Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

HOCHSCHULE BREMEN
UNIVERSITY OF APPLIED SCIENCES

Master 2012

Alexander Topoev

Development of a TCPIP-based Optical Underwater Communication System

ABSTRACT - Masterthesis

The motivation of thesis work was to develop a reliable data transmission link for Autonomous Underwater Vehicles (AUV). One of the possible usage of such vehicles is an inspection of wind power generators situated in sea.

Today the communication channel for underwater vehicles is mostly based on acoustic waves. This is because of low attenuation loss in water for acoustic waves. On the other hand usage of acoustic waves as a data carrier impose certain limitations in bandwidth. It comes from acoustic waves physics where the average sound propagation speed for salty water is about 1500 m/s. The acoustic channel doesn't provide sufficient bandwidth. It is limited up to 10-20 kb/s.

Nevertheless the electromagnetic wave could be applied for communication purposes, but their application is limited due to high electromagnetic waves absorptivity of water. This leads to rare usage of electromagnetic waves in transmission. One of the examples of the usage is Extreme Low Frequency (ELF) of 76-82 Hz. This range is used by US and Russian Navy to connect with submarines. Such low frequency gives a coverage area around the World Ocean but needs an antenna field length of 50km in order to give the desired wavelength.

The AUV has to communicate with a fixed base station in a maximum range which is less than 1 meter. For this short range transmission the proper choice would be an optical communication link. It gives a higher bandwidth - up to 100 Mb/s within short range of transmission.

To implement an optical underwater channel, in this thesis there was used a Free Space Optical transmission system (FSO). One of examples of such system is Reasonable Optical Near Joint Access (RONJA). It is an open source project for reliable optical data links with range up to 1.4 km and transmission speed of 10 Mb/s. This system has a point-to-point topology and provides a duplex connection for a long distance.

The thesis work investigates water conditions and their influence on data transmission quality. It gives an overview on link budget of a system and further the application of existing FSO technology to water conditions. With building up a setup it should be verified the theoretical investigations and compared with real measurements.