VIRTUAL LABORATORY FOR UNDERWATER NOISE ATTENUATION

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Abstract: *This paper presents a solution to reduce the noise produced by rig tenders. Underwater noise sources cause environmental pollution, with damage to marine life habitat, their communication, disrupting the feeding area, with economic repercussions on the number of fish and the fishing activity. Measurement of sound power level of these noise sources has led to the conclusion that the highest level, according to 120 dB re 1µPa criterion was extended to 3-5 km distance from the platform. Virtual instruments were built by the phenomenon of composition leads to attenuation of sound waves in the vicinity of marine platforms.*

Keywords: *underwater noise, antropic activity, virtual laboratory*

1. Introduction

In underwater environment, the acoustic pressure produced by sound waves attenuates depending on the distance and the obstacles they encountered. That's why is very important to reduce the anthropogenic noise.

Anthropogenic sound in the ocean is created unintentionally and randomly. Results are fluctuating noise intensities and frequencies. Anthropogenic ocean noise sources become stronger, increasing the background levels and peak sound intensity levels. Sound is an extremely effective way to propagate through the ocean energy and marine mammals have evolved to exploit its potential. Many marine mammals use sound as a primary means of communication.

An important source of noise is the industrial targets (offshore) during the construction and operational activities of their. In this category are included: wind turbines, offshore exploration and exploitation, LNG terminals (Liquid Natural Gas).

The paper presents a solution to reduce the generated noise from industrial facilities in operation or under construction by introducing noise from 180 ° out of phase noise at the source location.

2. Virtual instruments for noise injection

To reduce noise introduced into the environment by human activity, was proposed the insertion of an experimental context opposite phase noise at the source of noise pollution.

Used for this purpose is the physical phenomenon of wave composition. When the waves come from one or more sources that interact, they will compose leading either to increase or to decrease wave energy at the point where they meet. When meeting elastic waves with the same frequency, amplitude and are in phase their energy will accumulate so that the resulting wave (compound) will have a greater amplitude. Resultant of two waves out of phase by 180 degrees (which are in anti phase) has amplitude zero energy waves will cancel each other. At phase angles between 0 and 180 degrees will produce a range of intermediate stages between full sum and total cancellation. Resulting wave front can have different values, including zero, depending on timing sources.

Given the above we considered the introduction of noise out of phase by 180 º from the product source will result in lower sound pressure level that is emitted by the source.

For this we developed a virtual instrumentation to produce signal in opposite with the signal acquired of the underwater noise.

3. Virtual instrument "sinusoidal signal generator"

First built virtual machine is a signal generator that generates a sinusoidal wave with a prescribed form, and also a sine wave (180 degrees out of phase as the starting point of the wave).

These waves are combined in a summing VI and the resultant wave is shown in data presentation element on the front panel of the virtual instrument (Fig. 1). The resulting signal intensity is zero.

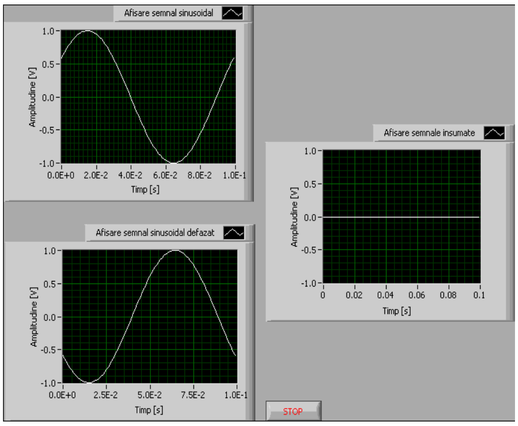

Figure 1: *VI front panel of the "sine wave generator".*

LabVIEW instrument library has a sub-VI "Simulate Signal" (Fig. 2), which is a signal generator for waveforms with variation defined by laws such as sinusoidal, rectangular, triangular, to saw tooth, signal ramp, pulse. This sub-VI was used to demonstrate the process of composing waves.

Block diagram of virtual instrument "sinusoidal signal generator" is shown in Figure 3.

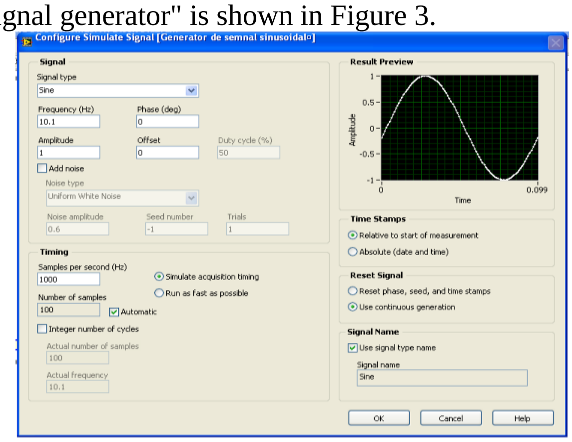

Figure 2: *Sub-VI's interface "Simulate signal".*

Virtual instrument is built into a repetitive structure with termination condition.

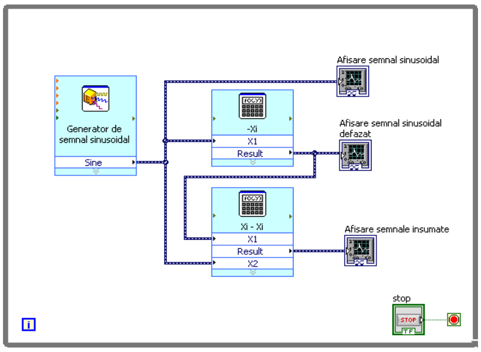

Figure 3: *Diagrama bloc a VI-ului "Generator de semnal sinusoidal" interface ".*

VI signal produced by the "Simulate Signal" is sent to a second sub-VI "Formula" (Fig. 4) using a computer interface to create mathematical formulas.

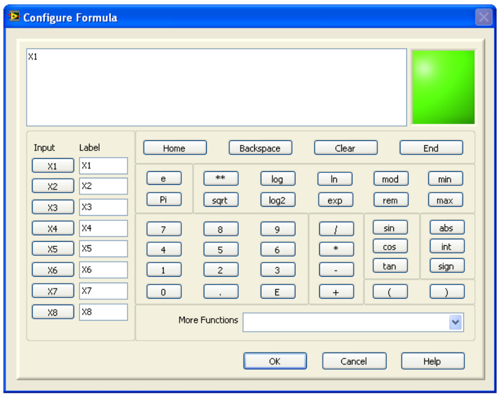

Figure 4: *Sub-VI-ul "Formula".*

In this sub-VI signals are added together and the resulting wave by canceling phase and anti phase signal is displayed on the front panel.

4 Noise signal acquisition. Description of the experimental

We build more devices than initially to test the possibility of obtaining a signal intensity zero and then the noise signals generated and measured to get off or reduce them.

For measurements of noise radiated by distance were made recordings with the following three components acquisition system and data processing Bruel & Kjaer 3560D, power amplifiers Bruel & Kjaer 2713, 2716, Hydrophones Bruel & Kjaer 8104, 8105, 8106 with calibrated frequency response. Experimental background noise and emission acquisition in antiphase is presented in Fig. 5. In Table 1 are given the depths to which they are located hydrophones and underwater loudspeakers.

Table 1

Nr.crt.	Object	Depth (m)
1.	Float cylindrical	3
2.	upper hydrophone	5
3.	median hydrophone	14
4.	lower hydrophone	22
5.	Ballast	27

Acoustic recording system is shown schematically in Figure 5.

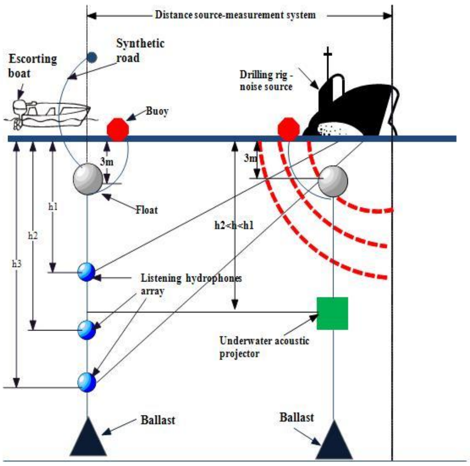

Figure 5: *Experimental background noise acquisition.*

The noise source upon which noise measurements were made was the research vessel “Mare Nigrum”. The experimental context has 2 major components: noise source connected component that contains; noise source: research vessel “Mare Nigrum”; a computer working virtual instrumentation; a system of three underwater sound projectors with systems of reinforcement / recovery related; component that records, measures and processes data related to noise that is reaching away from the ship (noise source).

Noise acquisition system consists of:

-three hydrophones Bruel & Kjaer 8104, 8105, 8106 in frequency response calibrated, placed at different depths, has adopted this type of array hydrophone because the noise diminishes with increasing depth and need to decide at what depth will be located projector underwaterc;

- data acquisition and processing system Bruel & Kjaer 3560D.
- software: Bruel&Kjaer Pulse 12.
- the system is reinforced and stabilized by means of a submarine cable with a buoy and ballast. Movement and location of the hydrophone system is done by a speedboat where as well can be placed the acquisition system.

Recordings were made over a period between 8 and 12 hours at each site with 44.1 kHz sampling rate. Sound recorder was anchored on the seabed with concrete weights. After each deployment the recording system recovers. Recording was done with three hydrophones placed at different depths:

- shallow hydrophone: 5m,
- average depth hydrophone: 14m,
- deep sea hydrophone: 22m.

The noise emission at 180 º out of phase consists of:

- three acoustic projectors, located near the noise source, anchored on the seafloor with a ballast and maintained at a depth h1> h> h2 with a buoy. Acquisition records for processing and storage of used software Bruel & Kjaer Pulse 12.It can display and process sound signal captured from three hydrophones placed at depths presented in Table 1.

Records show that the maximum noise level is the depth to which it is placed the median hydrophone (14 m).At this depth, the noise level is about 6-10 times stronger than that recorded by hydrophone located at 27 m.

5. Acquisition virtual instrument for real-time adjustable configuration

In cases where no data are available to properly characterize the noise source has designed a virtual instrument that has the following functions:

- Signal acquisition from the noise source;
- Produces phase shift of 180^0;
- Adds two signals (acquired at source and out of phase) and displays the result;
- Monitoring can be made as follows:
- by an operator remote from the source and communicating research results to the ship configuration or
- even where the both computers: the one using virtual instrumentation and the other computer that receives the signal acquired by remote hydrophone network are placed aboard.

Virtual instrument front panel of Fig. 6 contains only elements of presenting data appropriate signals such noise over the hydrophone and the result by composing with another of the same amplitude but in opposite phase.

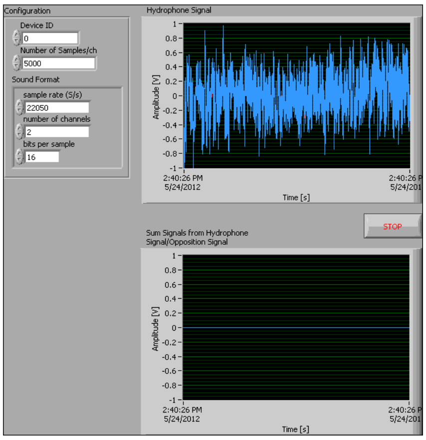

Figure 6: *Virtual instrument "Acquisition in real time adjustable configuration".*

Device's front pannel consists of:

- An overview of the data which is displayed in real time recorded signal;
- An overview of the data where the resulting signal is displayed by summing the two signals: purchased ("Show hydrophone signal to noise") and delivered ("Show summary acquired noise signal / noise out of phase") in antiphase;

Out of phase signal is taken IPA300T power amplifier power amplifier and played through speakers in the marine environment by composition waves causing noise attenuation.

Listen to underwater noise operator over the hydrophone and other acts on the level of the power amplifier up to reduce it as much as possible.

6. Conclusion

Devices were made "Virtual Instrument Sound File Read" for each of the three hydrophones acquisition, located at different depths as it may adopt a noise injection solution out of phase at all three depths where there is the necessary equipment. This tool is based on existing databases and used in contexts described the conditions under which the data were acquired. For purposes of applied field was a virtual instrument designed for "real-time acquisition adjustable configuration". This device is used when you want to set up a database, performing measurements for research or mitigation is needed as much noise pollution by adjusting power in real time acoustic signal emitted by underwater speaker. The instrument acquires samples of noise, in a controlled and continuous emission signal and makes of phase in real time.Virtual Instruments brings two new elements presented in noise management both through their conception and the presented experimental context:

- Practical solutions have been proposed, allowing immediate implementation of the objectives with the highest noise emission, in a first stage using existing databases;
- It was designed an experimental context that can be used for further research and for activities which are not available on database modeling scenarios appropriate to the type of activity. The use of such devices to minimize the impact of anthropogenic activities on the marine environment should become mandatory for all sources of noise emitted during construction and operation of industrial facilities offshore.

The use of silencers specialized for commercial ships, fishing and cruise may greatly reduce the overall level of environmental noise, their contribution to overall noise budget is around 37%.

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