WS 2018-2019, SIN, DISAL-SP124 Project Summary

Underwater Acoustic Communication

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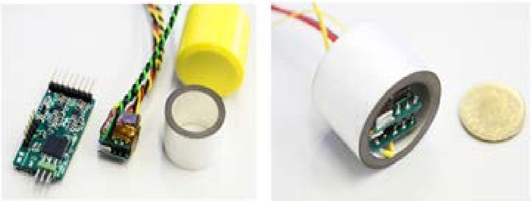
The first underwater communication systems appeared in middle of 20th century. However, the underwater communication systems began to emerge only after appearance of digital signal processors (DSPs) and since DSPs are low powered and lightweight it has been practical to be used in Autonomous Underwater Vehicles (AUVs). AUVs developed in DISAL laboratory 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 efficiently, therefore a proper communication 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.



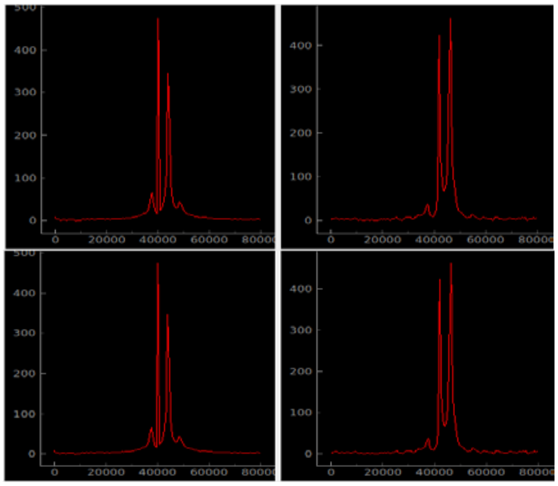
Device used for evaluation of modulation and demodulation schemas

Acoustic waves are the most promising medium of 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. Therefore, in this project multiple modulation schemas are evaluated, compared and the most suitable approach is implemented on a microcontroller.

Initially, a simulator is built in order to simulate a signal propagation through the water and in the simulator different modulation and demodulation strategies are evaluated. Simple techniques are used to introduce noise to a signal, as well as echoes.

Frequency-shift keying (FSK) is implemented on a 32bit AVR microcontroller. Due to low processing power of the microcontroller various methods are introduced to optimise calculations or to postpone it when the micrcontroller is less busy. Moreover, the implementation is integrated in existing codebase.

Various measurements are performed in order to evaluate performance of the implementation such as minimal distance between frequencies, error rate, influence of different environments and maximal number of bits per symbol. The results show that the required performance are achieved.



Response of 4 successive symbols in frequency domain

I proposed improvements to the implemented modulation and demodulation method that can ensure more robust communication with higher transfer speed. In addition, alternative modulation and demodulation methods are suggested. Plan for implementaion of higher level of abstraction to ensure minimal error rate is also given.

In addition, simulator is designed to be modular and easily extendeble. The implementation is described by easy to understand algorithms and it should not be difficult to implement on different microcontroller.