HYDROACOUSTICS
4, 217-220 (2001)

IMPROVING THE QUALITY OF NOISE DETECTION IN THE SOUTHERN BALTIC IN THE ASPECT OF IDENTIFICATION.

P. Soszyński[1], A. Cichocki[2]
Polish Naval Academy, Gdynia
[1]soszynski@amw.gdynia.pl
[2]acichocki@amw.gdynia.pl

Artificial intelligence systems have been more and more used for the purposes of classification and identification. Recently, a lot of attention has been devoted to the exploration of such techniques in combination with the passive acoustic signals of vessels in the sea environment. Although some of the research imply optimistic results it seems necessary to apply the results of investigations regarding the sound propagation in the sea. This paper suggests was of improving the quality of neural classification by narrowing broadband frequency band to some specific narrow bands.

INTRODUCTION

The acoustical noise is a result of an acoustical field of sound source in the sea environment combined with the ambient noise generated by man-made and biological activity. In general the measurements of the sea noise are oriented towards the improvement of our knowledge about the maritime environment as a medium for the propagation of the acoustic waves and towards the possibilities of detection of signals coming from various sources. In addition to these goals it seems beneficial to explore the possibility of estimation of maximum noise detection range that is specific in different locations. The subject of interest of this paper are the acoustic noises in the coastal area of Southern Baltic where the ambient noise is a result of sound produced by ship traffic and shore installations. Since the results of some research on identification of objects in the sea environment were optimistic [4] it seemed beneficial to further investigate the problem for the purpose of increasing the quality of identification. So far the emphasis was put to apply different types of neural network techniques that did not seem to improve the identification task. Therefore the attention should be oriented towards the necessity of combination of the mentioned artificial intelligence technique with the experimental model for sound propagation in the shallow sea. The possible vessel identification system that consists of a neural module is shown in Fig.1. The pre-processing component is responsible for the proper preparation of data that come from the hydrophone. The selection of frequency bands module has the task of intelligent choice of bands to maximize the efficiency of the whole system and will be described more in the following section.

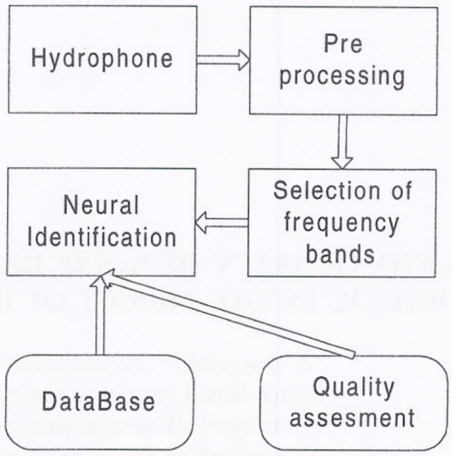

Fig 1. Vessel identification system

1. PROCESSING OF THE ACOUSTIC DATA

It is quite evident that modern sonar systems make a wide use of data processing techniques. Nevertheless, it is certain that the future belongs to systems that will make increasing use of advanced data processing methods. There are several distinct reasons for this which include the ever increasing data volume, the requirement to improve detection performance and the possibility of automated identification of objects. Originally this was achieved using a heuristic approach but has been replaced by using a neural networks capabilities. The neural networks approach is used as a pattern recognition facility, where the pattern of a particular vessel is contained in some combination of signal information present in the input data. The advantage of using neural networks is its ability to recognize an incomplete or slightly modified pattern. One of the main disadvantages of such systems is the necessity for the systems to be retrained on sufficient quantities of representative data so that the system can recognize the vessel. This data is normally of highly sensitive nature and usually hard to obtain. It is generally true to say that the more the classifier is trained the more reliable will be its action. This underlines the problem of validation because it is very difficult to understand why a neural network has failed to recognize a pattern. Besides the mentioned drawback the suggested tool still seems optimal for the identification purposes. Since there are so many types of neural networks and their learning methods it may seem difficult to choose one that is the most optimal for this task. This was addressed in previous works such as [1]. It turns out that already the simplest type of artificial neural network is quite suitable and reliable in identifying the proper signal.

From the point of view of this paper it is not essential to know whether the recognition rate can be improved on the grounds of finding the optimal network topology, learning type or manipulating its variables. It seems that the recognition or identification may turn out to be dependent not on the way we build the classifier itself but more on the characteristics of the sea environment in the measurement area, the way we pre-process the signal and how we feed it to the artificial neural network. Addressing these three issues may be more helpful in understanding the identification process and in improving its robustness. To achieve this end it seems useful to employ the results of past and undergoing research directed towards the investigation of sound propagation.

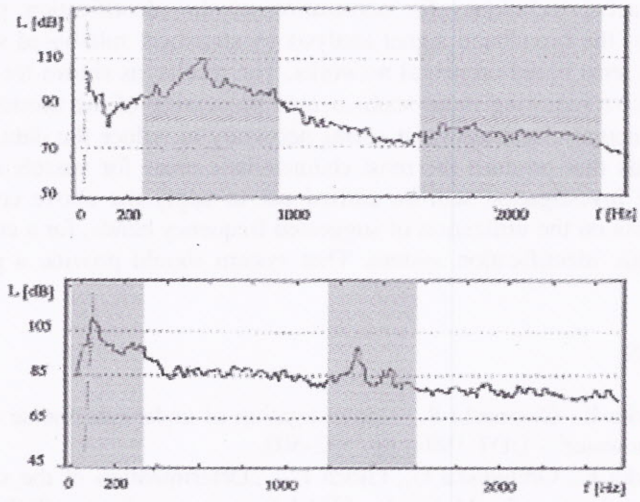

Fig 2. Typical fast and slow vessel characteristics

Acoustic disturbances presented by a ship is a very complex phenomenon. It depends on several internal and external conditions. The following factors belong to the first group: kind of mechanisms placed within a hull, their power and technical conditions, shock absorption of vibrating systems and acoustic isolation of hull's interior. To the second group belong: hull's shape, speed of motion, smoothness of surface, quantity of air in near surface water layer, load of propellers, geometry of propeller screws' blades. Another source of influence on the acoustic field comes from the man-made activity in the vicinity of the ship. All of the above influences are usually referred to as an ambient noise that has a significant and restrictive effect on the range and the quality of detection and identification. Previous investigations regarding transmission losses describe the experimental transmission losses in the Southern Baltic area and the frequency bands that are most suitable for identification purposes. It turns out that a good way to approach this problem is to divide the targets into two categories according to their velocities. Basing on the analysis of typical frequency characteristics of vessels, shown in figure 2, it can be inferred that: both fast and slow moving ships tend to have dominant frequency characteristics in two frequency bands.

- 300-900 Hz, 1600-2400 Hz – fast moving vessels;
- 10-300 Hz, 1200-1400 Hz – slow moving vessels.

These results come from the wide investigations carried out in the Polish Naval Academy and are more thoroughly described for example in the work [5]. From the above considerations it seems that the best identification by the neural network classifier can be achieved using the normalized and pre-processed acoustic signal data describing vessels based in the proposed frequency bands. This process may be a module of a larger hydroacoustic identification scheme, see Fig. 1. The band segmentation method for identification reduces the amount of further neural processing, accentuates the distinctive bands in the spectrum thus lowering the necessary neural calculations and increasing the quality of identification.

3. CONCLUSIONS

The current techniques for automation of the identification process were mostly oriented toward the broadband signal analysis by statistical rule-based systems and artificial intelligence systems based on neural networks. The results, as shown for example in work [4] were inconclusive requiring more sophisticated processing of the acoustic data. To improve the quality of neural classification it seems necessary to reduce the data fed to the system to frequency bands that produce the most characteristic areas for vessels on the basis of their speed. Further investigation will be carried out to apply the above considerations, with a special emphasis on the utilization of suggested frequency bands, for a construction of a more robust automatic identification system. That system should provide a good verification for this model.

REFERENCES:

1. Kozaczka E., Czarnecki S. – „Investigation of underwater noise radiated by a ship in shallow water" - UDT 1994, pp. 502-503.
2. Kozaczka E., Grelowska G., Gloza I. – „Determination of the ship detection area in the coastal region." – Materials of EAA Symposium, Jurata 1997r.
3. Zogoyski A. M., Dawe F. and Robinson M. – „Passive data processing" – UDT 1994, pp. 310-312.
4. Soszyński P., Stateczny A. – „The method of underwater object classification using multi-layer perceptron" – Proceedings of the 2nd International Symposium on Hydroacoustics, Gdańsk-Jurata, 24-27 May 1999
5. Kozaczka E., Grelowska G., Gloza I. – „Determination of the ship detection area in the coastal region." – Materials of EAA Symposium, Jurata 1997r.