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UNDERWATER NOISE – INSTRUMENTATION AND MEASUREMENT PROCEDURE

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Underwater noise generated by ships is the matter of interest as it may serve many purposes in underwater applications. The main goal of underwater noise application is the Anti Submarine Warfare. For underwater noise, measurement specific facilities are indispensable. The main part of measurement system is the array of hydrophones, which could be used in various configurations depending on the goal and conditions of investigation.

INTRODUCTION

Measurements of underwater noise including the noise radiated by ships are carried out by means of facilities of which the main part is a set of hydrophones submerged in the sea. The object is to create for oneself the most advantageous opening position for underwater detection and measurement. Knowledge about the radiated noise of our own ships is therefore a necessity just as is the evaluation of the efficiency of the own passive and active sonars. The purpose of underwater noise measurements of the ship is to provide following data:

- information of the type and positioning of main noise sources,
- the acoustical signature both in the time history and power spectral forms,
- the total underwater noise level and its power spectrum.

The underwater measuring facility consists of the three main parts:

- set of submerged sensors for underwater signal acquisition
- underwater and air tracking system of the target,
- centre of signal processing for analysis, classification and interpretation.

Configuration of the range of sensors is determined by the signal to noise ratio. For the examining ship that is noisy while the ambient noise is low, one can use a set of single omnidirectional hydrophones. If the signal to noise ratio is low one should use an array with beamforming. The number of hydrophones depends on the accuracy and the type of characteristics that we want to obtain.

1. MEASUREMENT FACILITY

As it was mentioned above, the measurement facility consists of an underwater part (see fig. 1) and recording part. There are also a tracking system and a processing centre. The underwater sensors may be configurated temporally for different tasks, as for instance to investigate a surface ship or submarine, or for the 2D or 3D directivity characteristics.

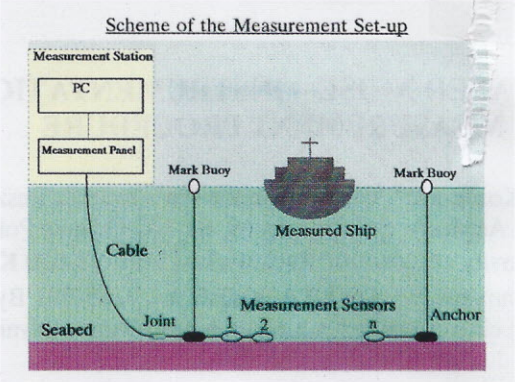

Fig. 1. Hydroacoustic measurement station

The signals are transmitted by means of a cable. Apart from signal transmission, the cable is used for power transmission, as hydrophones are equipped in preamplifiers. There is a possibility of remote calibration of each hydrophone. The measuring signals are recorded simultaneously both in the digital and analog form by means of Bruel & Kjaer accessories.

The tracking is very important for the accuracy of measurement because the energy of acoustic signals due to the propagation loss depends on the distance between sensors and source of the noise. For the surface ship tracking the DGPS system can he used and for submarine tracking a system consisting of a set of hydrophones positioned along line or two perpendicular lines must be used. Based on the calculated time differences one can determine the target trajectory.

2. SIGNAL PROCESSING CENTRE

Fig. 2. Equipment used in signal processing

Each of the signals received by particular hydrophone is recorded both in digital and analog form. They are then pre-processed to make them comparable as far as the level and time of duration are concerned. Using the Bruel & Kjaer accessories (Fig. 2) one can obtain the following characteristics: the power spectrum, the auto-correlation function, the cross-correlation function, the coherence function, the cross power spectrum, the trajectory of ship's way and so on. There is opportunity to obtain the fine spectrum and 1/3 octave or octave spectra. These characteristics are the base to recognising, identifying and classifying the submarines or surface ships. Moreover, we can collect the acoustic signature of the measured ships.

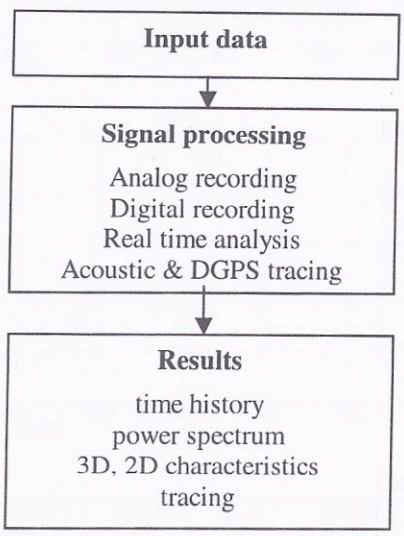

Fig. 3. Scheme of signal processing

CONCLUSIONS

The measurement and processing of measuring data connected with the underwater noise radiated by the ships or submarines is a difficult process. During the measurement, both the signal and the trajectory of the target should be recorded.

The signal-processing centre is linked with the set of sensors by means of waterproof cable (electric or fibreglass). The sensors should be temporary calibrated.

The pre-processing data are used for determination some acoustic characteristics such as fine structure spectrum, power spectrum, cross-correlation function, coherence function and others. Those allow us to characterise observed target.

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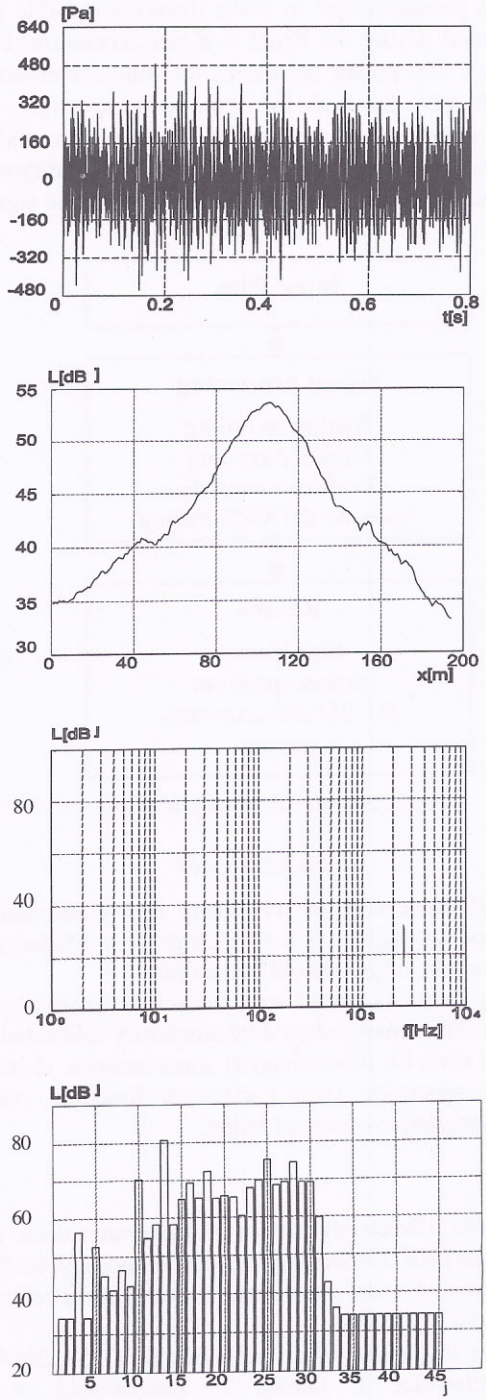

Fig. 4. Examples of results of analysis