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Design and Implementation of Under Water Optical Communication System

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ABSTRACT--- Underwater optical communication has become a promising technology for transmitting data in underwater environments. The technology involves the modulation of a light source to carry information, which is transmitted through water to a receiver. However, the challenges of attenuation and scattering of light in water pose significant obstacles for the technology. To overcome these challenges, various techniques such as high-power lasers, wavelength division multiplexing (WDM) techniques, and adaptive optics have been developed. The technology has significant potential for various applications in marine biology, oceanography, defense, and offshore industries. Further research and development in this area can lead to the improvement of the technology, making it more reliable and efficient for under water communication.

KEYWORDS – WDM, Under Water communication, visible-light communications, ocean optics

I. INTRODUCTION

Modern wireless communications is characterized by a relentless demand for high-end services like security, reliability and high-speed transmission. Reliable communication over wireless channels is achieved by employing channel coding and diversity. There seems to be a never ending demand for wireless services and this has led to the requirement of very high data rates to be sustained over wireless channels characterized by severe impediments (such as signal fading) and limited bandwidth. This has led to the design of terrestrial free space optic (FSO) systems which can sustain high data rates without any spectrum licensing issues. In addition to terrestrial FSO, there has also been an increased interest in underwater optical communication (UWOC) due to its possible applications in strategic and military domains. Such a system can allow for reliable and high data rate short distance (several tens of meters) information transfer between under water vehicles or between under water vehicles and shore installations. This has motivated us to take up experimental studies on the design of high speed reliable under water communication systems. In recent years, interest in UWOC and its possible applications has grown

enormously. Both theoretical and experimental studies have been reported. Djordjevic and Wang have given a detailed description of the terrestrial free space optical channel and have suggested channel coding schemes for the same.

Inspired by this work, we have started experimental studies on UWOC. We will work on various aspects of setting up of UWOC links such as the alignment and tracking problem, synchronization problem and the problem of designing appropriate channel coding/MIMO and interleaving schemes to improve the reliability of link. In this report, we have described the progress done so far in setting up the underwater channel, making provisions for introducing turbulence and blockage (to simulate such events in the actual channel) and some channel codes/interleaving that have been synthesized to improve the reliability of information transfer. The remaining part of the paper is organized as follows. In Sect. 2 the description of the system model is presented, Sect. 3 provides a description of the experimental setup and specifies the arrangements made to set up random and burst errors in the channel. Section 4 presents a discussion of the BCH code and interleaver arrangement used to minimize the effects of random and burst errors introduced by turbulence and blocking.

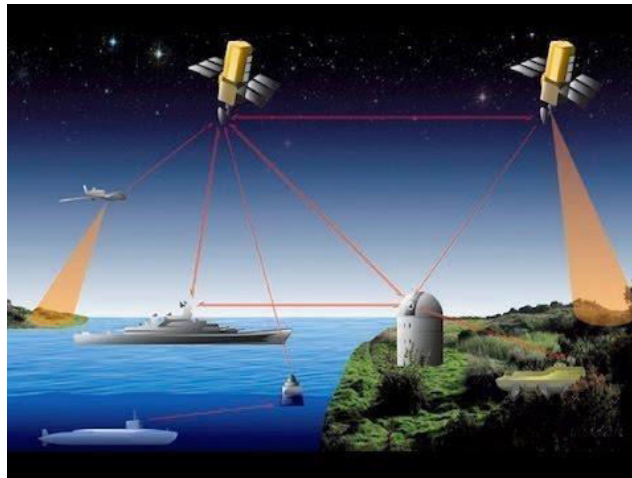


Figure 1. Typical application scenarios of UWOC.

II. EXISTING SYSTEM

Free space optics (FSO) is a method of optical communication that uses light to transmit data wirelessly through open air or vacuum, rather than through a physical medium such as fiber optic cables. The technology uses lasers to transmit information, which is modulated onto a beam of light and transmitted through the air to a receiver. The technology has many potential advantages over traditional wired communication, including high bandwidth, low cost, and flexibility.

The main challenge of FSO technology is the interference of light by atmospheric conditions, such as fog, rain, and snow. These conditions can scatter and absorb the light signal, leading to errors in data transmission. Additionally, the alignment of the transmitter and receiver is critical for effective communication, and any obstacles between them can cause signal loss.

Various techniques have been developed to overcome these challenges, including adaptive optics, which can adjust the beam of light to compensate for atmospheric interference, and diversity reception, which involves using multiple receivers to improve the reliability of data transmission. Furthermore, hybrid FSO and radio frequency (RF) communication systems have been developed, which can provide redundancy and increased reliability by switching between FSO and RF communication depending on the atmospheric conditions.

FSO technology has many potential applications, including high-speed wireless internet, backhaul connections between cell towers, and point-to-point communication in remote areas.



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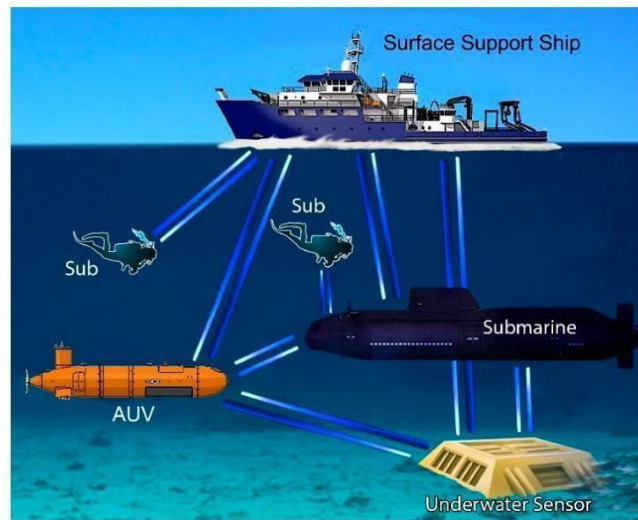


Fig 2:Free Space Optical Communication

III. PROPOSED SYSTEM

A system called "underwater optical communication" has been developed that would send data via water using light. Using this technology, information is conveyed via water to a receiver by modulating a lightsource. In comparison to conventional underwater communication techniques, the suggested system has a number of potential advantages, including more bandwidth and quicker data transfer rates.

The suggested system can employ a number of approaches, including high-power lasers, wavelength division multiplexing (WDM) methods, and adaptive optics, to overcome the difficulties given by the attenuation and scattering of light in water. High- power lasers can extend the range of transmission and lessen the impact of scattering, and WDM techniques enable the transmission of numerous signals across the same optical fibre utilising several light wavelengths.



Fig 3: Under Water Optical Communication System



Overview:

Underwater optical communication systems use light to transmit information through water. The basic principle of the technology involves the modulation of a light source to carry information. The modulated light is then transmitted through water to a receiver, where the information is extracted from the light signal. The primary advantage of using light for communication underwater is that it has a higher bandwidth than acoustic communication systems, which are

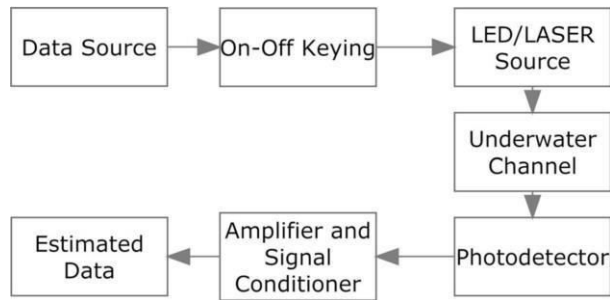


Fig4:Basic UWOC Block diagram

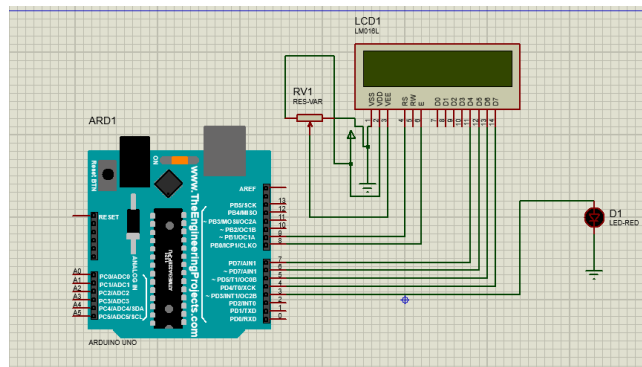
Challenges:

The main challenge of underwater optical communication is the attenuation and scattering of light in water. Water absorbs and scatters light, making it difficult to transmit signals over long distances. The scattering of light causes the signal to degrade as it travels through water, leading to errors and loss of data. Furthermore, water contains various particles and organisms that can cause additional scattering and absorption of light. Another challenge of underwater optical communication is the effect of turbulence on the light signal. Turbulence can cause the light signal to become distorted, leading to errors in data transmission.

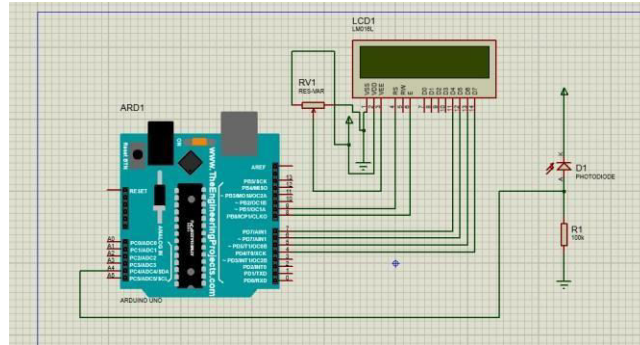
Solutions:

To overcome the challenges of underwater optical communication, various techniques have been developed. One solution is the use of high-power lasers, which can increase the range of transmission and reduce the effect of scattering. Another solution is the use of wavelength division multiplexing (WDM) techniques, which allow multiple signals to be transmitted over the same optical fiber by using different wavelengths of light. Additionally, adaptive optics can be used to compensate for the distortion caused by turbulence in the water.

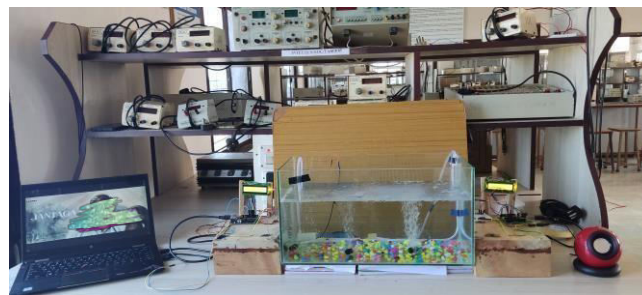
Designing of Transmitter Circuit:



Designing of receiver Circuit:



Experimental Setup:



IV. RESULTS

The output of the project is divided into two parts:

1. while transferring Audio
2. while transferring Text

outputs and input wave forms while transferring Audio through Under water channel:

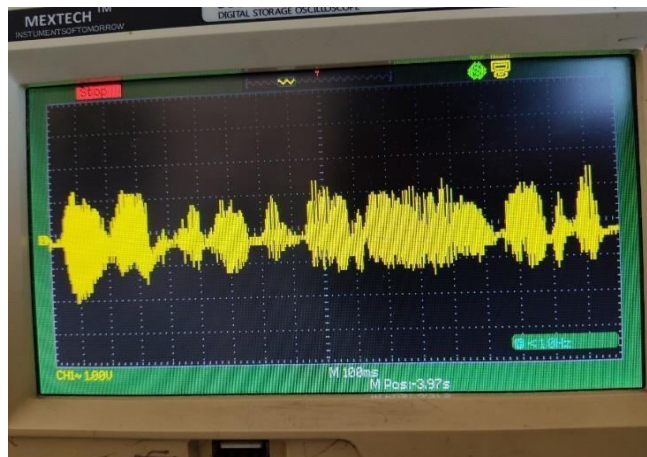


Fig6:Waveform at transmitter Block



In this Audio mode we have sent an voice recording of “WELCOME TO SVIET,NANDAMURU” ,which recorded by using Google’s Text to Speech service.

In this scenario ,the output wave form of transmitter has been recorded using an Digital Storage Oscilloscope (DSO).

The peak to peak voltage of waveform is 1V.The frequency is limited to <10Hz.

The LASER light intensity is being varied according to the variations in the Audio signal,this is an continuous time signal and the communication Is in Analog form.

The following figure shows the detailed view of the waveform, when it is zoomed in.

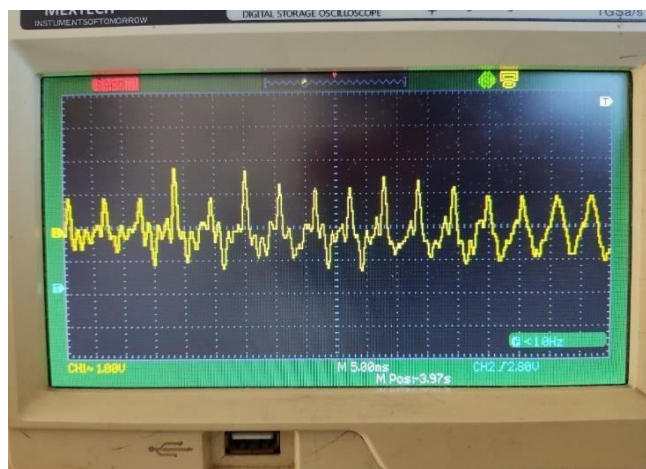


Fig 7: Transmitter output wave form

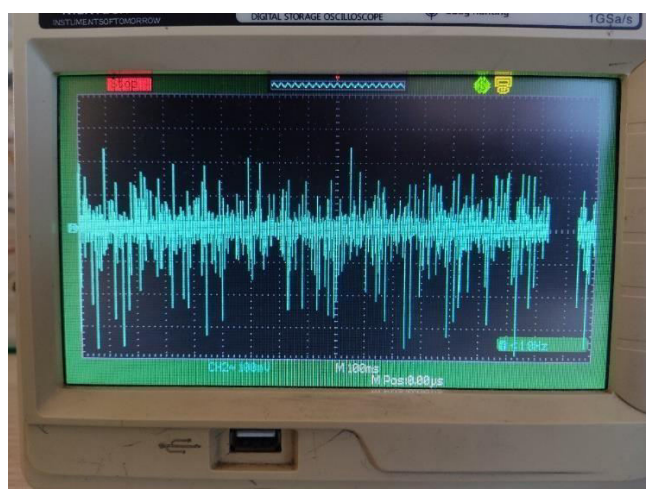


Fig 8: Waveforms of receiver

From the received signal ,we can observe thefollowing

- The strength of the received signal is 100mv,which is very less than the transmitted signal (1V).
- The frequency of the signal remains at <10Hz.



- The detailed view of the received waveform is given below.

WHILE TRANSFERING TEXT THROUGH THE CHANNEL

- To transfer text using LASER, we have used on-off keying modulation, which is basically turning the LASER ON when we want to send logic high (or) 1-bit, like wise turning OFF the LASER will give us the logic low (or) 0-bit.
- The entire modulation is achieved by using an Arduino uno Board, which converts the input text into ASCII and then turns the LASER ON and OFF according to the ASCII data of the text.

Transmitted text	Received text without Bubbles	Received text with Bubbles
A	A	A
B	B	B
C	C	C
D	D	D
E	E	E
F	F	F
G	G	G
H	H	H
I	I	I
J	J	J
K	K	K
L	L	L
M	M	M
N	N	N
O	O	O
P	P	P
Q	Q	Q
R	R	R
S	S	S
T	T	T
U	U	U
V	V	V
W	W	W
X	X	X
Y	Y	Y
Z	Z	Z
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8



9	9	9
0	0	0

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