Estimation of the shape of streamers of hydrophones towed by Autonomous Underwater Vehicles

WiMUST
Widely scalable Mobile Underwater Sonar Technology
http://www.wimust.eu

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The WiMUST project in a nutshell

The H2020 European Project WiMUST aims at expanding the functionalities of current cooperative marine robotic systems, enabling distributed acoustic array technologies for seismic surveying. In particular, WiMUST aims at designing, developing, and testing at sea, algorithms and methodologies for controlling the geometrical configuration of a team of cooperative marine vehicles and adapting it according to the needs of acoustic surveys.

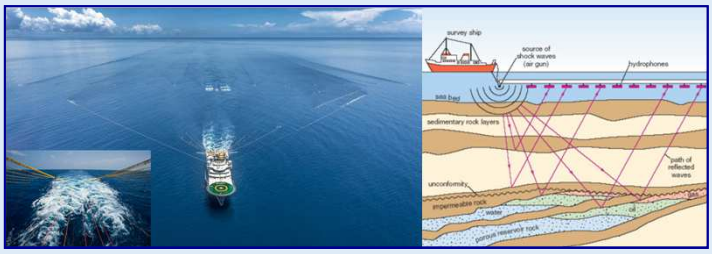
PARTNERS

Coordinator: Giovanni Indiveri, ISME **Duration:** 2015-18

Seismic acoustic survey with AUVs

Seismic acoustic surveys at sea are methods for the exploration of the sea bottom and sea subsurface for applications that span from the geophysical domain (e.g. oil&gas) to the geotechnical domain (e.g. civil and commercial applications, underwater constructions).

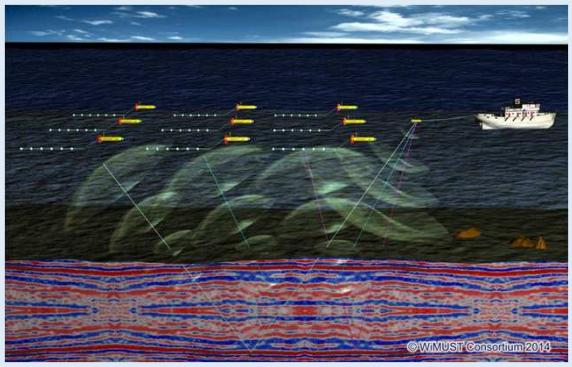
Traditional survey: performed using a manned surface vessel carrying one or two powerful acoustic sources, named sparkers, and towing a set of surface streamers along which are placed several hydrophones to register acoustic signals. The sparkers generate seismic waves by intermittently releasing pulses or bubbles of compressed air which generate low frequency sound waves. Such waves travel towards the sea floor and are reflected back to the surface hydrophones. The speed with which waves return to the surface, registered with the hydrophones, provides valuable information about the properties of the Earths subsurface.



WiMUST survey: streamers are towed by Autonomous Underwater Vehicles (AUVs).

Motivations: The loss of the towing system from the surface vessels introduces flexibility to the system in the sense of allowing to modify the horizontal and vertical displacement of the streamers to adjust according to specific needs (adaptive variable geometry acoustic array)

Challenges: the loss of the towing system introduces high complexity due to the needs of ad-hoc cooperative navigation and control architecture of the AUVs and of acoustic communication among the nodes.



The streamer shape estimation problem

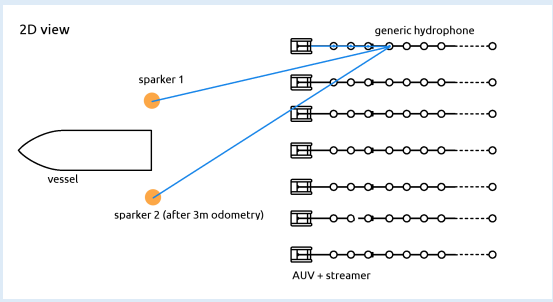
The hydrophone' positions, needed for the processing of acoustic seismic data, can not be easily computed as in the case of surface surveys since AUVs can not rely on GPS, the hydrophones are not constrained to remain on an horizontal plane, there is no GPS equipped surface buoy on the tail's.

Key Assumptions: AUV localized; sparkers localized; known hydrophone displacement along the streamer

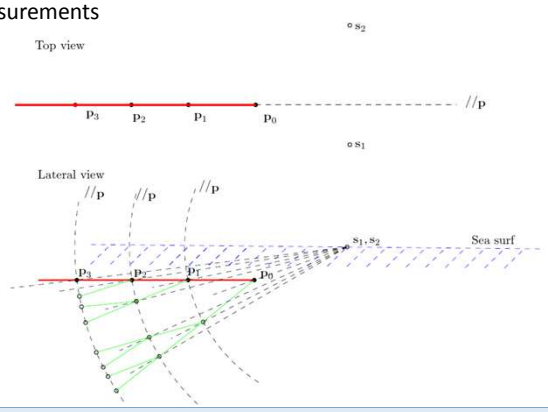
Streamer modeling: serial chain of rigid links

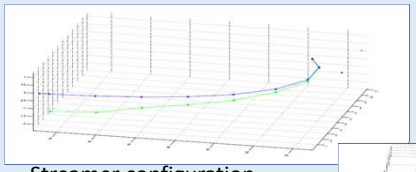
Measurements: ranges from one/two sparkers; possible tail

Cases studied:
- one sparker, no localized tail (2D/3D)
- one sparker, localized tail (2D/3D)
- two sparkers, no localized tail (2D/3D)
- two sparkers, localized tail (2D/3D)



Example of configurations that generate the same set of measurements





Streamer configuration estimate without tail

Streamer configuration estimate with tail