Smart Underwater Communication and Networking

PROBLEM STATEMENT:

The need to have a consistent method for underwater wireless communication and data collection is of foremost importance for monitoring underwater environment and exploration.

In Oceanography research, autonomous underwater Vehicles (AUV) and Unmanned Underwater Vehicles (UUV) are used to observe the environmental phenomena at a fixed location over a long period. But deep sea divers go underwater on different mission. They set out to document the underwater world or scientific diving, including marine biology, geology, hydrology, oceanography and underwater archaeology. Divers generally are trained to use hand signals to communicate within their group. They also use underwater writing boards, which allow better communication. Both these require light. If the water is murkier or if it is night time the communication becomes difficult. This leads to the need to provide low latency, high bandwidth

Communication method for underwater communication for divers. Underwater wireless communications can be carried out through acoustic, radio frequency (RF), and optical waves. This hardware idea intends to present and implement new methods to overcome these challenges.

IDEA SOLUTION: Copy and Paste the link for pictorial representation.

<https://1drv.ms/f/s!Ar7O8OpFLW34gioskirM1O9FLKBf>

The primary methods to achieve underwater communication are acoustic, optical and Radio Frequencies. The use of acoustics is untenable due to its high latency and low bandwidth. Also RF is highly absorbed and thus unusable. Optical methods fare far better since it has dual advantage of being High Bandwidth and Low Latency. The idea makes use of these advantages to provide a robust solution for underwater diver assistance and exploration. Using Visible Light Communication (VLC) Technology for the purpose of providing effective communication means for divers along with Sensor Nodes for monitoring the marine environment and the diver for effective real time danger warnings.The proposed network will consist of VLC transceiver nodes along with sensor nodes. All the sensor data will be directed to the server. Any vital response will be sent back using the same channel and thus keep the Operators and Divers informed of all the critical aspects of the mission. This network will also be of immense use in Oil Rigs for maintenance and in mines where the RF waves are a hazard. The hardware idea solution will a Smart Underwater Communication Network which not only caters to the need for communication between divers but also an IoT device with the capability to monitor the underwater environment and communication with network of sensors.

INTRODUCTION:

There has been a growing interest to explore the underwater environment for numerous applications such as climate change, the study of oceanic animals, monitoring of oil rigs, surveillance, and unmanned operations. All of these applications require a medium to communicate in the underwater environment and to the outside world. In recent past years, the study of underwater wireless media has attracted much attention for underwater communications.Today, underwater wireless communications (UWCs) are implemented using communication systems based on acoustic waves, radio frequency (RF) waves, and optical waves. Underwater acoustic wireless communications (UAWCs) have been one of the most used UWC technology as it provides communication over very long distances. However, acoustic waves still have many drawbacks including scattering, high delay due to the low propagation speeds, high attenuation, low bandwidth, and bad impacts on the underwater mammals and fishes. To alleviate the insufficient data rate of UAWC systems, research has been carried out in the past to use low frequency RF waves. Due to the limitations of low bandwidth and low data rate of underwater acoustic and RF waves, an alternative approach is to use optical waves which can provide high-speed underwater optical wireless communication (UOWC) at low latencies in return for a limited communication range. Optical waves have the advantage of higher data rate, low latency, and power efficiency at the expense of limited communication ranges. Therefore,networking solutions are crucial for mitigating range related deficiencies in order to employ optical waves for underwater wireless communications applications.

PROTOTYPE DESIGN:

Transmitter:

The system uses basic opto-electronic and electronic components, including LEDs, Voltage controlled Oscillators (VCO), PIN photodiodes and Phase-Locked Loops, to achieve a voice transmission with excellent signal-to-noise characteristics. The system consists of a transmitter module and a receiver module as shown in figure 1. In the transmitter side, data is transmitted by modulating (On-Off Keying) visible light LED’s and in the receiver side photo detectors are used for detecting (direct direction) the modulated light signal. The idea behind this work is based on fast switching and modulation characteristics of LEDs and spectral responsivity of the photo detector. The transmitter circuit must be designed in such a way that LED blinking is unperceivable to human eye so that it satisfies the conditions of both lighting system and transmit data simultaneously. Main blocks in the transmitter module are microphone with an amplifier, modulator, LED driver and a power supply block. The audio signal is detected by using a miniature microphone. The microphone used must have a good response within the audible frequency range (20Hz-20 KHz). Here a readily available condenser electret type microphone manufactured by Panasonic is used. The audio signal from the microphone has small amplitude and hence amplification of this audio signal is necessary. An amplifier stage is used to amplify the weak audio signal and shift the average voltage level of the audio signal to a suitable level within the capture range of a Voltage Controlled Oscillator (VCO). Here VCO is used as an FM modulator and the amplified output of the microphone will serve as an input to the FM modulation circuitry. The amplified output of microphone will act as the control voltage to the VCO and the VCO circuit provides an oscillating output signal typically of square-wave or triangular waveform whose frequency can be adjusted over a range by a dc voltage. The square wave output of the VCO is given as input to an LED drive circuitry. The drive circuit is used to convert the information voltage signal into a modulation current suitable for an LED source. The operation of the LED requires the switching on and off of a current which is in the order of hundreds of mill amperes. This must be performed at high speed in response to the voltage levels at the driving circuit input. The optical power output of an LED is directly proportional to the current flowing through the LED. But if we increase the current further a maximum value, the lifetime of LED will decrease. The current flowing through the LED is controlled by the drive circuitry. So design of the LED drive circuit is most important while considering the proper functioning and life time of the optical system.

Receiver:

At the receiver side the detector wavelength of maximum sensitivity must match with the spectral characteristics of the LED used in the transmitter side. This work integrates the concepts of underwater communication, modulation, signal processing and analog electronic circuit design. the receiver circuitry consist of a detector array, preamplifier, signal reshaping circuits, demodulator, filter, audio amplifier and a power supply block . The design of an optical receiver is much more complicated than that of an optical transmitter because the receiver must be able to detect week and distorted signals. At receiver side modulated optical signal is detected by using PIN photo detector and demodulation by using a Phase Locked Loop (PLL). A more detailed description of each stage is given below. An optical detector or photo detector converts the optical input power falling on it into a current output. Here a photodiode is used for detecting high frequency modulated optical signal. The detector switching time i.e., rise time and fall time is specified in the data sheet as 5ns. The maximum sensitivity wavelength of the detector is just outside the visible region but 90% of the maximum sensitivity falls in this region. The electric current produced by the Photodetector is proportional to the optical power and, hence, to the modulated incident light. But this current is in the range of microamperes. A preamplifier will act as a transimpedance amplifier and converts this photo generated current into corresponding voltage. For further signal processing to carry out, a multi stage amplifier is used to provide sufficient gain. The signal thus obtained will be sent to the controller node for further computation and networking.