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AREA OF EXPERTISE:	Machine learning, image processing, acoustics
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DISSERTATION TITLE: *Machine learning and image processing methods for acoustic seafloor mapping and classification*

Havbunnens fysiske sammensetning gjenspeiler biologiske og fysiske prosesser gjennom jordens nyere geologiske historie, inkludert menneskelig påvirkning, og har avgjørende betydning for marint liv, ressursutnyttelse og diverse marintekniske anvendelser. I denne avhandlingen presenteres metoder for effektiv og høyoppløselig kartlegging av havbunnssedimenter basert på moderne sonarteknologi og informasjonsteknologi.

Knowledge about the ocean floor, especially on the continental shelves, is important for political, commercial, and environmental reasons. A scientific understanding of the physical processes that form the seabed is also a goal in itself, and new acoustic techniques for seabed mapping are instrumental to achieve this. This thesis contributes in this respect.

The nature of marine sediments reflects past and present physical processes on the seabed, and is also a critical factor for marine life, ocean acoustics, and marine engineering. Inferring seabed properties using echo sounders is difficult, however, due to the heterogeneous structure of sediments and the complexity of seabed acoustics at high frequencies. Therefore, conventional seabed characterization is based on retrieving physical samples from the seabed in isolated spots, performing laboratory analyses, and extrapolating data to greater areas. It would be very time-consuming, in practice impossible, to accurately characterize anything but very limited areas using this approach.

One contribution of this thesis is a physical acoustics-based method that can perform the said extrapolation more accurately and efficiently using modern echo sounders. The method combines physical principles with a statistically robust approach. A key component is machine learning, said to be “the science of getting computers to act without being explicitly programmed” (Andrew Ng). Machine learning provides theory and algorithms that enable computers to make predictions based on observed data; here it is used to infer seabed characteristics from acoustic signals.

Another contribution is the introduction of a so-called image transform, which is a mathematical tool for enhancing data, like reducing noise or artifacts. In turn this enables accurate classification and interpretation of the data. It is shown that the image transform can be applied in other contexts, e.g., satellite imaging and seismic image analysis. The thesis also presents a new seabed sediment map of a large (23.000 km^2) area in the North Sea, the result of acoustic seabed classification and extensive geophysical data analysis.