Robotic Communication With Light

Introduction

Although high speed wireless communication has almost become an expectation in modern society, it is still primitive underwater. Wireless communication underwater is a complicated problem that serves many practical applications such as sending data from sensors to an above ground station, communicating between divers, or even controlling a robotic system via an external controller. Since radio waves do not propagate well underwater and acoustic communication has a relatively low bandwidth with large time delays, many researchers and companies have been considering optics as an effective method of communication underwater [1][2]. This paper is a review of the underwater visible light communication (UVLC) in the current market.

Current/Upcoming Technologies in the Underwater Light Communication Market

i-MAJUN

Currently, communication between divers is primitive as the most prominent methods include hand signals and a dive slate (a magnetic board used to write messages). Professional divers often use transceivers for wireless verbal communication, but even this method has its pitfalls. Notable failure points include difficulty comprehending incoming messages as well as wireless connection drops. In order to combat these issues, the Marine Comms Ryukyu Incorporation created a device that allows divers to communicate via an cluster of light emitting diodes (LEDs) which flash at an extremely high frequency to transmit data. The actual product is a mask that contains a microphone, a bone-conduction speaker, and light transceiver. As a diver speaks into the microphone, the i-MAJUN will convert the speech data into light and transmit using the transceiver. Similarly, upon receiving a message, the diver's receiver will decode the light-encoded message and relay the information to the diver through the bone-conduction speaker ensuring clear communication [3]. In order to increase the distance of which divers communicate, this device utilizes blue LEDs (which have a shorter wavelength) in order to send data to up to thirty meters. In addition, to combat the problem of messages being obstructed by objects in the ocean, the i-MAJUN uses a wide-angle lens to transmit the light encoded message so that the message is either reflected or refracted until it reaches the desired destination [4]. The i-MAJUN is still under development so the cost is still to be determined.

BlueComm

With the goal of finding a high speed communication platform, Sonardyne has created BlueComm: a through-water wireless optical communication system that can transmit subsea data, stream video, and perform fast cordless vehicle control. By using the electromagnetic spectrum, BlueComm is able to create a fast and efficient optical connection that can transfer data at a rate of 500Mbps to a destination that is near 150 meters away. Similar to the i-MAJUN, the BlueComm system uses an array of high power LEDs that rapidly modulate to transmit data to a photodiode receiver. This photodiode receiver can decode the modulated LED pattern to comprehend the transmitted message [5]. The BlueComm system has a variety of applications that include remotely controlling an unmanned underwater vehicle, sensor data collection from the sea-bed to an offshore location, or even system maintenance and monitoring using a live video stream. This product, although still in a research phase, is being used by NASA and other reputable organizations for complicated underwater applications. Due to its research focus, Sonardyne does not list a specific price associated to this product but rather creates a full BlueComm system unique to each customer's needs.

Autonomous Modular Optical Underwater Robot (AMOUR)

AMOUR is a robotic system created by the Computer Science and Artificial Intelligence Lab in the Massachusetts Institute of Technology (MIT) to find a more efficient method for underwater communication. Although it is not a commercial product, this state-of-the-art design provides insight to develop an underwater communication system using light. Once again, this lab's solution is similar to the two aforementioned products such that the AMOUR uses an optical modem to send and receive information from an on-land base-station [6]. The optical modem used in this project allows land-based user to remotely operate an underwater robot in real-time. The primary hardware needed to achievethis optical communication in the AMOUR system includes an optical receiver and transmitter. The optical transmitter operates outside of the water and sends light encoded data via a 480nm blue-green LEDs pointed at submerged robot. Upon receiving the modulated LED pattern, the receiver decodes the message and is able to control the robot accordingly. Based on the research done by this lab, this optical link communication proves to be an efficient and reliable method of communication with an underwater robot. Since this is not a commercial product, there is no listed price, however, a monetary value for the AMOUR system can be derived based on materials that were used.

Future

Based on these commercial products and research, optical communication underwater proves to be functional by using high wavelength light LEDs which module to transmit data. A basic system for optical communication requires an optical receiver and transmitter, where the transmitter is fitted with blue-green LEDs that can encode and flash data at a high frequency to the corresponding receiver.

References

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