Deep Water Communication Using Light Fidelity (Li-Fi)

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Abstract- Communication has been a crucial part of present and future upcoming. It is been pushing the today's world by the evolving and never halting momentum of wireless communication systems. Considering the underwater communication as of now there exists no such a reliable and an ideal technology for human interaction. Also, the congestion in the Radio Frequency Spectrum discourages the lookout for such an efficient technology. Also, it is practically next to impossible to create a place for such a set of customers and service providers with the interest in underwater domain. Although this situation seems to be pointing to a tough spot, there's an emerging field that could possibly a favorable and a reliable mode of communication for these needs. Light Fidelity also known as LiFi can be an alternative. LiFi, is a field of wireless communication and transmission of energy waves carrying information optically. Also, for a case, it can be a replacement for Wireless Fidelity (WiFi) as LiFi being a higher intensity wave transmission is capable of providing higher rate, capacity to utilize its bandwidth to the fullest and the covers more bandwidth spectrum than that of Radio Frequency. This literature survey will try to explore the different aspects of the Li-Fi based underwater communication system, by exploring the recent study regarding same and will also mention a probable system for a Li-Fi based communication that could be practically achievable with consideration of the capabilites to handle multiple users for a unit coverage area.

Index Terms- Light Fidelity (Li-Fi), Deep water Communication, Visible Light Communications (VLC), Wireless Fidelity (Wi-Fi).

I. INTRODUCTION

Light Fidelity (Li-Fi) is the upcoming exemplar of revolution one of the usual human behaviors in attempting to explore the higher frequency bandwidths, [2] in the field of bounded wireless communication. The hypothesis that can be claimed as a basis for this technology led to a probability that the data can be transmitted with the help of light emitting diodes (LED) with a controlled transmission rate achievable by adapting the light intensity which varies way much faster than the observation capability of an average human eye [1]. For such a system, the light emitted and managed through the LED panel can be a reliable source as well are target for transmission and reception of data simultaneously. The coverage for such a case can be varied by increasing or decreasing the number of diodes that boosts the intensity of energy wave which in hand boost the transmission rates

The Journal of Light wave [1] mentions about the varying behavior of the communication system with the change in the distance between LEDs. Just briefing on some of the concerned research and studies I have tried to put this note in a way that covers What exactly Light Fidelity can be interpreted as by going through every necessary building unit for these systems to fulfil the need of setting up a Wireless Communication system. This kind of system can be referred to a nanometer wave communication as the light energy spans the wavelength of 400nm - 700 nm capable of functioning both as a transmitter as well as receiver. Even though the term LiFi comprises of light, it highly differs from Visible Light Communication [2]. Where LiFI tends to be a multiuser system, VLC has applications limited to point-to-point communication. In addition to that LiFi can be a full-fledged networking system. As LEDs play a crucial role in the propagation of energy waves, selection of these LEDs has a considerable impact on the systems efficiency. Attributes like the number of LEDs per unit area, the ability to change the state (I.e., ON/OFF) with a rapid rate. The size of LEDs also impacts the speed by which the data is transmitted.

II. LI-FI BASED UNDERWATER COMMUNICATION SYSTEM OVERVIEW

2.1 TRANSMITTER & RECEIVER

LED Bulbs as mentioned earlier are an ideal and most efficient transmitter being an energy efficient option with less explicit architecture needed. The ideal option for the driving transmitter devices is the incomprehensible solid-state lighting LEDs specifically due to the low-price and high availability in current markets. Because of these component's unique limitations and capabilities, transmission of cryptic data can only be achieved by the intensity of the light. This is possible by opting for the energy waves that differ in frequency. On a simpler term by opting colored lights. But if we talk about a reliable and efficient technique, only LEDs emitting blue light is essential for such a model. Considering speed, 1 Gbps can be attained using phosphor-coated white LEDs [4] and 3.4 Giga bits per second by the red green-blue (RGB) LEDs [5], the highest speed that can be ever achieved from a single-color incoherent LEDs is 3.5 Giga bits per second as of in air medium. But considering this model data speed

can be kept as a secondary need. A white light emitting diode is to usually made of blue LED with yellow phosphor coating. When a beam of blue light passes through yellow phosphor coating layer it becomes white light. Another option is can be a blend of red, green and blue (RGB) LEDs [3]. With appropriate and measured use of red, green and blue a white can be fabricated. As the light emitted by LEDs are incoherent in nature, there is a necessity of **Intensity Modulation** (IM). In IM signal, the optical power output of a source is varied in accordance with some characteristic of the modulating signal. This signal is received at a receiver by using **Direct Detection (DD)** method.[4] Here, a photodiode would be responsible for the conversion of optical energy to a proportional voltage level.

As Li-Fi transmission using Avalanche Photo Detector as receiver with Tx wave Intensity Modulation or Direct Detection is a preferred choice when compared to a PIN photodiode LiFi communication model [3].

2.2. MODULATION

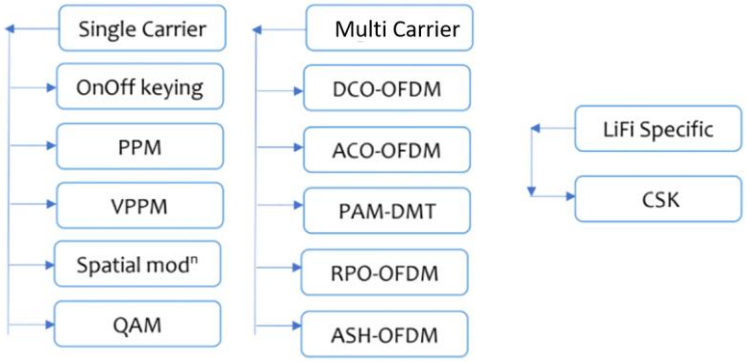
Primarily, Li-Fi based systems uses dimming based modulation schemes which are single carrier-based modulation techniques. The necessary data rate for transmission is achieved by On-Off state of the LEDs on the backend monitoring the voltage levels. Pulse Width Modulation, On-off keying, Pulse position modulation, Variable pulse position modulation, optical spatial modulation and Overlapping PPM are the major approaches for dimming based modulation[13].

On the other hand it is possible to tramsit data at higher data rate by using multicarrier modulation but it leads to more energy loss during transmission which can be a concer as the main problem to tackle in LiFi is the coverage area. Though the preferred approach for such modulation is Orthogonal Frequency Division Multiplexing (OFDM) , it has bipolar behavior. So, it demands few changes in the traditional system to implement the OFDM for Light Fidelity with efficiency at its acme. In “OFDM visible light wireless communication based on white LEDs” author proposed an Asymmetrically- Clipped Optical (ACO) OFDM in which odd subcarriers are modulated DC- biased Optical OFDM is a scheme in which all subcarriers are modulated and unipolar signal is generated by adding positive direct current [13] being more energy-efficient when compared to DC-biased Optical OFDM. The overall performance of these OFDM modulation techniques hs a affectation due to the non-linear relationship between the LEDs and the current supplied to it [13].

The need for the communication and illumination can be achieved by these modulation techniques when combined with the diiferent wavelengths of light energy i.e. multicolor lights. A scheme named Color Shift Keying (CSK) [8] relies on the encoding of color intensities emitted by the RGB LEDs. The constant color is maintained by mapping the transmitting bits in to instantaneous chromatics of LEDs to ensure constant luminous flux. CSK has Reliability on LED performance due to constant luminous flux and has no flicker effect over all frequencies. In “OFDM visible light wireless communication based on white LEDs,”[8] author mentions the Metameric modulation (MM) that is capable of modulating data in the visible spectrum while maintaining a constant lighting state. MM has a better Color quality control and higher energy efficiency. Color intensity modulation (CIM) proposed in [8] provides dimming in color space. CIM also satisfy the need of color matching and increases the data rate in signal space for multicolored LED based system.

Considering the Modulation techniques, they can be categorized as;

- Single Carrier Modulation
- Multi - Carrier Modulation
- Li-Fi specific Modulation



HISTORY & STATE OF THE ART:

Basically, the concept of Li-Fi was been proposed in the 1960’s considering theoretical approach but was unable to produce a practical product as of the date technology for artificial light was “Tungsten Filament bulb”.

This technology led to a meaningful technology, as the LED was invented and hence technology of LiFi was invented and proposed by Prof. Dr. Harald Hass in TED Global, March 2011.

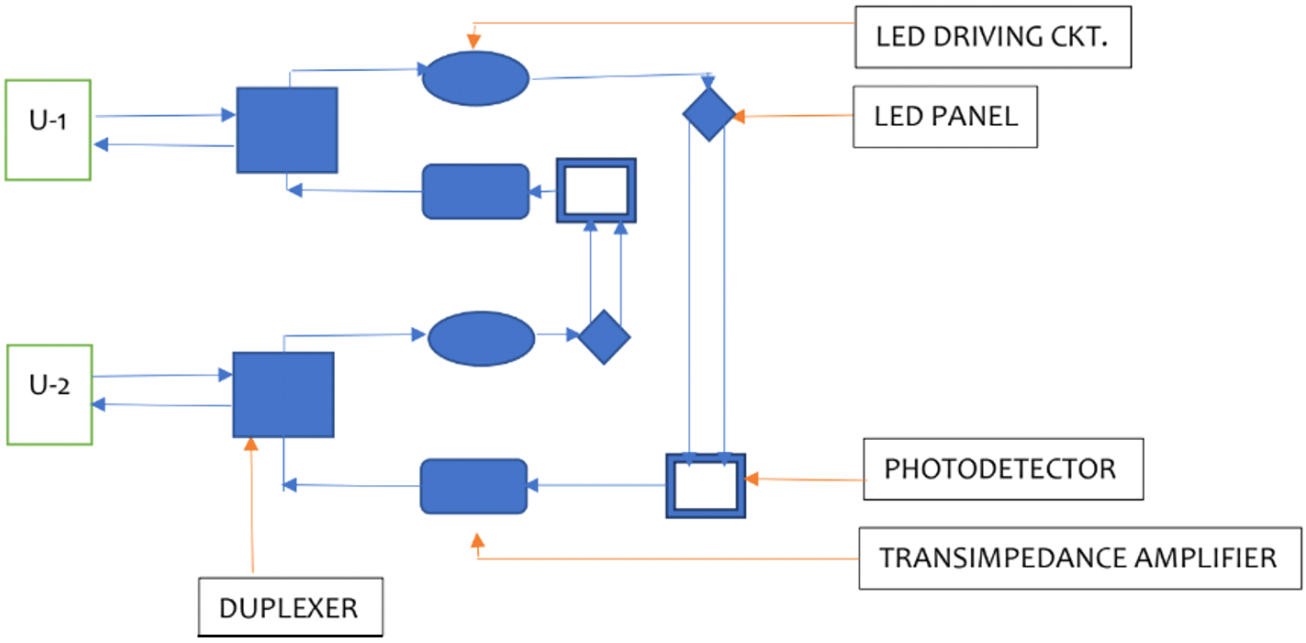
So, the first working prototype of LiFi was made by “Pure LiFi” a university-based Organization by University of Edinburgh. But the prototype was used for the air medium.

DEEP WATER:

The area below 1000 meters of the sea water surface is the area named “Deep water”. This is the area where the Radio Frequency is of no use for any of the technology. So, currently there is no mode of communication underwater so the only option for such a technology is communication through Light waves but in order to achieve a point to multipoint or multipoint to point communication using Light Fidelity.

Currently Visible light communication systems are in existence but such systems limit to point to point communications.

PROBABLE SYSTEM:



So, the above system provides an underwater communication system. Both the user uses duplexer as it is needed to communicate and receive data at both the sides. The arms have amplifier and led driving circuit each for modulation and receiving purpose respectively.

So, for a case the sound signal from use is transmitter through duplexer to decide the condition of transmitting or receiving. On the basis of selection, the data is further transmitted to;

- LED driving Circuit:

This device does convert the sound data to digital data i.e., logical 1's and logical 0's according to the base of intensity of light which is directly based on the electrical signal produced by the sound waves.

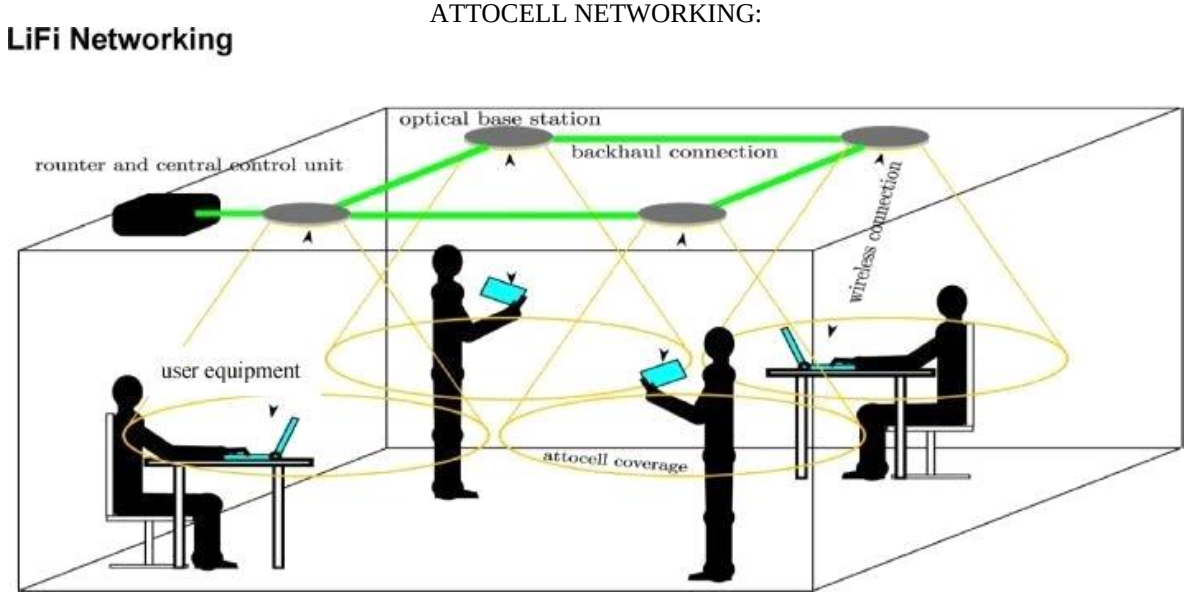
- Trans impedance Amplifier:

This is the case for transmission, here the data is modulated in order to prevent data loss during transmission and then passed to LED. The led glows on the basis of parameter considered for modulation providing a logic 1 or logic 0 digitally.

Following is the data conversion i.e., sound to digital data conversion

CELL NETWORKING:

ATTOCELL NETWORKING:

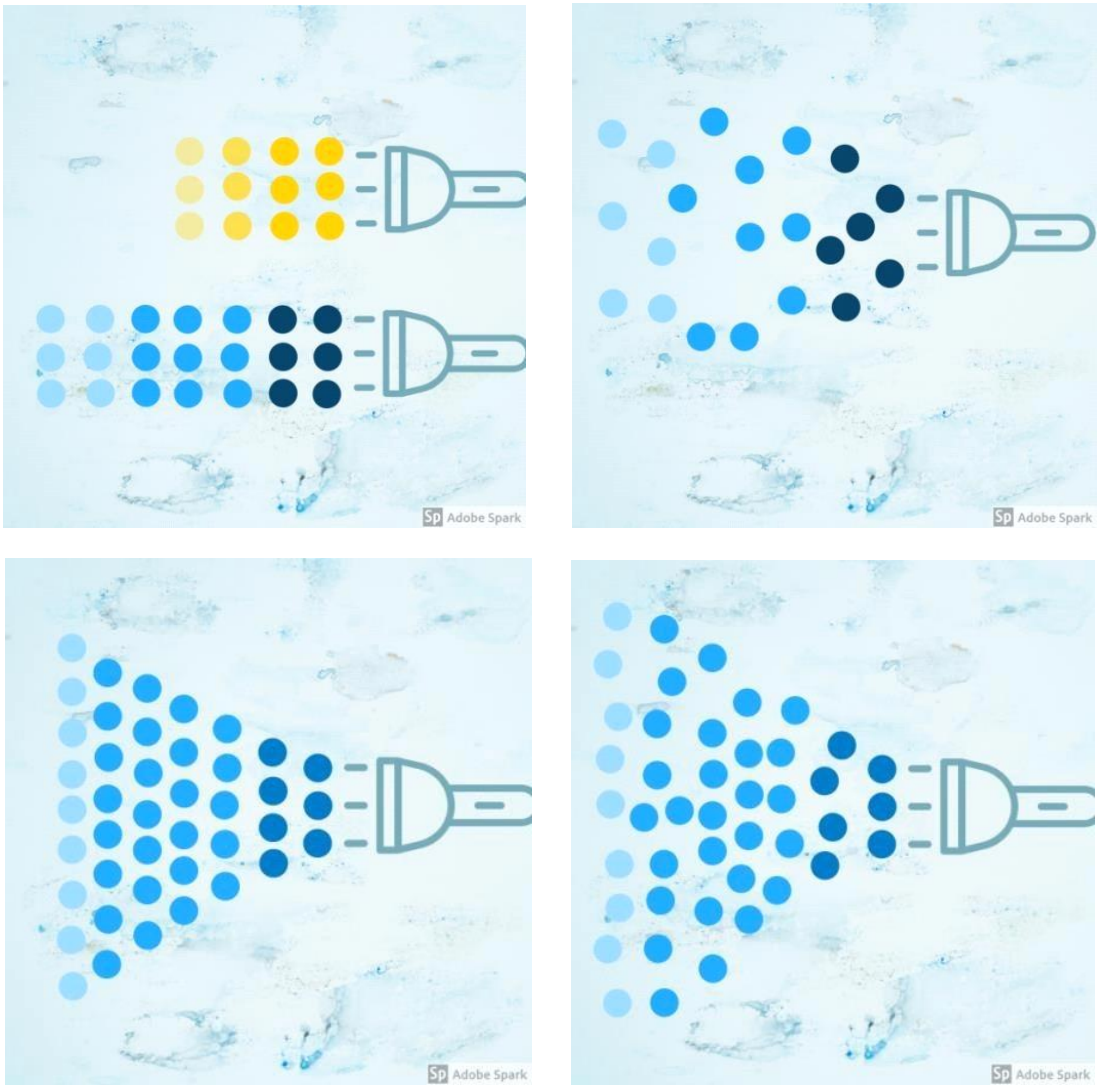


Basically, Cell relates to a term related division of an area under substations named Base Station (BS). Generally, the Cell for mobile communications is a Hexagonal Cell Network. But for LiFi Communications the Cell networking used is called Atto Cell

Networking. So, this Cell Networking is used for the simple handover strategies.

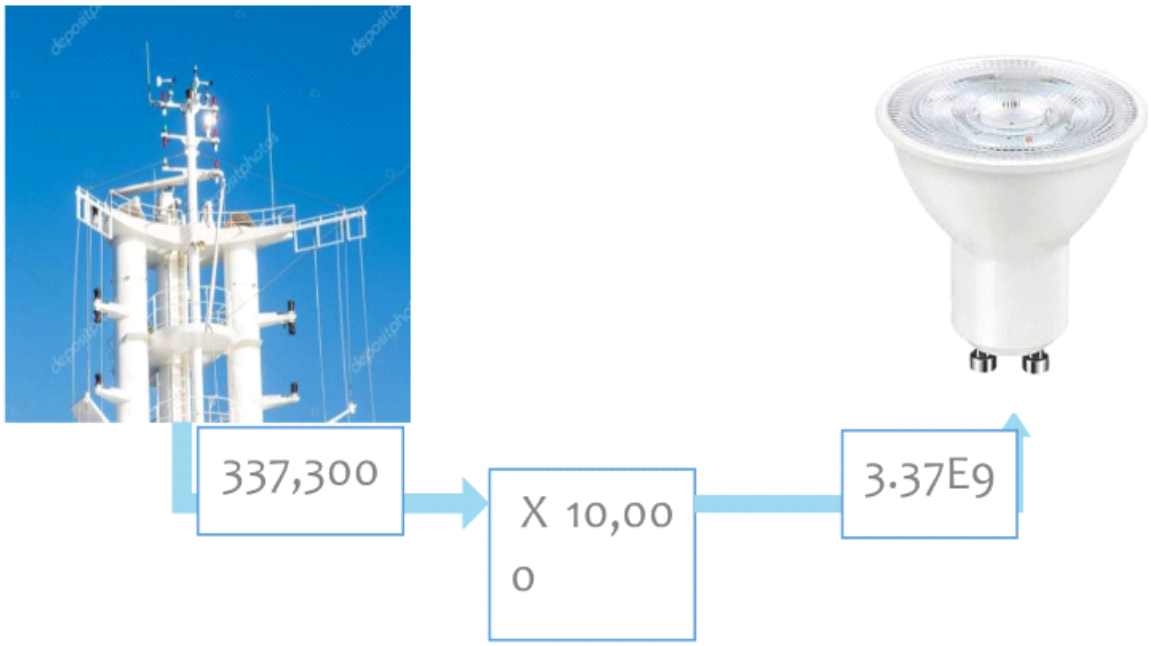
Handover is the technique used for the user when crossing a cell to another and hence is needed to be registered on the moving cell. So, Atto cell has a round coverage with decreasing luminous intensity as we go far from center of source and its usual case for interference. So, Router comes into work here by continuously monitoring the intensity value of an average transmission. So, during interference the user gets registered under the server providing high value intensity or above threshold value.

CHALLENGES IN DATA TRANSMISSION:



ARCHITECTURE REQUIRED:

According to [12] there exists total number of 0.337 millions of antennas used for communication and as the Radio Frequency is highly congested. So, 0.337 millions of antennas utilize complete RF so multiplying by 10,000 (as the visible light obtained is 3.37 billion which is very much low as of the global production till a new LED working gets useless. So, the major architecture needed for this system to accept globally is in our surroundings just there is a need of chip consisting of transmitter & receiver.



III. CONCLUSION

A scenario based LiFi system design is achievable with unit coverage area measured as cells. We can control the coverage area by considering cell size, cell shape, and light intensities. We have also presented an overview of LiFi based underwater communication system. LiFi based system can potentially be a more efficient substitute for RF based communication with an implicit ability to turn every LED in use to be a wireless transmitter and receiver itself promoting the use of LiFi. Though the implementation requires a massive initial investment, the throughput when implemented on a macro or even a wider area network scale has higher probability of compensating it. Considering current limitation of the reach of the transmission waves, LiFi would demand an advance research to overcome this to be on the practical side of its use.

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