Project/master thesis proposals in Marine Acoustics, 20.04.2017

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Proposals on Acoustic Remote Sensing:

Inferring ice properties from hydrophone measurements
Ice in the Arctic can generate underwater noise due to break-up and collision of floes. The goals of the project are to define a single hydrophone (sonar) system to measure such noise and assess a method to infer properties of the ice sheet from these measurements. The project can be continued with a M.Sc. thesis, where relevant measurement data can be made available.
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Analysis of acoustic data from LoVe (IMR)
The Lofoten - Vesterålen Cabled Observatory (LoVe) has been in operation with one node since 2013. The system collects echosounder data from one steerable horizontal pointing transducer and one vertical directed transducer. Simultaneous, data of water properties are collected by a two acoustic Doppler current profilers, various environmental sensors and a camera image a coral reef at fixed interval. Camera and horizontal transducer are motorized and there is a need to develop processing algorithms and routines for processing information for subsequent feedback on the motorized units. This may include extended tracking of single fish or fish schools, and change pointing direction and imaging frequency of camera to follow moving objects and thus improve the efficiency of the data collection.
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Bias in bearing estimates from small hydrophone arrays near the sea floor
Bearing estimates from small hydrophone arrays near the sea floor may be subject to bearing bias due to local bottom conditions near the sensor, and other propagation effects. The student should study the physics behind this phenomenon, and use it to explain actual observations in data previously collected by FFI.
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Studying the impact of man-made noise on fish and invertebrates
Man-made sounds can have strong negative effects on marine animals. Great attention has been paid to the impact on marine mammals and attempts have been made to establish sound exposure criteria setting regulations on the levels of noise in terms of impact on marine mammals. However**,** there is much less study on noise impact on fish and invertebrates although these are present in far greater biomasses than marine mammals. Low frequency sound/noise by pile-driving and subsea mining has high-level power, can propagates along/into the seabed with long distance and produces large seabed vibration. This may affect fishes and invertebrates that dwell close to or within seabed. In order to study this effect, sound propagation modelling will be carried out and both sound pressure and particle motion should be included in the modelling. The existing model of OASES (frequency-wavenumber integration technique) will be used and the modelling results will be analyzed.
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Proposals on Underwater Acoustic Communication:

MIMO underwater communication

Underwater acoustics is the main method of obtaining wireless communication under water. Wireless technology is needed e.g. for communicating with underwater vehicles and for deployment of underwater sensors without expensive cabling. Applications are many, in natural sciences, environmental protection, aquaculture, oil and gas, deep sea mining etc. The communication technology is under development worldwide, but conditions are challenging and the demonstrated performance highly variable. Multiple Input Multiple Output (MIMO) is a promising approach to obtaining high performance. This amounts to using transducer arrays and signal processing to increase robustness and data rates. The project shall explore the potential of using MIMO principles in high capacity underwater acoustic communication. Specifically signal fading statistics and spatial correlation between array elements shall be measured and based on this, communication channels assessed. The fundamental measurements shall be carried out in the Trondheim fjord using NTNUs research vessel Gunnerus. Signal analyses can then be carried out off line, e.g. using Matlab, and channel assessments (capacity, robustness) carried out using quite simple formulas/algorithms.

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Acoustic signal processing and algorithm design

BACKGROUND: Acoustic signal processing has gained a lot of attraction in different wireless underwater applications. These underwater applications include oil exploration, studying the ship wrecks in the sea bed, biological studies of different fishes and deep sea searches for minerals using underwater vehicles. In all of these applications there is a requirement of a reliable acoustic communication link between the source and the receiver. The main motivation for this work will be to perform signal processing techniques on the experimental data from Trondheim Fjord and propose some algorithms for improving the acoustic communication link. Underwater signal processing is becoming integral part of underwater modems for improving the communication system performance. In addition to that oil companies are very interested in acoustic solutions for different oil mining operations.

PROBLEMS: Complex underwater channel: Underwater channel is a dual spread channel which imposes time delay and frequency spreading. The time spreading results in multipath while the frequency spreading results in Doppler spreading of the propagating signal.

TASKS: In the above mentioned problem, the main requirement will be to study signal processing algorithms for combating the underwater channel effects. The main focus will be on Doppler compensation. Different algorithms are proposed in the literature for Doppler compensation including time-domain resampling and equalization. These algorithms will be first tested on synthetic data and then implemented on the real data. The synthetic data will be obtained by running the Time Variable Acoustic Propagation Model (TVAPM). Using TVAPM, the TrondheimFjord environment will be modeled and Doppler will be induced by assuming a moving source and receiver.

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