Underwater Acoustics

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Autonomous Underwater Vehicles (AUVs) are developed by DISAL for the purpose of gathering environmental data in water bodies. The AUVs are equipped with a suite of sensors that measure various parameters eg. temperature, a concentration of various substances and turbidity. Multiple AUVs have to collaborate in order to localise and gather data more effciently, therefore a proper communication channel between the AUVs is required. Since electromagnetic waves do not propagate in water, communication and localisation is a challenge. The AUVs have to periodically surface to receive a Global Navigation Satellite System (GNSS) update or to communicate with the base station.

Acoustic waves are a suitable alternative to electromagnetic waves for wireless underwater communication as they can achieve long ranges. However, communication-based on acoustic waves brings many challenges, such as frequency-dependent attenuation, multipath propagation and low speed of sound. As the result, underwater wireless communication based on acoustic waves has limited bandwidth and cause a signal dispersion in time and frequency. Despite all those limitations, acoustic waves are the most promising solution for underwater communication.

Taking it into consideration, DISAL developed hardware support for acoustic underwater communication. It consists of a custom built transducer, receiver and PCB with AVR 32bit microcontroller AT32 UC3C2512C2 dedicated to signal processing. Therefore, the goal of this project was to study and explore possible solutions for underwater acoustic signal modulation and demodulation, simulate it, implement it to the microcontroller.

In this project, several methods were explored and implemented for communication and for detecting ranging signals. They were deployed and tested on robots running in Lake Geneva. These methods were then compared in terms of their computational cost, usage of the acoustic channel, bandwidth and susceptibility for errors.

In general, we found that the usage of the acoustic channel (in terms of the length of the signal in time) inversely correlates with susceptibility to errors. Further, we found that using multiple frequency channels introduces errors in communication, which is suspected to be due to the unexpected mechanical behavior of the transmitter piezo transducers.

Further work was done for integration of DiveNET acoustic modems into the DISAL AUV system. The firmware driver for the modem was developed and tested in Lake Geneva.

DISAL AUV acoustics hardware module

DiveNET Microlink Modem