UNDERWATER WIRELESS OPTICAL COMMUNICATION

Ranjith.M.S[1] | Vignesh Gopal[2] | Sabari.K[3] | Vijay Shanmugan.M.M[4] | Vinod.K.S[5]

[1](Dept of ECE, Anna University, Coimbatore, India, ranjithms31@gmail.com)
[2](Dept of ECE, Anna University, Coimbatore, India, vigneshviha@gmail.com)
[3](Dept of ECE, Anna University, Coimbatore, India, sabari.4466shaba@gmail.com)
[4](Dept of ECE, Anna University, Coimbatore, India, vijayhoney261096@gmail.com)
[5](Dept of ECE, Anna University, Coimbatore, India, ksvinod1@gmail.com)

Abstract— *The need for underwater wireless communications exists in applications such as remote control in off-shore oil industry, pollution monitoring in environmental systems, collection of scientific data recorded at ocean-bottom stations, speech transmission between divers and mapping of the ocean floor for detection of objects, as well as for the discovery of new resources. Wireless underwater communications can be established by Li-Fi technology. Underwater communications are a rapidly growing field of research and engineering as the applications, which once were exclusively military, are extending into commercial fields, the possibility to maintain signal transmission, but eliminate physical connection of tethers, enables gathering of data from submerged instruments without human intervention, and unobstructed operation of unmanned or autonomous underwater vehicles. Light signals can travel long distance without any obstruction in water, because of high speed of light, in underwater data communication is possible to increase the data rate using "Li-Fi" technology.*

Keywords— Under Water Communication; Opical Waves; Data Rate; Water Medium; Wireless

1. Introduction

Demands for underwater communication systems are increasing due to the on-going expansion of human activities in underwater environments such as environmental monitoring, underwater exploration, and offshore oil field exploration. There is also an increasing use of robotics in underwater missions in order to increase precision and operability. Remotely-operated vehicles (ROVs) and autonomous underwater vehicles (AUVs) are usually used in such applications and an important point is how to communicate with them. Classically, cabled or fibre-based techniques are used, which offer high speed and reliable communication. However, their use can be challenging in difficult-access locations and in deep sea as they will limit the range and maneuverability of the underwater vehicle. In such cases, there is a high interest in wireless communication techniques. Optical communication can provide unprecedentedly high data rates (on the order of Mbps to Gbps) for short and moderate ranges (up to several tens of meters typically) thanks to the large available bandwidth. Also, due to the high propagation speed of optical waves in water, optical transmission does not practically suffer from latency. Therefore, optical communication is an attractive alternative (or a potential complementary) solution to long range acoustic communication. As a matter of fact, underwater wireless optical communication (UWOC) uses the visible band of the electromagnetic spectrum (the spectral range of 450-550 nm), where water is relatively transparent to light and absorption takes its minimum value.

2. Related Works

High-speed underwater optical communication has now become an enabling technology that has many prospective employments in a range of environments from the deep sea to coastal waters. This development effort has enhanced infrastructure for scientific research and commercial use by providing technology to efficiently communicate between surface vessels, underwater vehicles and sea floor infrastructure [Farr et al., 2].

There has been a rising need for automating the underwater research applications. The proposed work is motivated by the idea of many works such as [Bales & Chrissostomidis, 3] in which the author proposed an underwater optical system using LEDs that is able to communicate at 10 Mbps over the range of 20m.

In [Smart, 4; Giles & Bankman, 5], the performance of wireless underwater optical communication in varies water types and at different range is studied using simple exponential attenuation model.

To perform under water task remotely operated device (ROV) and autonomous underwater vehicle (AUV) are used since 1950s.

3. Construction and Working

Transmitter and receiver are the key components of the system. Overview of the system design is presented in this section.

A. Transmitter

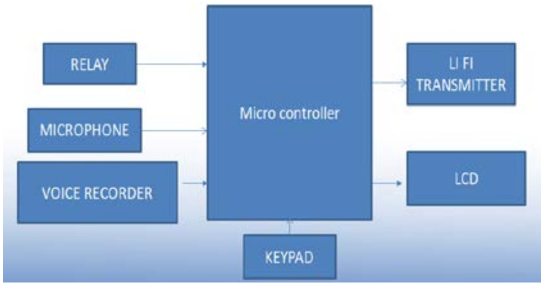

Fig 1: Block diagram

This section comprises PIC microcontroller, voice recorder, microphone, LiFi transmitter, relay, LCD and a keypad. The microcontroller acts the main computing unit. The voice input is fed into the system using a microphone and a voice recorder. The text data is pre-dumped into the microcontroller. The LCD indicates if the transmitter is in voice or data mode. Relay is used for switching between the voice and data mode. The type of input to be transmitted is controlled using the keypad. The system has to be power efficient, small sized, less complex and can transmit at longer distance that is why LEDs are a better choice due to their less cost, size, power and longer life time [Gabriel et al., 7; Gabriel et al., 8; Hanson & Radic, 9].

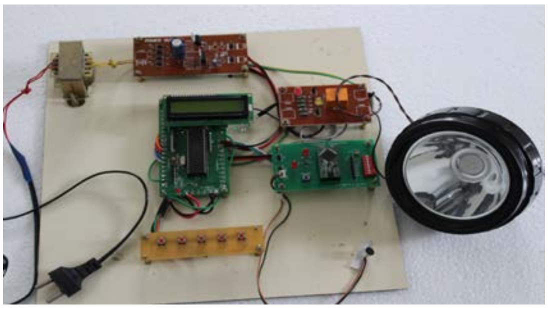

Fig 2: Transmitter

B. Receiver

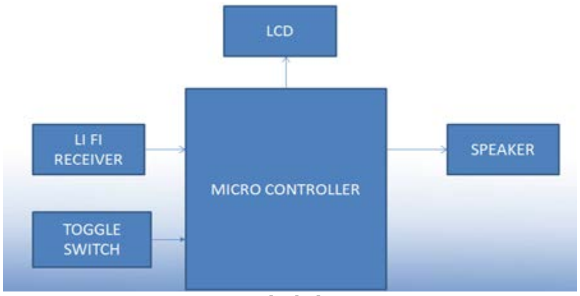

Fig 3: Block diagram

This section consists of Li-Fi receiver module, PIC controller, toggle switch, speaker, LCD. Receiver consists of detector and amplifier. The work of photo detector is to detect the incoming signal and the amplifier amplifies the detected signal [Shah, 10; Pignieri, 11]. The controller processes the received data based on the toggle switch input. When the toggle switch is set to text mode the controller will execute the code to process text input. While in audio mode the controller will execute the code to process audio data. Speaker is used to play the audio output and a LCD is used for text output.

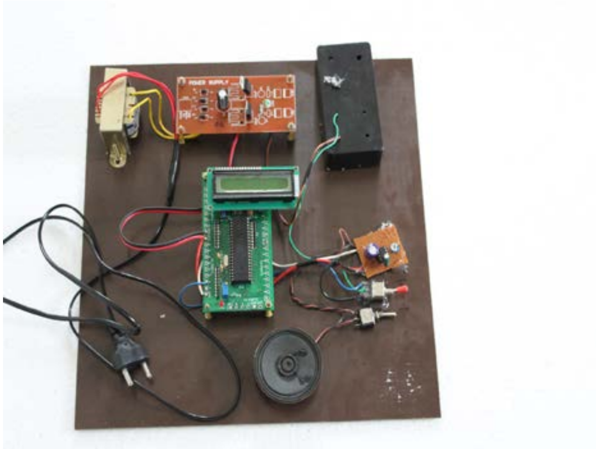

Fig 4: Receiver

4. OUTPUT

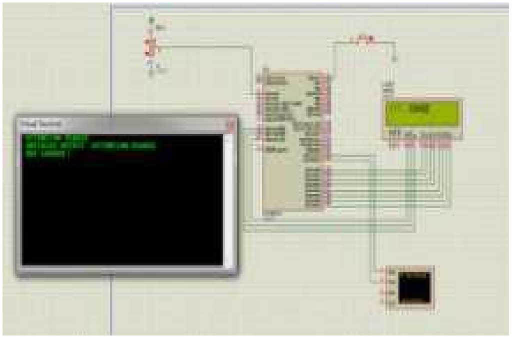

Fig.5 Simulation Output

The simulation of the project is done with proteus software and the compilation of the program is done using MPLAB IDE. The figure below is the simulation output of the project.

Figure 6 is the image of the working model of our project. It can be seen that optical waves passes through the water medium before being received by the receiver module.

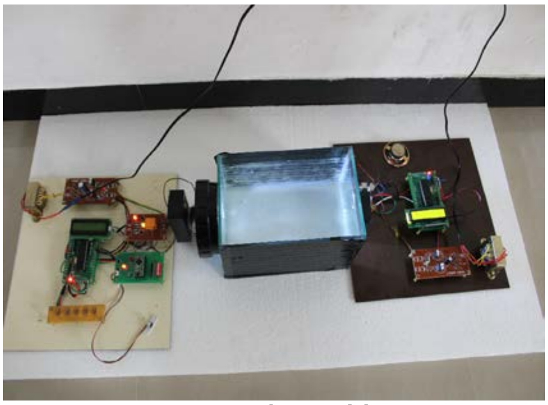

Fig.6 : Working Module

5. APPLICATIONS

A. In Submarines

Data can be transmitted between two submarines and obstacle in the path can be detected.

B. For Fisherman Security

Our System is useful for the fisherman also if the fisherman finds some problem in sea or his ship then he can send the message to the other ship or central authority.

C. Rescue Operations in Sea

If the rescue operation taking place in the sea then the one information can be transfer from one ship to another.

D. For Defense Operations

The proposed system is useful in the Defense operation. While Patrolling if the Unknown Ship is find in the sea then the patrolling ship also send the information to the Central authority.

6. CONCLUSION

Thus Li-Fi is used in place where high data rate is required at moderate distance. It is faster, cheaper and power efficient. It is useful for the ship to ship underwater communication at faster speed in Gbps. Our system is very cost effective so it can be more effective than the other systems like the Acoustic wave communication and Ultrasonic wave communication. So our system may replace the existing underwater communication techniques and it is better than the existing systems.

7. ACKNOWLEDGMENT

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