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# Design of Clean and Green Smart Visible Communication System with LED/LASER

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***Abstract – With the advancement of the ICT services and their impact in all sphere of life is well acknowledged by the society. Innovation and automationhas developed an advanced communication system. Demand and necessity in the acquiredtechnology is uprising vertically andhorizontally in terms of development of the nation andits economy. Today wireless communication has become the integrated part of our life, whether it is professional or personal. With highly increased demand of data , many new service provider have increased significantly and as a result capacity of micro wave spectrum is drying up and interference has become a major problem, in addition of use of microwaves are restricted insome area like aero plane,under water etc.To prototype the frame work of national vide communication channel to meet the demand of the ICT service by the society and the requirement ofEnergy to meet and sustain the frame work of communication Technology.***

***LI-Fi may play an important and vital role to innovate the communicate techniques. LI-Fi Communication Technology has overcomes all the drawbacks of existing Wi-Fi technology.Present paper enlightens the issues and solutionto prove the LI-Fi as one of the pioneer technology and also comparison of different sources used in the same. Li-Fi based on light spectrum so LED and Laser can be used as Source. Both have some pros and cons.We havedone experiment with both and result is summarized.***

***Keywords- Microwave, limitations, Li-Fi, BTS, OFC, Electro Magnetic Interference, Spectrum***

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## 1. INTRODUCTION:

Communication systemhas been employed to transfer the data and information between source and destination. Nowadays communication system has becomethe essential part of our life. It is not only needed for entertainment but also in allimportant field like education, business, airtrafficcontrol, satellite etc. It's not possible to run this world withoutcommunication even to each other for one day. Time the communication was only form of speech so used to cover small distance. With the time, technology also developed and a better way of communication with cables started, which was more efficient and covered more distance than before. Later advance version of this was adopted i.e. OFC (Optical Fiber Communication). OFC was more secured, fast, compact, easy to installed and less costly, but the only drawback was wired. So we moved to wireless communication through microwaves. Microwaves have overcome all limitations of previous mode ofcommunication but due toincreasing demand of data the spectral becomes sodense that Electro Magnetic Interference is increasing rapidly and any time lead to network crash. Furthermoreelectromagnetic waves has hazardous effect on humanbody.By taking all these issues in account weare trying to use this new mode of communication called Li-Fi, which is a wireless communicationsame as present with only difference of wavelength,here we are using visible light spectrum in place ofmicrowave which overcomes all shortcomings listed above.

## 2. LITERATURE REVIEW AND STUDY:

LASER and LED are used as reliable sources of communication in Visual Light Communication (VLC). However, LASER is used more often due to its inherent properties over LED. LED is also limited by distance even though it forms a relatively cost effective wireless transmissionlink. Blue – Greenlaser is good choice for underwater communication. In these paper we have done experiment with LED and different color of laser and observed the speed, the distance covered, spectrum width and many more parameters.

## 3. THE TECHNOLOGY AND TECHNIQUE USED IN LED /LASER BASED LI-FI COMMUNICATION SYSTEM

### Experimental set up

The information from a personal computer (PC) in any kind of format is first coded into a string of pulse electrical signals by microcontroller (MCU) using the interface circuit. These signals drive LED using a LED driver circuit. As a result, there will be signal conversion from electronic to optical level. Due to flickering property of LEDs, the information and light will only be appearing as normal light from an LED for an observer. This information is then send over the channel depending on the various channels we have to experiment on. Our channels include, air, fresh and saline water. At the receiver, the photodiode will detect the optical signal and then convert into electrical signal. The signals thus detected can be amplified using an amplifier setup. The data thus receiver after amplification or signal processing will be send to thePC receiver using the RS -232 interface. The experiment is repeated in 3 different scenarios.

## 4. EXPERIMENTATION AND OBSERVATIONS

The effect of interference is high as the communication is involving light. The communication is limited by factors like distance, number of proper receivers, effect of saline water in underwater communications etc. Different digital modulation schemes are deployed to reduce the signal error rate and enhance the received signal power. Theunderwater communication was a real challenge due to the effect of saline water. Thedistance measured between transmitter and receiver was different in clear water and saline water. Results are plotted in table 1.

| Distance between transmitter and receiver (cm) | Clear water (data status) | Saline water (data status) |
|---|---|---|
| 5 | Yes | Yes |
| 10 | Yes | Yes |
| 15 | Yes | No |
| 20 | No | No |

**Table 1: Comparison Clear water and saline water**

There should be line of sight between the transmitter and receiver. Else the communication will be suspended. The speed of transmission and the size of LED are related inversely. A simple microchip LED can generate speeds up to 150 Mbps. A LED smaller than that can generate speeds in Giga Hertz range. The field of view should be less to have a better performance. Field of view is the angle of spread from the light source. Variation of intensity is a challenging factor which is depending on the distance between transmitter and receiver. When we increased the current to the LED, the intensity was good and it yielded better results. But it will damage the LED. When LEDs (white LED) are used for communication, the range was very less; in the order of centimeters. When replaced by LASER (650 nm red dot) the range substantially increased to several meters.

The effect of natural light was found minimal as the receiver is capable of distinguishing the flickering of LED from natural light. Still, experiments in dark environment gave fast and clear results. The temperature ranges while experiment was conducted was in the range of 25 to 30degrees. When more LEDs were attached to the transmitter thus forming an array of LEDs, it is found that there is significant amount of Inter Symbol Interference in the received signal due to spread of the signal. The use of directive LEDs reduced the interference to a good level.

The numbers of LEDs were then increased to three to see how the distance affects faithful reproduction. The distance, as expected is a factor as the information was not received after a particular distance. The details are listed in the table. The PIN photodiode was used and MSM metal semiconductor Metal photodetectors were also used while testing. OmittedAvalanche photodiode due to cost.

| Distance between photo diode and LED | Faithful reproductive |
|---|---|
| 1 | Yes |
| 5 | Yes |
| 10 | Yes |
| 20 | Yes |
| 30 | Yes |
| 40 | Yes |
| 50 | No |

**Table no 2: Distance between transmitter and receiver outside water**

We also measured signal intensity using an LED array and function generator setup andholding the receiver at a distance to measure the maximum

distance of signal reception. The results are shown in the graph

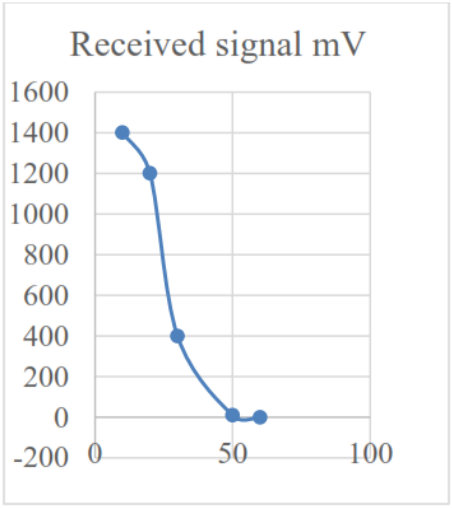


**Figure 1: Showing Received signal strength vs. distance**

The received signal is in mille Volts and it's plotted against distance in centimeters. There was minimal background noise as the transmitter and receiver were arranged properly.

The experiment is repeated underwater and the transmission distance was poor in the range of few centimeters. So, repeated the same experiment with LASER to get a better result. The blue green LASER with a wavelength of 470-570 nm was used for the purpose. The result thus obtained is shown in graph. The measurement is made around 10 times and the number of successful data transmission were plotted for a distance of 1 meter between transmitter and receiver.

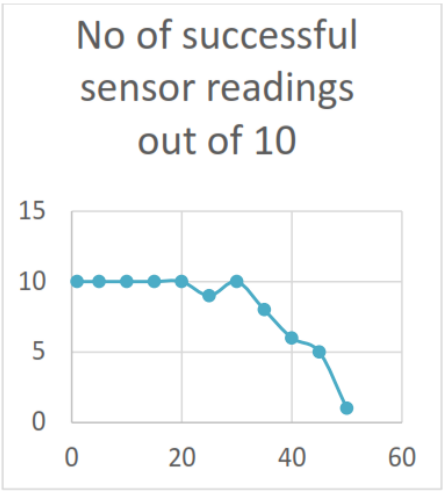


**Figure 2: Showing Faithful reproduction under water using LASER**

LEDs like an array there are chances of inter symbol interference and performance degradation. Although LEDs are a cheaper option in underwater communications, LASERs proved to be more effective considering the distance that can be covered.

*Special Observations Effect of Natural Light*

- The natural light doesn't seem to disturb the receiver much which made the communication smooth.(while using LASER)
- When repeated the experiment in dark, the received image was a little better than when received in light.
- The effect of any sort of obstacle completely disturbed the image and the image was failed to be reproduced
- The issue while transmission was time which is limited by factors like baud-rate, LASER used, Modulation schemeused, photodiode used etc. The transmissionwasnot proper/possible with higher baud rates used.

There are methods to convert using different sources. LASER is preferred over LED when transmission distance is more. Transmission can be done and modulation schemes can be enabled to have a better performance. LED source is relatively cheap and can be implemented when such applications are to be dealt.

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