Geophysical Research Abstracts
Vol. 14, EGU2012-2685, 2012
EGU General Assembly 2012

Optical Communication System for an Underwater Wireless Sensor Network

C. Gabriel (1,2), A. Khalighi (1), S. Bourennane (1), P. Léon (2), and V. Rigaud (2)
(1) Aix-Marseille Université, Institut Fresnel, UMR CNRS 6133, Marseille, France, (2) IFREMER, La Seyne-sur-Mer, France

Seventy percent of the Earth is covered with water. Yet, we know so little about what lies below the sea surface. One new emerging technology that can help in oceans exploration is underwater wireless sensor network (UWSN). In such a network, a number of sensors are connected to a set of nodes that collect the data from them. Then, each node communicate its retrieved data to the other parts of the network through wireless links. So, an important step in the implementation of an UWSN is the design of an adequate transmitter/receiver system that is reliable, easy to implement, energy efficient and adapted to the underwater environment.

Thanks to its cost-effectiveness and low-energy consumption property, optical underwater communication turns to be the most adequate solution for medium range node connections in an UWSN. To evaluate the optical underwater channel, we have studied its impulse response using a Monte Carlo simulator that takes into consideration all the transmitter, receiver and medium characteristics. We have demonstrated through these simulations that the channel delay dispersion is negligible in most practical cases. Therefore, we do not need to perform computationally complex signal processing such as channel equalization at the receiver.

After studying the channel characteristics, we have turned our attention onto the transmitter/receiver system design. For this, we have simulated a system composed by a high-power monochromatic 532 nm LED transmitter and a Silicon PIN photodiode receiver with a collimating lens for capturing the scattered light. After photo-detection, the photo-current is converted to a voltage and low-pass filtered to limit the thermal noise variance which is the dominant noise in the receiver. Note that, in our case, background noise can be neglected because we are working in deep waters were the sunlight cannot penetrate. Then, using on-off-keying (OOK) modulation, we have proceeded to signal detection based on optimum thresholding. We have evaluated this system by studying its bit-error-rate (BER) performances in different water types as a function of the transmitted power, the transmission range and the receiver lens aperture size. As a typical case, considering an acceptable BER of 10^{-6}, we have shown that in clear ocean waters, for a transmit power of 0.1 W and a 20 cm lens aperture at the receiver, we can reach up to 20 m while transmitting at 1 Gbps bit-rate.

Now, we are working on the development of new signal processing techniques related to the transmitter and the receiver in order to improve the system performance and enable transmission over longer distances and with higher bit-rates.