Abstract

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NLoS underwater VLC system performance: static and dynamic channel modeling

the impact of water channels under different communication link parameters is studied for underwater visible light communication (UVLC). The objective is to highlight the best results for non-line of sight (NLoS) communication links. In addition, NLoS links are studied under different parameters: LED colors, viewing angle, receiving angle, and data rates. The results are obtained and plotted using MATLAB simulation. The performance of the received power is first measured at different wavelengths and data rates. Then, the best results are further investigated at different viewing angles and receiving angles. The obtained results show that using cyan color provides more depth for the NLoS case, as well as a low bit error rate compared to the other colors. Most of the literature is concerned with unpractical configurations in underwater scenarios, such as an empty sea assuming no human-object blockage environment. We use the practical setup in Zemax Optics Studio to allow a precise description of ray tracing and high order of reflections inside a sea water environment. The channel impulse response (CIR) is obtained for static channel modeling, including a blockage environment to evaluate the best transmitters in sea water. Also, we are able to compare the average delay and the average delay spread of the source colors. The reflection characteristics of the sea water are considered as wavelength dependent. The CIR obtained by Zemax Solver andMATLAB indicates that cyan is the best source in sea water for different LED chips. Moreover, other previous studies assume perfect alignment scenarios between divers, which is not practical and not suitable for real channel gain results. Accordingly, we present a comprehensive dynamic channel modeling and characterization study for UVLC.Our study is based on Zemax programming language (ZPL) combined with Zemax Optics Studio. Using ZPL enables us to apply a mobility algorithm for divers and measure the channel gain variations due to random motion. We introduce a dynamic motion in a single-input single-output scenario and a single-input multiple-output scenario in the presence of blockage divers. Statistical analyses are studied for the appropriate distributions that can fit the data with various transmitter and receiver specifications. All dynamic scenarios are performed using cyan color in sea water, as it is proven to have satisfactory performance. The statistical results are beneficial for further analysis. As case studies, we consider various underwater scenarios, and the resulting parameters of statistical distributions can be used for future analysis in UVLC dynamic environments.