An Algorithm Based on Wavelet Neural Network for Garment Size Selection

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Abstract

Size fitting problem is a main obstacle to large scale online garment sales.It is the difficult to customers to find the fit garments when they couldn't try on. In this paper, we present an algorithm base on wavelet neural network to help customer choosing their clothing specifications automatically. After the reasonable wavelet function is selected, we established the model structure and the initial parameters. The wavelet neural network is trained by the body measures and the result of AHP algorithm after normalization. The new data are used to test the network. As a result, the error from wavelet neural network is smaller, and the prediction accuracy is proved than that from the algorithm based on traditional BP network.

Keywords*: Wavelet neural network, wavelet transform, Garment size selection, matching algorithm, Fit garment matching*

1. Introduction

With the development of shopping online, the status of garment network sales is rising gradually. According to the statistics, 50% returns are because of unfitted problems since customers can't try garments on by online sales [1]. Many researches devote themselves to find a method can keep customer's measurements match with garment size. In garment size selection algorithm, least-square method has been applied on garment size classification for a long time [2]-[4], it can develop the rationality by using weighting method. Yu [5] put forward a garment size selection method by comparing the matching relationship between figures and garment size. Through the comparison between chest、waist、hip width of figures and the ones on garments, define the matching relationship between figures and garment size. He [6] made research on Yu's method, and proposed modified advice. Xu put forward using AHP method to select garment size [7],the method makes size selection into quantification, which is suitable for garment sales online. On the basis of AHP, Ding and Xu also developed a garment size selection method combined immune algorithms and AHP [8], and support that the prediction accuracy of it is higher than using AHP alone. The method from Chen, made use of BP network to process size classification [9], can apply on garment size selection the same. Some garment size matching algorithms are completed in the form of virtual fitting. In this case, garment pattern has been regarded as a pure geometry problem transferred from two dimensions into three dimensions. Structure grid was made on the patterns, and then finite element method is used to calculate the surface curvature of garment models in order to process salient points matching automatically [10]-[11]. Propose a co-evolutionary immune algorithm for the multi-criteria decision making (MCDM) model, and use the model to solve the large scale garment matching problem [12]. The application of neural network on size selection use the measurement points as input and the corresponding garment sizes as output to train the network [13]-[14] .

In this paper, we developed the method of garment size matching on the basis of wavelet neural network. It could input new somatic data and actual suitable garment size by trying on in the follow-up step, by means of training reduce the discrepancy between neural network output and actual results.

2. Wavelet neural network size matching algorithm
2.1. The selection of wavelet function
We choosed several wavelet functions as the basic function of the neural network, including Morlet's wavelet ,which is used to establish wavelet neural network and has been applied on kinds of fields widely. The wavelet function is used as hidden layer nodes of the network. Hidden layer nodes number is 100. The error of mean square（e）for trainings is defined as follow:

$$e = \sqrt{\frac{1}{L-1}\sum_{i=1}^{i=L}(d_i - y_i)^2}$$

(1)

In the formula: L is as hidden layer nodes, d is as the ideal results. (This paper results from AHP), y is as neural network output.

After 100 times training, the network error use Littlewood-paley wavelet function can decrease by about 0.35,while the one use Morlet wavelet is about 0.4.Made experiments on Mexican cap wavelet、Shannon wavelet to process test, the results is still not better than Littlewood-paley. So this paper uses Littlewood-paley wavelet function as basic function of hidden layer.

2.2. Confirm hidden layer nodes number
It's very important for wavelet neural network training study to confirm hidden layer nodes number. if the hidden layer nodes number is too little, network will not possess the essential ability of processing data. On the other side, if there are too many nodes, the network complexity will be increase greatly, which will slow down the network learning speed. process. The common approach is cut-and-try, that is, hidden layer nodes number is confirmed by trials. The test starts with a minor node. As the nodes number is increased step by step, the results were compared. We get the test on the selected hidden layer nodes number. The results are showed as below, in which the errors are the data of 100 times trained.

Table 1. Nodes number and Training error

Nodes number	10	20	40	80	120	160
Error	0.301	0.275	0.217	0.106	0.099	0.080

The results show that, the training error will be getting smaller as the nodes number get bigger within a certain range. We use the number 100 as our hidden layer nodes number considering that the bigger number would lead to the over-fitting of neural network and influence on training speed.

2.3. The selection of initial parameters
The selection of initial parameters makes effect on local minimum point and network convergence speed. If initial weight value is not suitable, learning process will get into local minimum point, and might even stop working. In the wavelet neural network, we could use the random value between (0, 1) as the initialization of connection weights between hidden layer and input layer, and the one between output layer and hidden layer, as we used in BP network.

2.4. The confirmation of learning rate
Since the selective wavelet function mostly has limited support, the big learning rate might lead the network parameters to be out of suitable scope, and then the output value might be to zero. So the wavelet learning rate should be a positive number as small as possible.
Experiments shows that the big learning rates (i.e. learning rate of connection coefficient µ1=0.1, learning rate of scaling parameters and translation parameters µ1=0.1) lead

the network fall into local minimum, thus the training failed. While μ1=0.1 and μ1=0.001 are selected, the training result is better.

Figure 1 shows the establishment process of neural network structure above. Figure 2 shows the neural network training process.

3. Simulation
3.1. The selection for training sample set

637 sets of body data is selected from age 18-35, which is measured by BoSS-21 3D body measurement system from Zhejiang Science and Technology University fashion institute. 600 sets of data are applied for neural network training, and other 37 sets are applied for neural network test.

Neural network structure is 5×100×1(input layer: 5 nodes, hidden layer: 100 nodes, output: 1 node).In the training process, 5 critical part measurements (chest、waist、shoulder width、sleeve length、centre back length)are putted on input layer nodes The ideal results, d, is got from the output result of algorithm based on AHP. -1 is used to represent small size, and 0 is used to represent middle size, and 1 is used to represent large size, and 2 is used to represent extra large size. Data is normalized to the interval between [-1,1] before training.
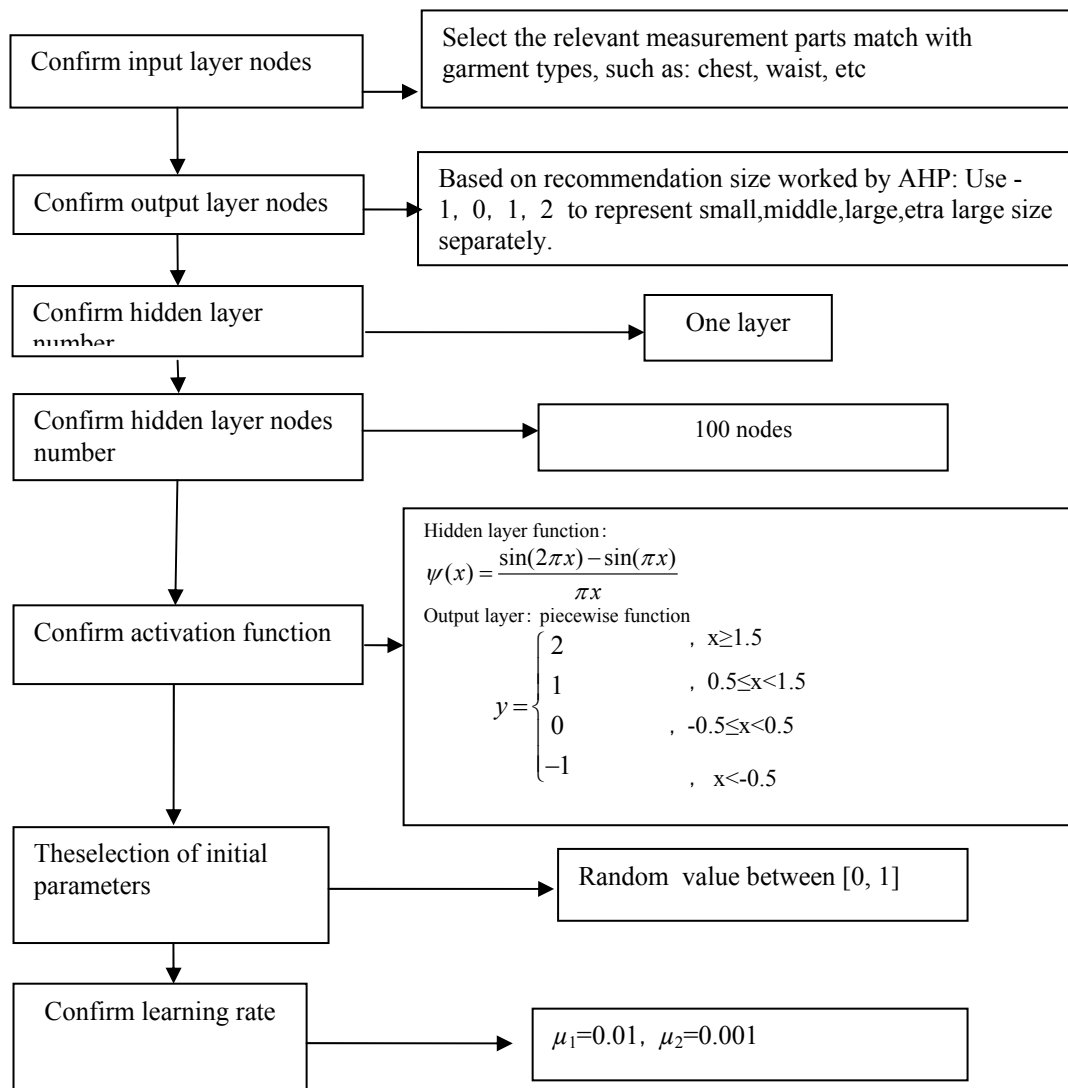

Figure 1. wavelet neural network model flow chart

Definition: N:Input layer nodes number ;l:output layer nodes number; L:hidden layer nodes number; wln: the connection coefficient between the nth input layer node and the 1st hidden layer node; wl: the one between the 1st hidden layer node and output layer nodes; a:the expansion coefficient of wavelet function; b: he translation coefficient of wavelet function , μ:learning rate; k :iterations.

Initialize coefficient

Normalize input and output data:
tn :value for the nth node after normalizing somatic data on input layer
Ŷ: ideal results,
d's: normalized value

Iterations<*k*>

N

Y

$$y = \sum_l w_l \psi \left(\frac{\sum_n w_{ln} t_n - b_l}{a_l} \right)$$

$dw_l=-(\hat{y}-y)*\psi_l$
$dw_{ln}=-(\hat{y}-y)* w_l*\psi_l*t_n/a$
$db_l=(\hat{y}-y)* w_l*\psi_l' /a$
a_l variation
$da_l=$
$(\hat{y}-y)*w_l*\psi_l'*(\sum_n w_{ln}t_n - b_l)/a^2$

$w_l = w_l -\mu_1*d\_w_l$
$w_{ln}=w_{ln} -\mu_1*d\_w_{ln}$
$b_l=b_l-\mu_2*d\_b_l$
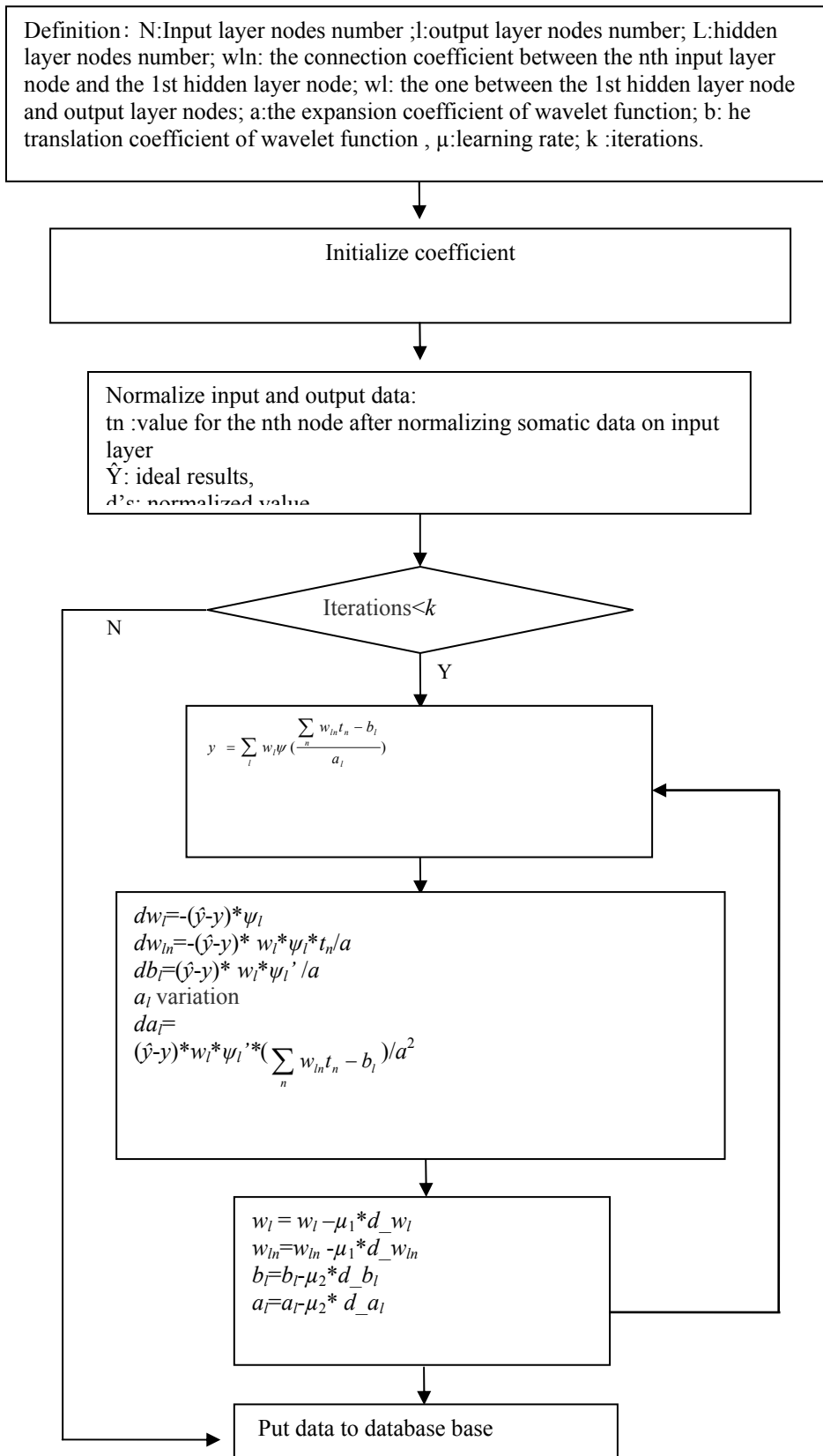$a_l=a_l-\mu_2* d\_a_l$

Put data to database base

Figure 2. Neural network training process

3.2. Network training

After about 100 times training, the error does not decrease obviously anymore. The minimal training error value is 0.38, shown as Fig. 3. The recommended size of 37 sets of body data by neural network is shown as Fig. 4, and the accuracy is 95%, compared with trying on person.
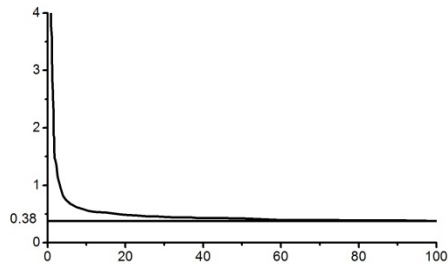

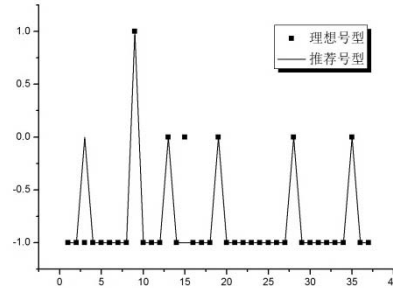Figure 3. Training error of wavelet neural network

Figure 4. wavelet neural network testing

3.3. Contrast experiment

When function $f(x) = \dfrac{1}{1+e^{-x}}$ is used as neural network hidden layer primary function and other sets are put as the same as the wavelet neural network, the recommended result from the BP algorithm is shown as Fig. 5. The training error decreases into 0.4 in the end. The accuracy of 37 sets of data test samples is 89%.
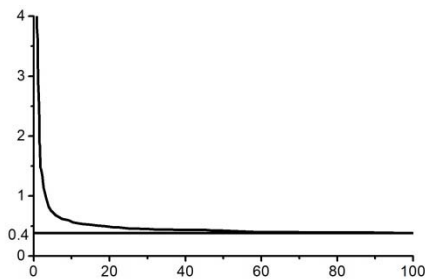

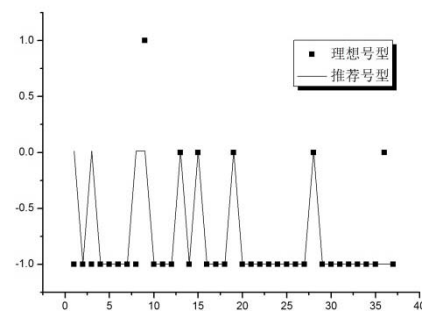Figure 5. Training error of Back Propagation network

Figure 6. Back Propagation network testing

4. Conclusion

The paper extends the application of wavelet neural network to garment size selection field. The training error and prediction accuracy have been developed compared with the algorithm based on traditional BP network. Indeed, there are still some problems need to solve in future. For example, the network may fall into local minimum point, and requests huge data preparing for models training at early times. And the network needs training data as more as possible. If the samples are not enough, training results will not be better as we expect.

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