Summary of the present work

A novel hydrophonic probe (“Soundfish”) placed inside the WWF-Natural Marine Reserve of Miramare (Trieste, Italy) allowed for characterization of the underwater acoustic background noise, and the noise produced by a small outboard-engine boat moving at 6 knots not just in terms of sound pressure, but also of the three Cartesian components of the particle velocity.

Description of the recording probe

The system is based on a modified ZOOM H2 digital sound recorder, re-named Brahma, capable of recording the signals coming from a probe consisting of 4 hydrophones, placed at the vertices of a tetrahedron; this is the underwater equivalent of a Soundfield™ microphone. The recorder operates at 48 kHz, 24 bits and records standard uncompressed WAV files over a 16Gb SD card, which can be easily processed later on a PC.

A software tool, named Brahmavolver, was developed for converting the raw signals coming from the 4 hydrophones to output signals, representing respectively the Sound pressure and the three Cartesian components of particle velocity. Ultimately, this analysis reconstructs the trajectory of the sound source, and, with some approximation, also evaluates the distance of the sound source from the probe. The processing is based on the use of a matrix of 4x4 FIR filters, currently 2048 points long, as shown in the figure on the right.

The inputs are the sound pressure signals sampled by the 4 hydrophones (M), located at the vertices of a tetrahedron (properly aligned with the Cartesian reference system of the probe which is usually manually aligned with the geographical reference system). The outputs are the sound pressure signals sampled by the 39 hydrophones (B), located at the vertices of a tetrahedron (properly aligned with the Cartesian reference system of the probe which is usually manually aligned with the geographical reference system).

The probe and the Brahma recorder, located inside a waterproof container, were placed on the sea bed, at a depth of 8 m, in the protected area of the Miramare Reserve (receiving point: Lat 45°42‘01.61”, Long 13°42‘41.96”). A 30 minutes long recording of the Sea Ambient Noise (SAN) was performed, without significant boat activity around.

Then a fiberglass speedboat, (w-shaped hull, 4.70 m lenght, 815 cm² / 4 strokes outboard engine) was operated, in a series of passages above the probe, for checking the capability of detecting the variable direction-of-arrival of the noise during the pass-by.

Conclusions

The new Soundfish probe can be employed for an analysis of the cause-effect relationship, as at every instant the position of the source, relative to the receiver, is known, alongside with the quantities relevant for assessing the impact of human-produced noise over marine species, either sensitive to sound pressure or to particle motion.

The reliability of the new measurement system must now be assessed by employing it in a number of surveys, under different sea conditions, at different depths, and with various kinds of noise sources. It could also be advisable to repeat the calibration in the pool, employing narrower angular steps, for ensuring computation of even better digital filters.

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