

# NEW METHODS OF UNDERWATER SHIP NOISE CLASSIFICATION

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*The detection, classification, identification and recognition ships noise features have been of the highest importance for scientific and also defense interest. A big effort is made in the passive sonar technologies that allow applying underwater noise for practical purpose. Results are presented which demonstrate the ability of the network to classify man made sources as are underwater ships noise. The paper presents a method based mainly on neural network that is very helpful for classification of these types of sources on the way to recognizing them.*

## INTRODUCTION

Among acoustic waves produced by ships and war ships could be distinguished those, which, are closely connected with possibilities to discover them by means of their signature. The noise is produced mostly by driving and auxiliary systems. The noise level depends mainly on resistance putting up by the environment to the moving object, what is usually connected with forward speed or rapid change of acceleration in case of maneuver movements. Turning ourselves to classic classification of noise produced by ships [1], it is possible to segregate them into:

noise generated by devices active dynamically placed inside and on the surface of the hull, mainly by engine, propulsion and auxiliary, and system of transport of mechanical energy-shafting,

noise produced by ship propellers,

acoustic effects connected with cavitation of propellers and flow around the underwater part of the hull.

In this paper we use the underwater signals to classification process by means of a method that apply a feature of the neural network.

## 1. THE UNDERWATER NOISE MEASUREMENT

The acoustic field of sailing ships changes along with the change of sailing speed and is bound with the mechanical activity of wave sources mounted in the ship's hull (main engines, current generating sets, gears, pumps, shafts, pipelines, ventilation channels etc.) and of hydrodynamic sources like the ship's propeller, the hull's flow around

The identification of sources of underwater noise generated by the moving vessel, with various devices mounted on her, is a complex subject and continues to be an object of systematic research in the structure elements of the ship the propagating vibration energy interferes with acoustic waves originating from various sources, which makes their identification even more difficult.

A method of identifying the vessel's underwater noise is a penetrative examination of its spectrum. From measurements carried out, some characteristic components can be singled out, which are strictly bound with the working of mechanisms and devices mounted on the vessel. The continuous spectrum, which reflects the work of the cavitating ship propeller, turbulent flows in pipelines, ventilators, friction in slide bearings etc. also constitute an object of interest. In practice, it is difficult to identify underwater noise. The vessel's own noise "sums up" with technical noise originating from remote ships' environment, the shipyard industry or the working of a port. There is also noise of natural origin: wave motion, wind and rain. The identification of acoustic spectrum components may be made even more difficult by the fact that various ship devices may be sources of waves of similar or identical frequencies. Identifying the propagation of waves contained in the continuous spectrum of a ship in motion is significantly more difficult to interpret. The hydroacoustic waves coming from cavitating screw propellers, the hull's flow around, turbulent flow of air and liquids in a vessel's pipelines propagate in a wide frequency range. Apart from that, numerous transient processes generate acoustic disturbances, which are difficult to interpret

This work presents results of research on the underwater noise of a moving ships registered by means of the measurement range. During measurements the ships move on set trajectories through the measurement area on a course and counter-course at constant settings of the vessel's propelling system. The set dynamic quantities of the ships reach a minimum of 300 meters before the detectors and do not change it on a section of at least 600 meters (300 meters behind the measurement antenna). A constant recording of acoustic pressure is performed in a certain distance interval before the ships bow and behind the stern. Information obtained in this way permits to characterise the underwater disturbances of the of the ship.

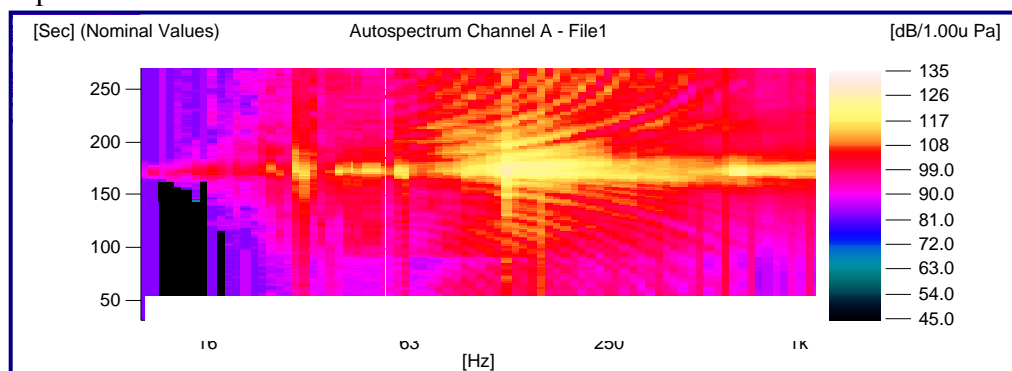


Fig.1 An example of underwater ship noise characteristics in the form of the spectrogram

## 2. THE NEURAL NETWORK APPLICATION TO UNDERWATER SOURCE OF NOISE CLASSIFICATIONS

We used for our investigations the following neural network that consists of the multilayer form shown in Fig .2. The signals from analyzers in form of vector were being given to the inputs of this network.

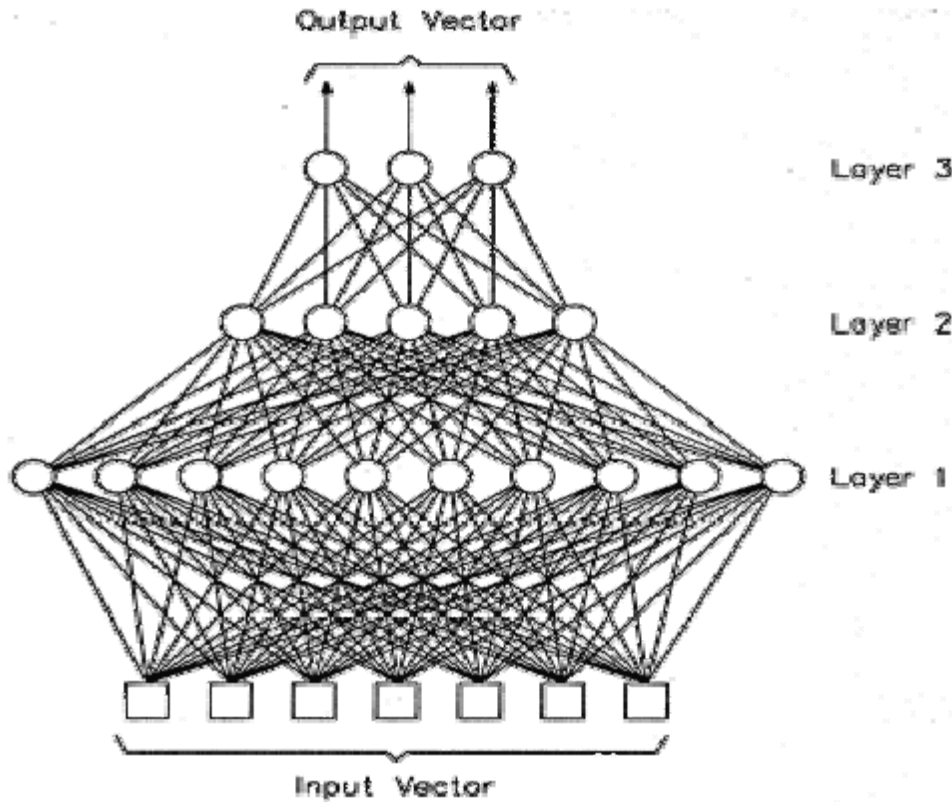


Fig.2 The model of applied network

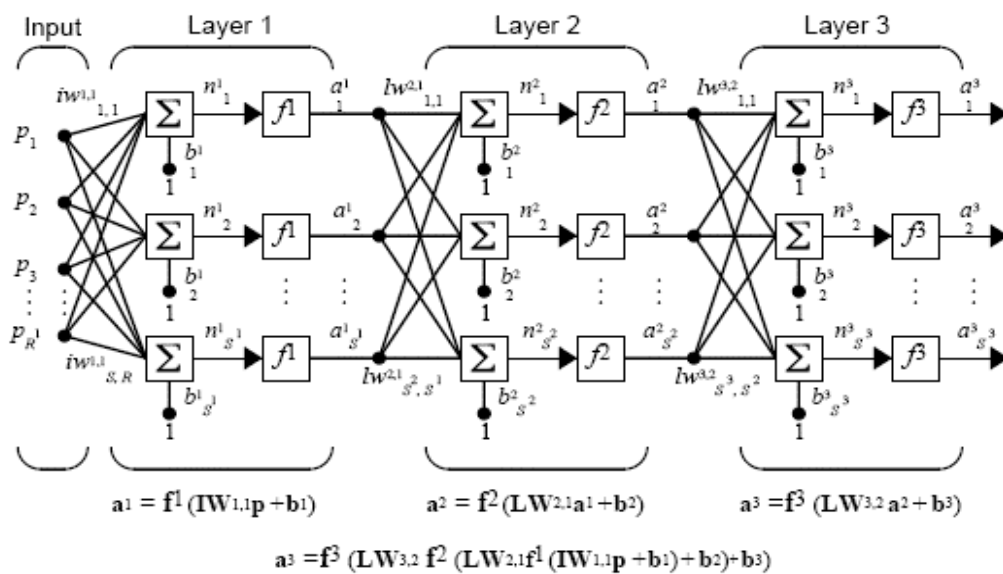


Fig.3 An example of operation schema of the neural network

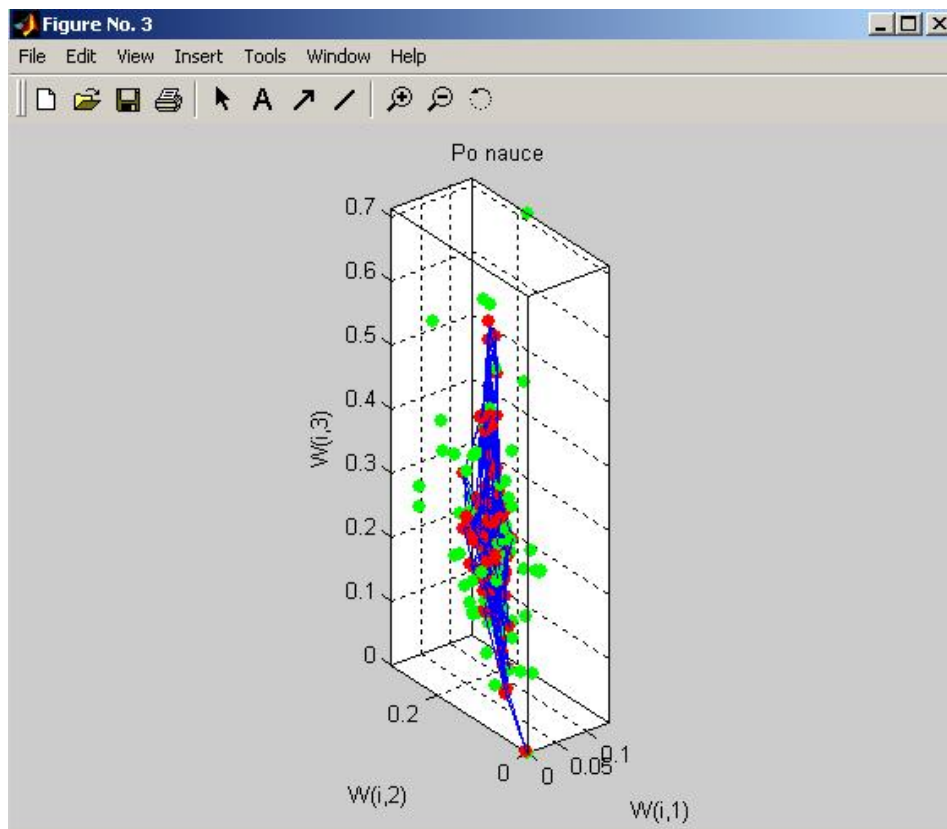


Fig.4 An example of preliminary results (S. Malyska)

### 3. CONCLUSION

The neural network can be useful tool for classifications and recognitions underwater sources of noise. The application this method allows to achieve a high level of protection in the defense area.

### REFERENCES

- [1] B.P. Howell, S. Wood, S. Koksal, Passive Sonar Recognition and Analysis Using Hybrid Neural Networks" Florida Institute of Technology, 1997
- [2] T. Masters, Sieci neuronowe w praktyce, 1996