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Treated Result of Chaotic Detecting System about Radiating Noise of the Ship

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Abstract We performed a detecting experiment about the record data of radiating noise of the ship by chaotic detecting system and compared it with the result of the previous study. The compared result shows that the SNR of new method is greatly high than the previous method.
Key words chaos, radiating noise, signal treatment

Introduction

The passive sonar receives radiating noise sending out by the ship and decides its existence. In that case we can't use the removal method like as a filtering, because frequency band of oneself noise and one radiated by ship are the same. Only the correlative treatment in time field will be successful.

In recent years the chaotic signal detecting system began to employ for detecting the ship radiating noise with high sensitivity and noise control ability. But in the previous study they treated line spectrum band less than 100Hz by the rotation of propeller and the number of wing and it was not compared with the previous method[1－3]. To detect so low band signal, there are so many limitations, due to the extensive size of underwater antenna.

We have done the experiment for detecting and treating radiating noise record data of the ship of 30kHz band that sensible with underwater antenna of small size by chaostic signal detecting system and compared that result with the previous method.

1. The Theoretical Consideration about the Radiation Noise of the Ship

If the velocity excesses the certain value when the ship navigates, it can generate the air bubble by the rotation of propeller and bring about strict air bubble noise. This propeller air bubble has the specific acoustic property, the frequency band have an extensive range from 5Hz to 100kHz and a relative stable low frequency line spectrum.

The air bubble generated in low pressure zone breaks down with high speed when it enters into high pressure zone and the sound pressure pulse formed in that time will be attenuate as an exponent rule [4].

$$p = p_{0v} e^{-\gamma t} \tag{1}$$

where γ is the attenuating constant and p_{0v} is the maximum value when the sound motion starts.

The energy spectrum corresponding to equation (1) is as follows.

$$\left|p_v(\omega)\right|^2 = p_{0v}^2 \frac{1}{\gamma^2+\omega^2} \tag{2}$$

where ω is the angle frequency.

The generation and disruption of propeller air bubble depends on the distribution of tag flow field and the generating moment of the countlessly a lots of air bubbles and the distribution of tag flow field are accidental, but the rotating number of propeller and the number of wing are determinative. By the common action and influence of accidentalism and determinism, the air bubble noise will have semi-period property.

2. The Experimental Method and Results

2.1. The experimental method

The signal treating algorithm is exhibited as Fig. 1.

For convenience of signal treatment we previously converted the noise signal of 30kHz into 8kHz.

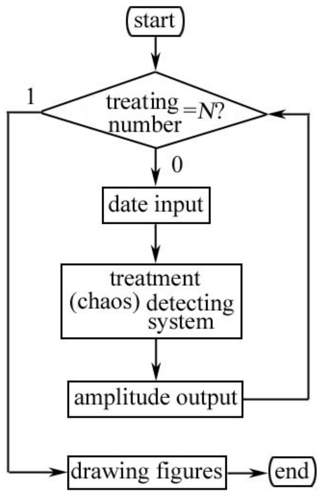

Fig. 1. The signal detecting

2.2. The experimental results and analysis

As you can see in Fig. 2, the detecting system of correlative treatment + chaos, highly improved the rate of signal noise of source signal than the previous method.

For analysis, at first we extended the treat curved line into vertical direction (Fig. 3).

As seen in Fig. 3, noise level spread over all interval bottom in the curved line that we obtained in the previous method, but hardly find the noise level in the curved line obtained by the new method.

Secondly we extended the source signal of interval corresponding to no output and the one that appears as the peak into horizontal direction respectively (Fig. 4).

As seen in Fig. 4, in the interval where no output has, the waveform is disordered. Accordingly the signal detecting system dose not response on it and repressed it. But the noise repressing ability of the previous method is remarkably weak, so in this interval still something weak noise remained. In the other hand the signal that appears as the peak in the treatment result is semi-period signal.

As a result, two methods sensitively response to it, however the output obtained by new method greatly large than the previous one. So we can know that the respondent ability of new method is remarkably good.

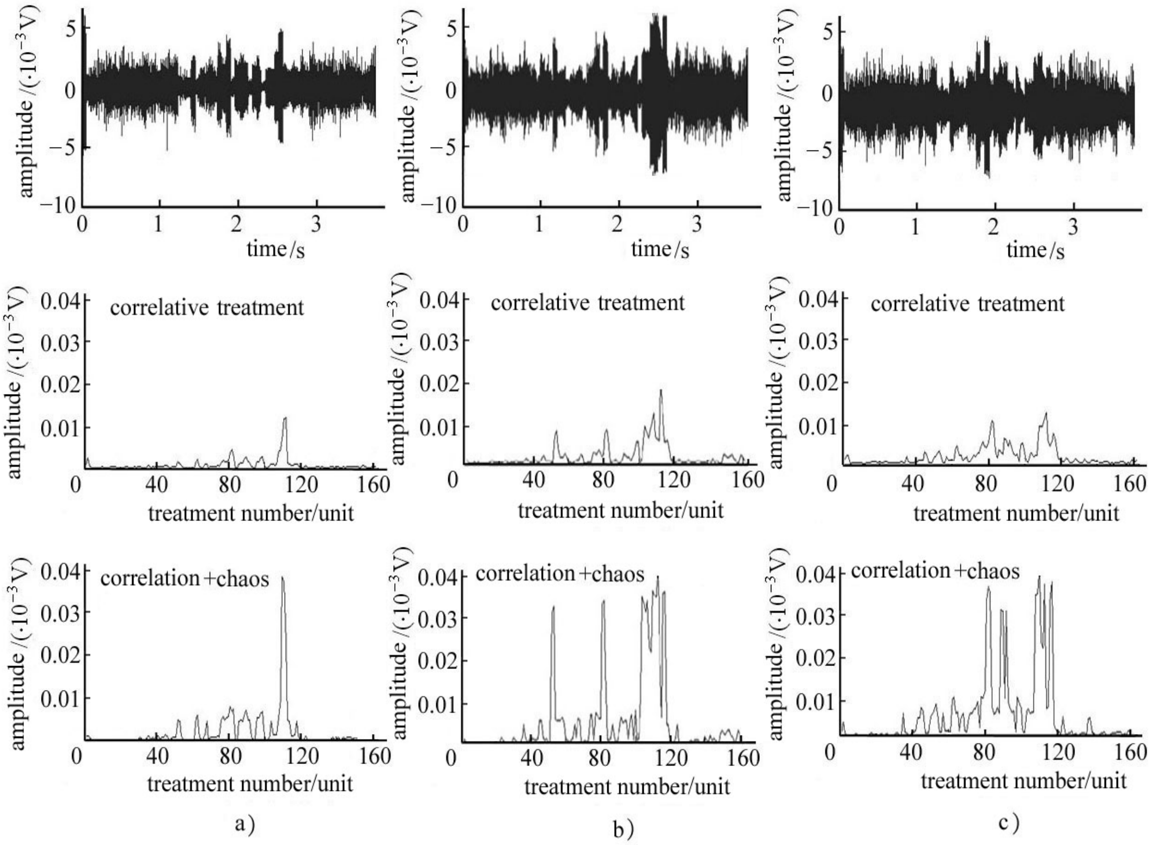

Fig. 2. Detected results according to treating method

a－c are the pathway of 22-6, 22-9, 22-4 respectively

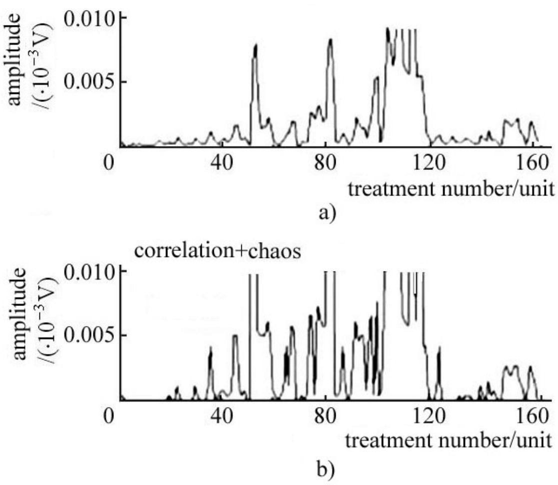

Fig. 3. Treated curved line extended into vertical direction

a) The previous method, b) The new method

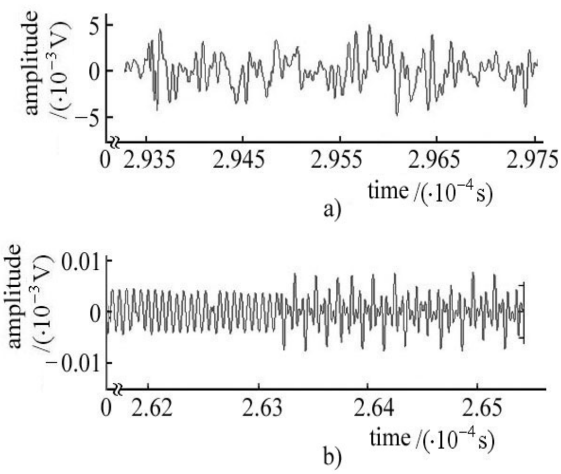

Fig. 4. The source signal extended into horizontal direction

a) No signal interval, b) Interval of signal appears peak

For investigating the frequency component of each interval we executed Fourier convert about two intervals respectively (Fig. 5, 6).

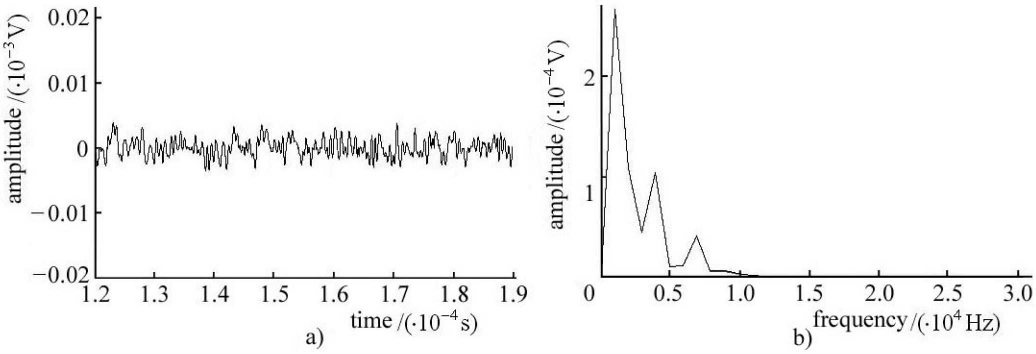

Fig. 5. The frequency component of the output nothing interval

a) The source signal, b) The converted signal

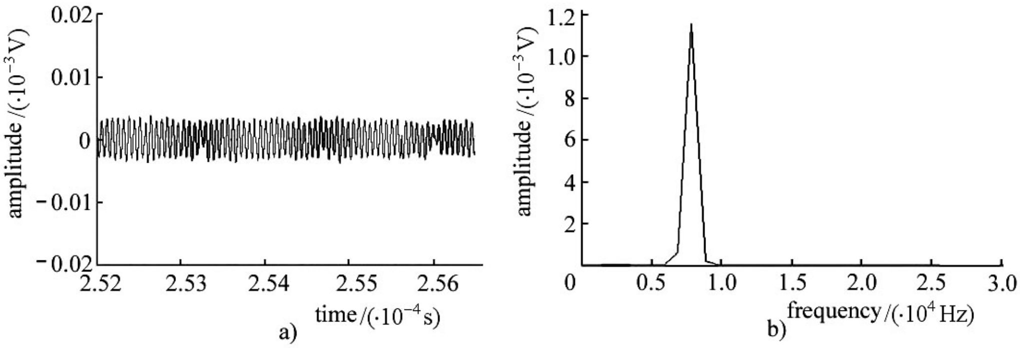

Fig. 6. The frequency component of the output appears peak interval

a) The source signal, b) The converted signal

The frequency component in Fig. 5 is the output nothing interval. In this interval we can see that the frequencies inclined toward the low frequency band and the 8kHz component almost can't find.

The Fig. 6 shows that the output appears as the peak, in which the frequency component is composed by 8kHz.

Conclusion

The noise signal of about 30kHz by air bubble disruption is semi-period signal.

The correlative treatment +chaotic detecting system can highly raise the effective signal level and depress the noise level to near zero, so the capacity of the detecting system can be sharply improved.

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