

Marine Acoustics

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What is marine acoustics?

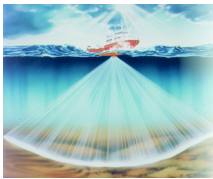
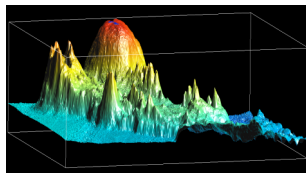
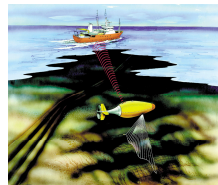
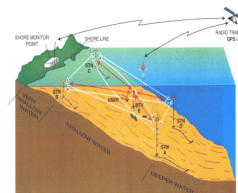
In the sea, acoustic waves are used for transmission of information in the same way as electromagnetic waves are used in air. Since the attenuation of acoustic waves in water is quite low, long transmission ranges can be obtained, especially for low frequencies. However, the ocean with boundaries at the sea surface and the bottom is a very complicated transmission channel that can change rapidly with the environmental conditions. In addition, the relatively low bandwidths and the slow wave propagation velocities can represent limitations for some applications.

In order to overcome these problems and limitations, advanced signal processing is very important and required to make optimum use of the transmission capabilities. Signal processing in the time, frequency and spatial domains is therefore an important part of modern marine acoustics. The area of marine acoustics is in rapid development, driven by increasing demands for improved system reliability and performance, and by new possibilities and solutions continuously made available as consequences of advances in electronics and computer technology.

Applications of marine acoustics

The most important fields of applications for marine acoustics are:

- Military applications and surveying of coastal areas for vessels and mines.
- Fishery acoustics and abundance estimation of fish and plankton.
- Sea floor acoustics, mapping of the topography and structure of the sea floor and sub-bottom.
- Underwater acoustic communication, navigation and position reference systems.
- Acoustic remote sensing of the marine environment.



COURSES

Marine Acoustics I - TTT4175

An introductory course giving the foundation for the use of acoustical waves in water, starting with the development of the acoustic wave equation from basic principles. The course covers reflection and transmission at interfaces, wave propagation methods such as ray tracing techniques and normal mode theory. The specifications and performance of acoustic systems for detection and localisation and for communications are discussed using the sonar equations as a reference frame.

Marine Acoustics II - TT8305

This course builds on *Marine Acoustics I* and gives a deeper and more theoretical treatment of some central issues and problems relevant for marine acoustics. The course covers refraction and scattering of simple geometrical bodies, particles and scattering of rough surfaces. Furthermore, the course treats acoustic and elastic waves in solid media and waves in layered media.

Theoretical Acoustics - TT8307

The subject contains acoustic waves in gas and fluid media - wave equations, reflection and transmission between two fluid media, from multi-layers and thin elastic plate. Furthermore the course deals with room acoustics, reverberation and statistic aspects and vibration from source and vibrating bodies; effects of viscosity and other dissipations; scattering and diffraction; ray acoustics and nonlinear effects in acoustic wave propagations.

Numerical Acoustics TT8303

Numerical methods like the finite difference method, finite element method, and the integral equation technique for solution of relevant wave equations will be covered. It will also be given an introduction to geometrical methods and methods based on cellular automats. The most important applications are acoustic propagation in air and water and the interaction of sound and vibrating structures.

Statistical Signal Processing TT8304

The course deals with discrete random signals, statistical signal processing and applications of statistical signal processing. The course contains the following subjects: fundamental methods of characterizing random signals and signal processing; classical statistical signal processing including estimation theory and optimal filtering; modern statistical signal processing which covers linear prediction, signal modeling, and spectrum estimation.

Geo-acoustic Modeling and Inversion - TT8306

This course offers a basic introduction to acoustic modeling in range dependent and range independent environment by application of ray theory, normal modes, wave number integration techniques and the parabolic equation. The theory for inverse modeling such as simulated annealing, genetic algorithms and others are developed and discussed.

RESEARCH PROGRAM

The Acoustics Research Center has a long and continuous activity in the field of marine acoustics. The main areas of interest and competence are acoustic/seismic wave propagation and signal processing in sonar systems for military and civilian applications. This includes low frequency and long-range propagation studies, sonar systems for detection, localization and classification of fish, plankton and other objects in the sea. Of particular interest is underwater acoustic communication and acoustic remote sensing for environmental monitoring and observations.

Acoustic remote sensing

The research in acoustic remote sensing involves development of propagating models based on modern wave theory and numerical mathematics. Techniques such as ray theory, normal modes, wave number integration techniques and the parabolic equation are relevant as well as numerical techniques as finite difference, finite elements and boundary element methods. Of particular importance is modal-based inversion schemes, such as simulated annealing, genetic algorithms and others and the application of these techniques for the estimation of parameters of the marine environment.

Underwater acoustic communication and navigation

There are emerging new demands and possibility for underwater acoustic communication and navigation, both for defense and civilian applications. We the future, one can envision local area communication networks of transmitters and receiver, of the same type as used for mobile telephone communication. The utilization of new low power electronics and adaptive signal processing is essential to deal with variable propagation and environmental conditions.