CONCLUSION

Li-Fi based LED prototype is working as input light varies according to the light illumination brightness, thus corresponding d.c volt changed and output will respond to the input from LED. This output this recognized from d.c motor with load condition, for further future concept with advance Controller which support Giga bit Ethernet for perfect data communication.

Graph output shows the illumination changes with respect to the light intensity vs. voltage, for further studies this paper help for research in data transfer with light intensity in underwater communications like submarine, military & defense purpose.

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