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Recognition of Underwater Acoustic Communication based on Artificial Neural Network and Signal Feature Extraction

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Abstract

- Modulation pattern recognition is an important part of underwater acoustic communication. Due to the complexity of underwater acoustic media (propagation loss, ocean noise, multipath effect and Doppler effect), underwater acoustic channel is considered to be one of the most challenging wireless communication channels.
- This paper proposed an intelligent underwater acoustic signal processing and recognition method based on **artificial neural network (ANN) and signal feature extraction**.
- Firstly, the real part and imaginary part of the signal are extracted by fast Fourier transform (FFT), the variance, mean and other eigenvalues of the real part and imaginary part are calculated, respectively.
- Secondly, the extracted signal features are used to train ANN classifier to realize the classification and recognition of different signals. In this way, the intelligent recognition of underwater acoustic signal by **data-driven method** is realized.
- Finally, the effectiveness of the proposed method is verified by simulation, and the good recognition effect is achieved.

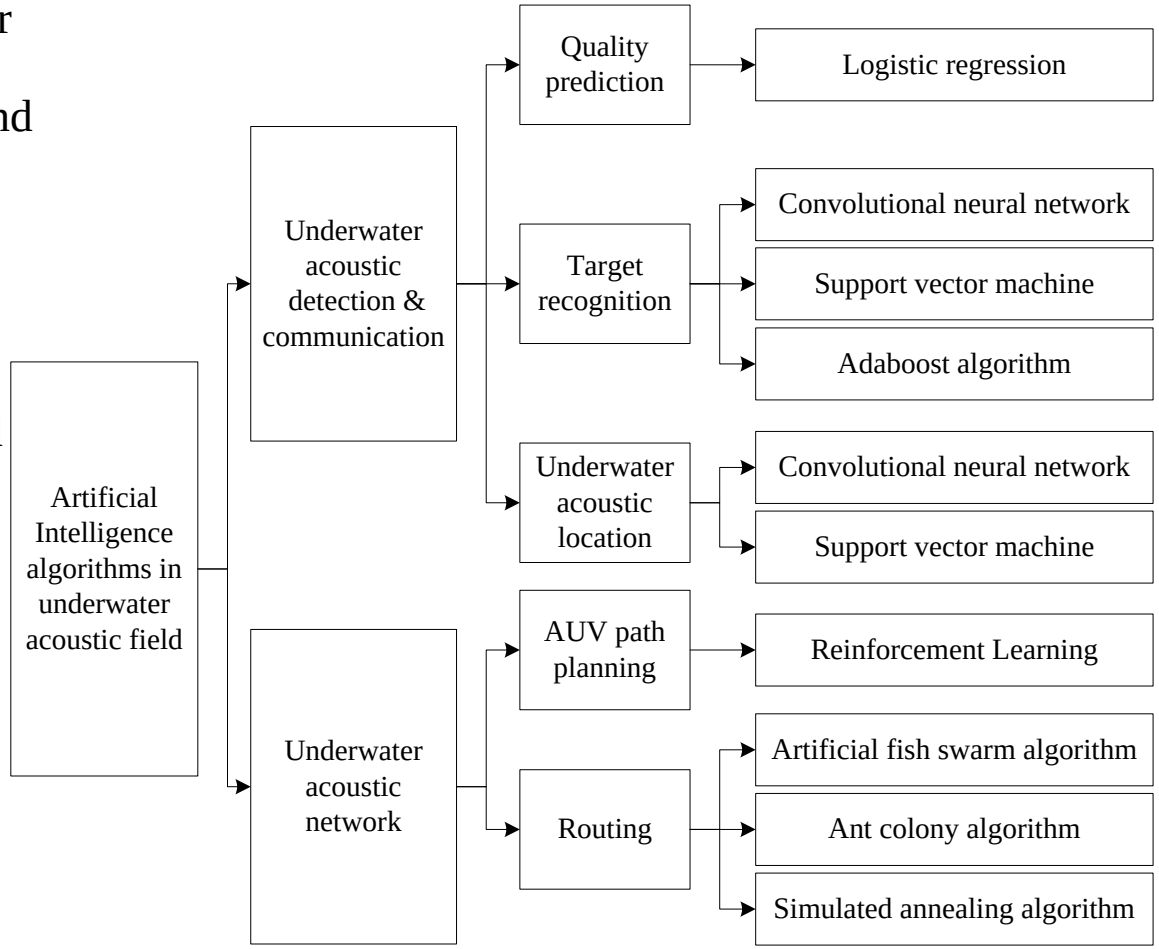

Fig. 1. AI algorithms in underwater acoustic field

Signal Preprocessing

- Signal Transformation:

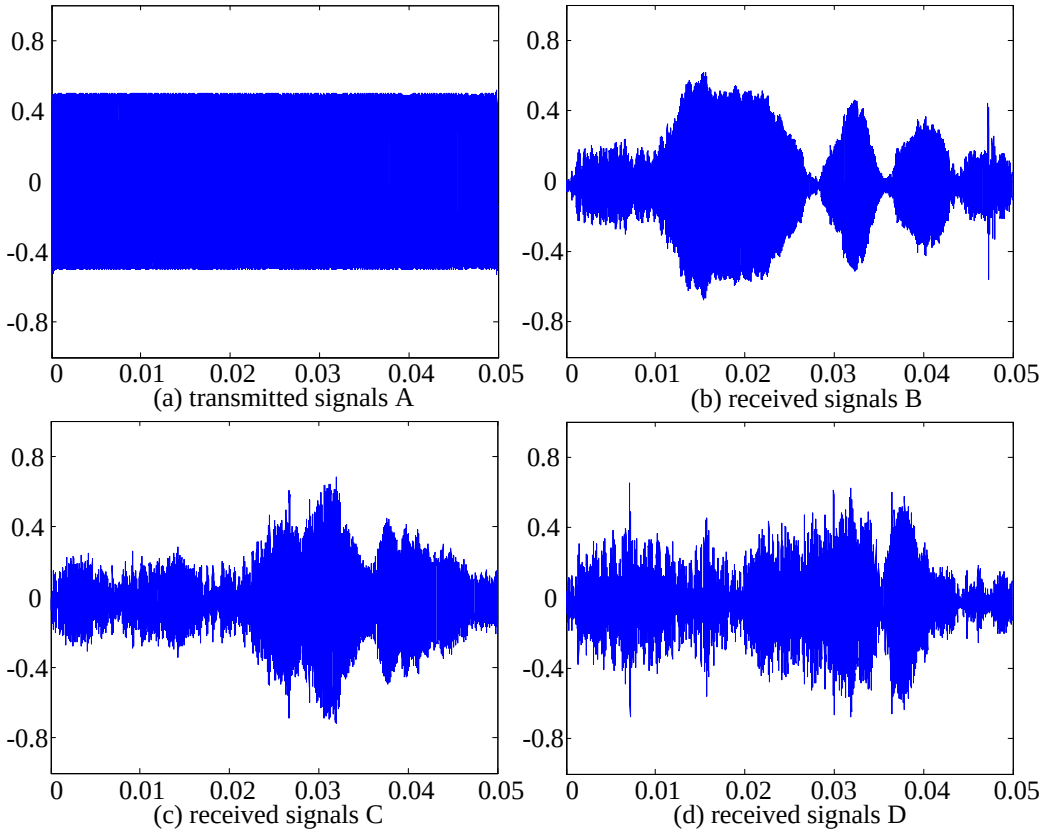

Fig. 2. original signals

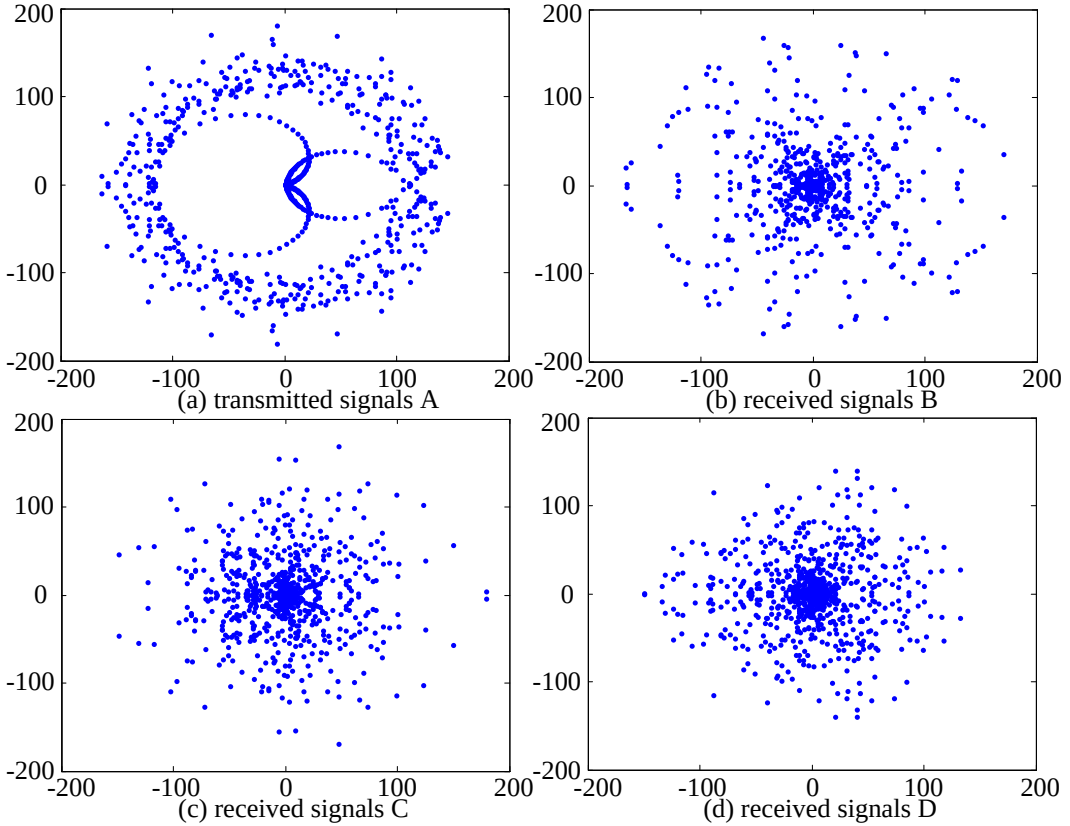

Fig. 4. real part and imaginary part of original signals after FFT transform

Signal Preprocessing

- Feature Extraction:
- The maximum value and minimum value of the imaginary part are linearly related, and only one of them needs to be retained.
- The mean value and median value of the imaginary part are both 0, and they make no contribution to categorizing, so they are removed.
- Therefore, the maximum value, minimum value, average value, median value and standard deviation of real part, the maximum value and standard deviation of imaginary part are adopted to train the ANN classifier.

Signals	Real part					Imaginary part				
	maximum	minimum	average	median	standard deviation	maximum	minimum	average	median	standard deviation
Signal A	145.38	-163.65	0.37	0.22	22.25	180.4	-180.4	0	0	22.98
Signal B	170.38	-213.87	-0.06	0.01	14.57	167.57	-167.57	0	0	14.77
Signal C	179.42	-213.7	-0.01	0.06	12.85	169.12	-169.12	0	0	13.75
Signal D	132.11	-213.8	-0.04	0.04	13.57	139.76	-139.76	0	0	13.01

Signals Recognition classifier based on ANN and Feature Extraction

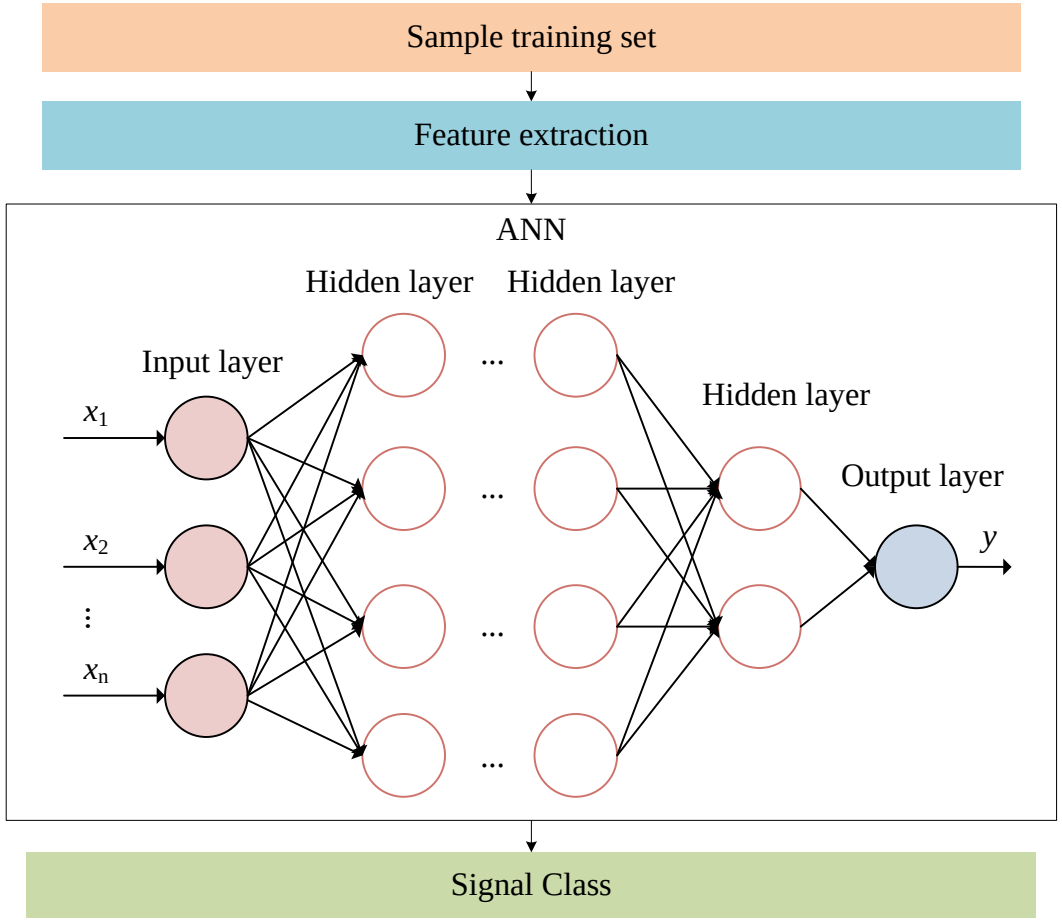

Fig. 9. Training flow chart with proposed method

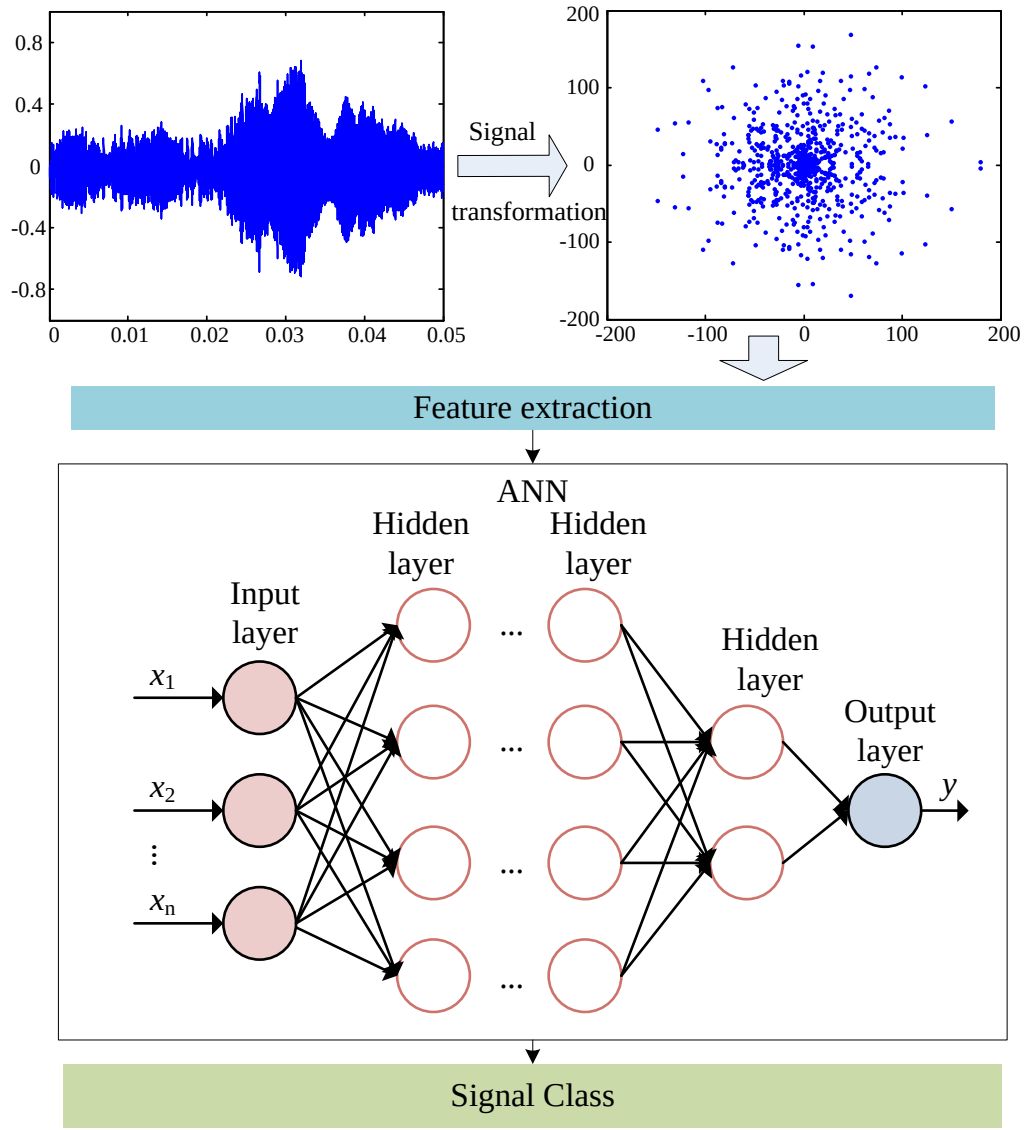

Fig. 10. Flow chart of signals recognition

Conclusion

- This paper proposed an intelligent underwater acoustic signal processing and recognition method based on ANN and feature extraction.
- Firstly, the real part and imaginary part of the signal are extracted by fast Fourier transform (FFT). Then the maximum value, minimum value, average value, median value and standard deviation of real part, the maximum value and standard deviation of imaginary part are adopted to train the ANN classifier.
- Compared with original method, the proposed method has better performance, more useful features are extracted, and the dimension of the data are reduced, and the generalization ability is greatly improved.
- Finally, the effectiveness of the proposed method is verified by simulation experiments of signals recognition.