ADAPTIVE NOISE CANCELLATION APPLIED IN HYDRODYNAMIC FIELD

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ABSTRACT There are strong ocean wave interference with big amplitude very low frenqencies which are similar to the ship's hydrodynamic signals. To detect ship's hydrodynamic field will be faced various natural hydrodynamic interferences which are radom and the prior knowlege of which are not know. This paper proposes to use the adaptive noise cancelling principle and used the model of adaptive wave canceller to eliminate the ocean wave interfrence and detect the ship's hydrodynamic signals. Computer simulation results shown that signal to noise ratio can be raised from several to ten times. It shows the fact that this mathod can detect the ship's hydrodynamic signals from the strong ocean wave interferences while it is difficult for the old methods.
KEY WORDS Adaptive noise technology. Hydrodynamic field. Ship's hydrodynamic signals. Adaptive wave canceller. Ocean wave interference.

1. INTRODUCTION

There are two kinds of hydrodynamic fields,one is ship's hydrodynamic field, another is natural hydrodynamic field. All natural hydrodynamic fields are interfrence noises when we detect ship's hydrodynamic signals. These interfrence noises produced from ocean waves are ofen existed and belong to AR moden noise. But the ship's hydrodynamic signal suddenly appears, and existed very short time. In ocean,it can not extract the ship's hydrodynamic signals applied conventional double input channels adaptive noise channcelling system. This paper proposes an improved singleinput channel adaptive signal processing as shown in figure 1.

2, SINGLE INPUT CHANNEL ADAPTIVE SIGNAL PROCESSING

In ocean, while detecting ship's hydrodynamic signal with transducer, it must accept waves hydrodynamic interfrence noises at same time, but hasn't anather reference input which consits of noise alone. Therefore in order to structure an adaptive noise canceller, it must be through primary input across delay line to form an appropriate reference input channel. Delay line is such chosen that wave interference noises in primary and reference inputs are correlated but signal uncorrelated as much as possible. By learning and through adaptive algorithm of LMS iteration and recursion of one order, adaptive filter can automatically

adjuste its own impulse response, hence it may be cancelling the wave interfrence noises and extracting the ship's hydrodynamic signal from noise effectively. The principle of processing of this adaptive wave interfrence noise canceller may be expressed as following:

Output signal of transducer is

$$d(m)=s(m)+n(m) \tag{1}$$

$$x(m)=d(m-k) \tag{2}$$

s(m) is ship's hydrodynamic signal
n(m) is waves interfrence noise
x(m) is reference

Output of transversal filter is

$$y(m)=\sum_{n=0}^{N} \hat{w}_n(m) \cdot d(m-n-k) \tag{3}$$

N—link number of filler
k—link number of delay line

System output is

$$e(m)=d(m)-y(m) \tag{4}$$

Processing by LMS adaptive iteration and recursion of one order:

$$w_n(m+1)=w_n(m)+ 2\mu e(m)d(m-n-k) \tag{5}$$

$$\hat{w}_n(m+1)= \alpha w_n(m+1)+(1- \alpha) \cdot \hat{w}_n(m) \tag{6}$$

Where α is the constant of recursion

$$w_n(0)=0,\ \hat{w}_n(0)=0,\ n=0,1,2,3\cdots,N \tag{7}$$

Under litter prior knowledges of s and n,owning to the abilities of self

learning and tracing, this improved adaptive signal processing system according to the differences of noise and signal as before descripted, hence it can cancel the wave interfrence noise and keep the ship's signal effectively.

3. DESIGN PARAMETERS

Convergence factor μ is a constant that governs rate and stability of convergence. It can be chosen suitable over the range of $0<\mu<1/\lambda_{max}$, λ_{max} is maximam eigenvalue of noise correlation matrix. Chosen the magnitude from big to small of two value method, the convergence rate and the signal to noise ratio can be raised simultaneously. Weight length is $n = M/\mu\lambda$. Delay line $\triangle$ decide on correlation. Recursive constant $\alpha<1$. The frequency of ship's hydrodynamic signal below 0.1 Hz, hence sample frequency should greaten (0.2-1)Hz, iterative period should be less than 0.5 sec., one operational calculus of iteration of single -chip microcomputer is about 14ms. only, therefore it is satisfied with the real-time entirely. Figure 2 is the sum of ship's hydrodynamic signal and a background noise of wave interferences. Figure 3 illustrates the result of extracting the ship's signal from that noise. It can be seen this improved adaptive signal processing increases the signal noise ratio remarkably.

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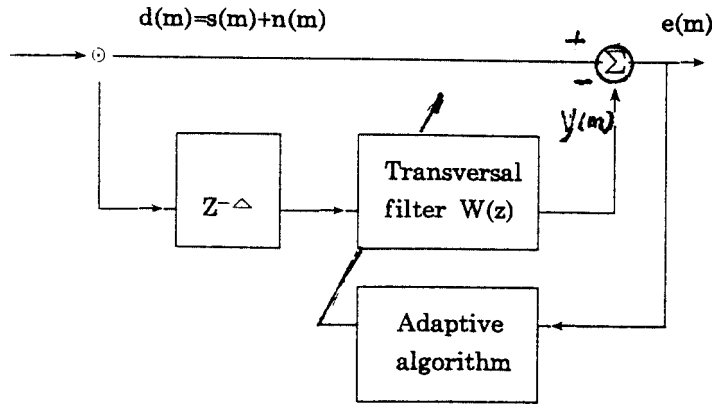

Fig. 1. single input channel adaptive signal processing

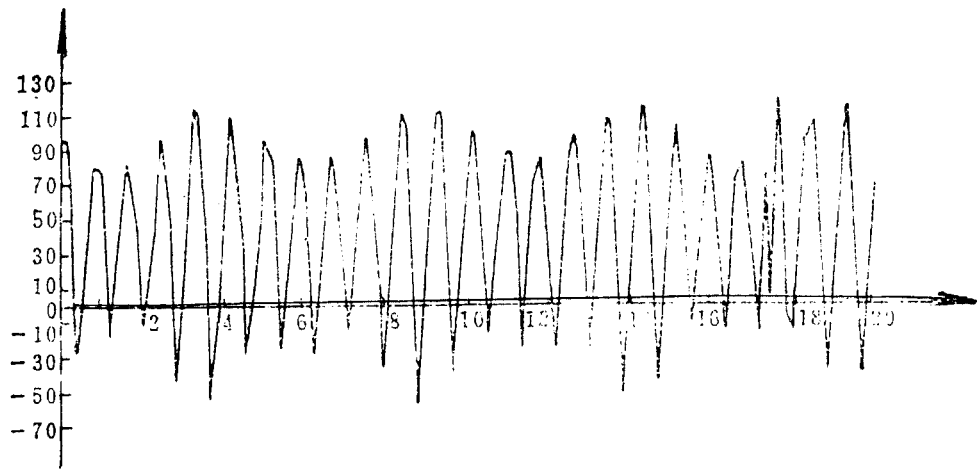

Figure 2 is the sum of ship's hydrodynamic signal and a background noise of wave interferences.

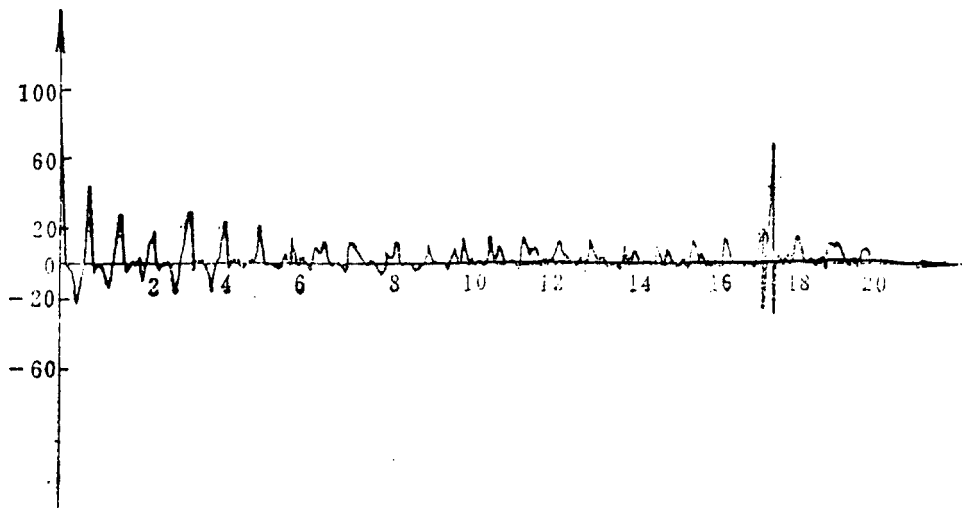

Figure 3.

result of extracting the ship's signal from that noise.