THE ADAPTIVE NOISE CANCELING BASED ON THE BACK PROPAGATION ALGORITHM AND THE GENETIC ALGORITHM

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Abstract: In this paper it is proposed that the algorithm of back propagation algorithm and the genetic algorithm joined. The back propagation algorithm is the most typical multi-layer neural network algorithms. It is more successful in local searching. but because BP network adopt gradient searching mostly, therefore it exists that the convergence rate is slow unavoidably, easy to fall into local minimum searching extremely. And the genetic algorithm is good at the global searching, and its performance of robust is excellent. This paper will adopt the genetic algorithm to optimize the initial weight value in the network , it combines two kinds of algorithms and makes complementary advantages. Learned by the simulation result, the mix algorithm of BP and GA algorithms raise no matter at operation speed or operation precision compared with single BP, and it reach obvious result at improvement degree of SNR, the SNR of the mix algorithms raise about 23db to the cosine signal.

Keywords: the adaptive noise canceling, neural network, BP algorithm, genetic algorithm, SNR

Introduction: The technology of the adaptive noise canceller is on signal processing ,which can clear off background noise effect better. When the disturbance source from environment is not available ,its way to transmit is a constant change ,background noise and tested sound wave are similar .Using the technology of the adaptive noise canceller ,we can clear off disturbance from environment effectively better and acquire high SNR of tested signal .

Theoretically, the adaptive noise canceller is a kind of expansion based on the adaptive filter. In brief, we change the expected signal input $d(n)$ of the adaptive filter into the primitive input end that a signal adds the noise and interferes. And its input end changes into an interferes noise end, we may offset primitive input noise of interfere by adjusting parameter of transversal filter, at this moment the error outputted is a useful signal. In the collection and processing of digital signal, the linear filter is a method of the most frequently used elimination noise. It is easy to analyse linear filter, because using minimum criterion of variance it can find close solving. If the type of noise is one gauss of noises, it can reach best filtering result. While gathering in the real digital signal, the noise disturbance superposing signal is not single gauss noise. But the linear filter required medium noise of wave filter is skew, it makes linear filter to non-gausses noise filtering performance drop. In order to overcome the shortcoming of linear filter, we often use non-linear filter. So in this paper the method of filter processing to signal is by neural network[1].

The adaptive noise canceling based on the back propagation algorithm and genetic algorithm joined: The back propagation algorithm is the most typical multi-layer neural network algorithms. It is more successful in local searching. but because BP network adopt gradient searching mostly, therefore it exists that the convergence rate is slow unavoidably, easy to fall into local minimum searching extremely.

The genetic algorithm chooses probability as the main means, and it is good at the global searching , and the genetic algorithm one is excellent in robust, it is very meaningful to combine the genetic algorithm and BP network[3~7].

The inspiration of the structure optimization method of BP-GA is:

(1) Utilize BP neural network mapping the relation of design variable and goal function, restriction;

(2) Realize optimizing and searching for with the GA;

(3) The calculation of fitness function in the GA adopts the neural network to realize.

The design step of BP-GA mixed algorithms is:

(1) Analyse the question, put forward goal function, design the variable and restraining the condition;

(2) Establish the proper training sample, calculate and train the sample;

(3) Train the neural network;

(4) Adopt the GA to seek the optimal structure;

(5) Use the trained neural network to check up the GA results, if they meet the demands, it is over to calculate; if the error does not meet the demands, will make the examine results add to the trained samples, then carry out 3-5 steps repeatedly until meeting the demands;

Using the online error $E_{k'} = (S_{k'} + n_{k'} - y_{k'})^2$ trains the adaptive filter. It makes $E(n_{k'} - y_{k'})^2$ minimize. If the adaptive wave filter simulate a noise wave filter, the output y_k of the adaptive filter is approached to n_k, then the noise of the system output e_k will be suppressed basically, the error e_k will approach the initial signal not interfered , thus achieve the goal of canceling the noise[2].

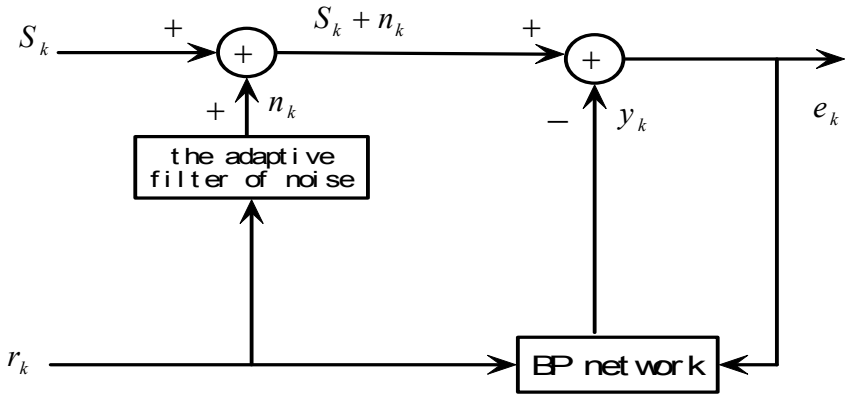


figure 1.1 the adaptive noise canceling system

This paper under Windows98 , utilize MATLAB language carry on algorithm emulation , and makes noise offset with cosine signal, filtering to one gauss of white noises mainly. by Fig. 1.1 the adaptive noise canceling systematic principle block diagram shown , make input noise of consulting as mean value, value is 0, variance as the white noise array of normal distribution of 1, produced by the non-linear difference equation, this is realized through Fig. 1.2 system.

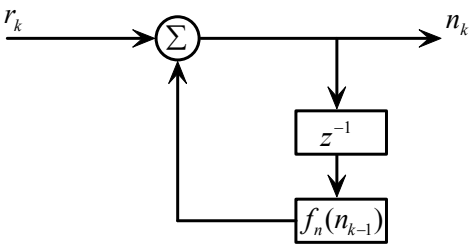


figure1.2 the noise filter

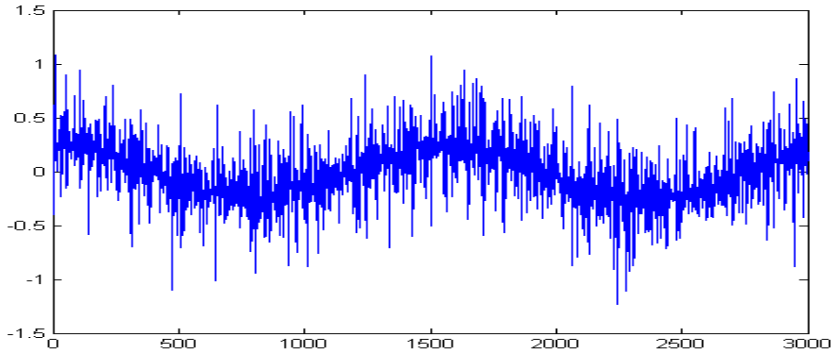
This paper use MATLAB to program the neural network and the genetic algorithm in order to be used in modeling and optimize separately, carry on noise canceling test with cosine signal, through use single BP algorithm and mix algorithm comparing respectively.

Results: Table 1.BP algorithm emulation result of the cosine signal

Learning rate	epochs	error	snr	snrf	time(s)
0.05	1000	0.0139	-1.6558	18.8166	192.6300
	2000	0.0167	-1.6505	18.9099	502.5700
	3000	0.0103	-1.4420	19.3115	673.2200
0.01	1000	0.0163	-1.9023	19.7746	202.6200
0.1		0.0116	-1.4377	18.7248	208.7200

Table 2.the mixed algorithms emulation result of the cosine signal $(lr = 0.05, epochs = 1000)$

population	Probability crossover	Probability mutation	error	*snr*	*snrf*	$t(s)$
30	0.8	0.05	0.0062	-1.4983	21.4556	92.4900
20			0.0120	-1.7810	20.4264	101.9900
40			0.0095	-1.4983	21.4556	112.2705
50			0.0151	-1.2142	17.9141	199.4900
30	0.8	0.01	0.0128	-1.7810	19.6638	116.6600
		0.1	0.0128	-2.0127	19.8690	110.6700
	0.5	0.05	0.0126	-1.5502	19.4527	176.7500
	1.0		0.0128	-1.9543	20.0131	131.1100



Figure(a) the added noise signal

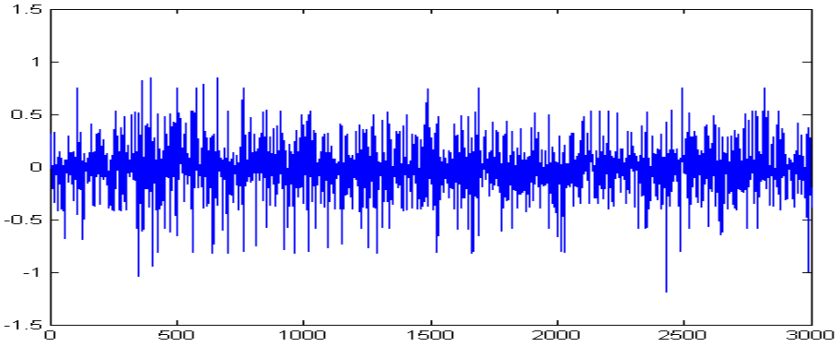
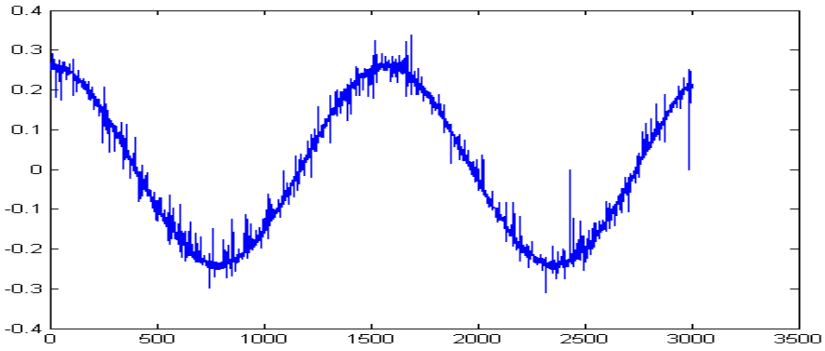
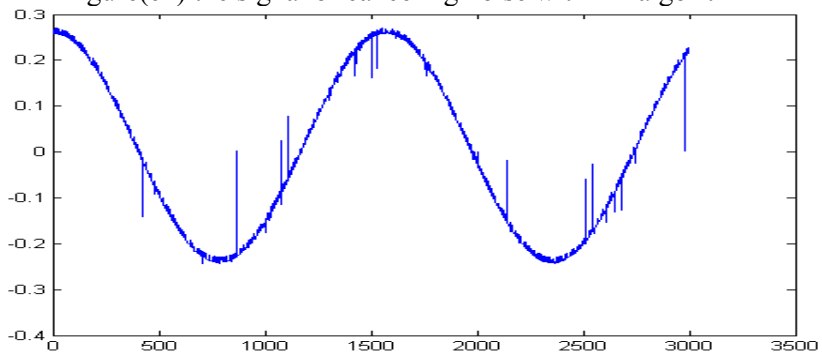


Figure (b) the output signal of the adaptive filter



Figure(c1) the signal of canceling noise with BP algorithm



Figure(c2) the signal of canceling noise with mixed algorithms

Discussion: Through using cosine signal to offset testing, in single BP, the training number of times, the learning speed , the network layers and determination the number of each layer, which are important parameter influenced BP network. Through simulation experiment we can find proper training times may make the error minimum, but if training times are too much, training time will be too long, so it is easy to fall into bad circulation, or learning precision is decrease. Learning speed can't choose too heavy, otherwise the algorithm appear non-convergence, can't choose too light either, the training time will be too long. So as generally we choose the value of 0.01~0.1, then we confirm the value according the gradient change and the square error change in the course of training.

BP based on gradient principle, searches for only alone in solution space, and it is extremely easy to convergence to the local minimum, but numerous individual of GA search for a lot of solution in space at the same time, therefore GA can prevent effectively to convergence to the local minimum during the searching course. Nothing but the parameter and the GA operation of operator of algorithm are chose properly, the algorithm has great assurance to convergence to the global solution. Using genetic algorithm need operation parameter that determine population size show including individual quantity in the population, when the populations are small, it can raise the operation speed of GA , but it has reduced the variety of the population, can't find out the optimum solutions; When the populations are bigger , it can increase calculations , and make GA operational efficiency decrease . so we choose the value of 20-100 as the populations generally; The probability crossover is controlling the frequency of operated alternately, because it produces the new individual's main method in the GA to operate alternately, so the probability crossover should usually choose greater value , but if too big , it may destroy the optimum mode of the population, generally we choose the value of 0.4-0.99; The probability mutation(pm) is also one factor that it influence the new individual producing, if pm is little, produce individual little, if pm is too heavy, it can make GA turn into at random searching for, so we choose the value of 0.0001-0.1 generally.

Conclusions: Learned by the simulation result, the mix algorithm of BP and GA algorithms raise no matter at operation speed or operation precision compared with single BP, and it reach obvious result at improvement degree of SNR, the SNR of the mix algorithms improve about 23db to the cosine signal.through using single BP algorithm and the mixed algorithms relatively we find the GA algorithm has strong processing and optimize ability separately, optimizing the weight of BP with it ,compared with original single BP algorithms , the mixed algorithms can save a large amount of learning and calculation time, and improve SNR.

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