



## NEW METHOD FOR HAND GESTURE RECOGNITION USING WAVELET NEURAL NETWORK

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**Abstract:** This paper present a method for hand gesture recognition through Statistic hand gesture which is namely, a subset of American Sign Language (ASL). The proposed technique presents an image of hand gesture by passing it through four stages, preprocessing, normalization, feature extraction, and classification. The wavelet neural network is used to build information models because it can handle very complex interactions. The practical system is simulated using MATLAB. The performance of suggested method is excellent compared with traditional approaches and the final results of selected patterns recognition are powerful

**Keywords:** *Wavelet, Multi-wavelet, Neural Networks.*

### طريقة لتمييز اشارة اليد باستعمال الشبكات العصبية الموجية

الخلاصة: هذا البحث يقدم طريقة لتمييز اشارة اليد من خلال استخدام اشارة اليد الثابتة والتي تسمى فرع من اشارة اليد الاوتوماتيكية . التقنية المقترحة تقدم صورة اشارة اليد من خلال امرارها بأربع مراحل . تم استخدام الشبكات العصبية المرتبطة مع التحويل الموجي لبناء نموذج للمعلومات لان هذا النوع من الشبكات يعالج التداخلات المعقدة بكفاءة عالية . النظام العملي المستخدم تمت محاكاته باستخدام برنامج ماتلاب . الاداء للطريقة المستخدمة ممتاز مقارنة بالطرق التقليدية والنتائج النهائية لعملية تمييز النماذج المختارة كفوة .

## 1. Introduction

Signal processing is one of the most fields that updateds and updates. Research work has been done over the past few decades into developing reliable identification techniques.

One of the most familiar fields of signal processing is image processing. Methods for image recognition have been the subject of several studies over the past decade.

The progress in soft computing methods and transformers have produced algorithms capable of surpassing the existing image recognition only. This paper presents new technique with types of images that named sign language to obtain better performance if the proposed method is compared with the past techniques. The recent resurgence of interest in neural networks has its roots in the recognition that the brain performs

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computations in a different manner than do conventional digital computers [1].

Also caring with transform has been developed, in applications to discrete data sets, wavelets may be considered as basis functions generated by dilations and translations of a single function. Analogous to Fourier analysis, there are wavelet series (WS) and integral wavelet transforms (IWTs). In wavelet analysis, WS and IWTs are intimately related.

The IWT of a finite-energy function on the real line evaluated at certain points in the time-scale domain gives the coefficients for its wavelet series representation [2]. The enhanced method is presented in this paper by use wavelet neural network in our application hand gesture recognition, as appeared in [3].

## 2. Object Recognition

As explained, our work is a MATLAB implementation of the Hand Gesture Recognition using wavelet Neural Networks, using orientation histograms a simple and fast algorithm will be developed to work on a workstation.

In some interactive applications, the computer need to track the position or orientation of a hand that is prominent in the image. Relevant applications might be computer games, or interactive machine control. In such cases, a description of the overall properties of the image, may be adequate. Image moments, which are fast to compute, provide a very coarse summary of global averages of orientation and position. If the hand is on a uniform background, this method can distinguish hand positions and simple pointing gesture [4].

In spite of almost 50 years of research and development in this field, the general problem of recognizing complex patterns with arbitrary orientation, location, and scale remains unsolved. New and emerging applications, such as data mining, web searching, retrieval of multimedia data, face recognition, and cursive handwriting recognition, require robust and efficient pattern recognition techniques [5].

American sign language is one of most famous sign languages in our world , and its importance came from use it in life problems for set of people, by the way entering this field is useful for evaluate sign languages.

## 3. Wavelet Transform

The wavelet transform, as an important tool of signal processing, has been applied to many fields, the discrete form for the wavelet have major place in these applications. The continuous Wavelet Transform (WT) of an arbitrary signal  $S(t)$  is defined as [6]:

$$w(a, b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} \psi^* \left( \frac{t-b}{a} \right) s(t) dt \quad (1)$$

where  $w(a,b)$  and  $\psi(t)$  are the wavelet transform coefficient and mother wavelet, respectively,  $\psi^* (t)$  is the complex conjugate of  $\psi(t)$ ,  $a$  is a positive number called

scale, and  $b$  the time-shift variable ( $a$  and  $b$  are also known as the dilation and the translation parameters, respectively).

The small  $a$  corresponds to a high frequency and vice versa, while  $b$  simply shifts the wavelet with respect to time without altering the frequency content.

The main idea from Discrete Wavelet Transform (DWT) explained as samples division into two bands high and low which based on linear convolution between the input signal and the basis function, it can be described by filter bank.

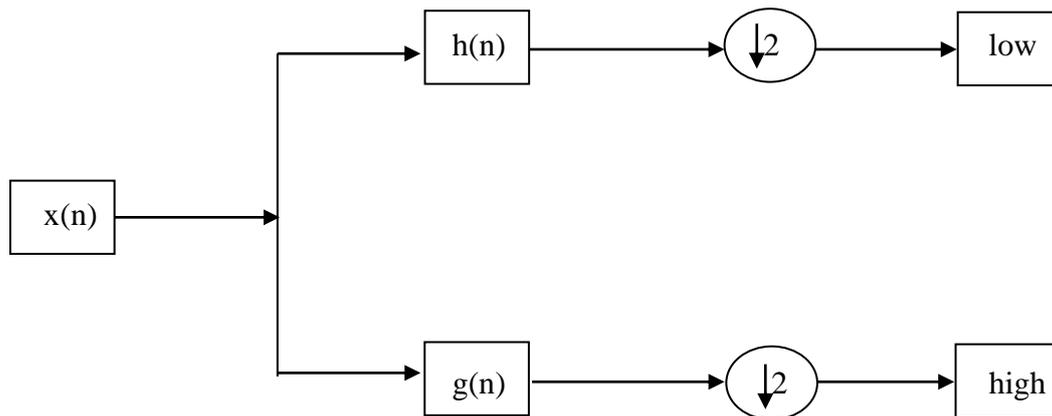


Figure (1): Discrete Wavelet Transform (DWT) decomposition by a filter bank [6]

Many applications used discrete wavelet transform or multi-wavelet, for example One of the main advantages of the two-dimensional filtering, taking use of the Discrete Wavelet Transform, is that it preserves important image characteristics, by filtering smooth noisy areas , without much interference on edges and objects details presented on the image.

This is possible by creating several well defined frequency sub bands. In a wavelet decomposition, the image is decomposed in a set of sub bands, which represent spatial oriented details at different scales [7].

Many applications has been started from this easy idea of DWT, and produce benefits by using any basis function for wavelet.

### 3. Neural Network

The most advanced technique in artificial intelligence was neural network, which composed from elements implements an operation similar with human neurons.

The basic operation that a neural network do it , called Learning .There are two modes of learning; supervised and unsupervised that differs in existence and absence of supervisor in the feedback direction for the network.

However, elements in neural network (Neurons) an adaptive elements; Therefore, they have learning rules governing the operations, such as: Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule , Winner-Takc All Learning Rule , Outstar Learning Rule.

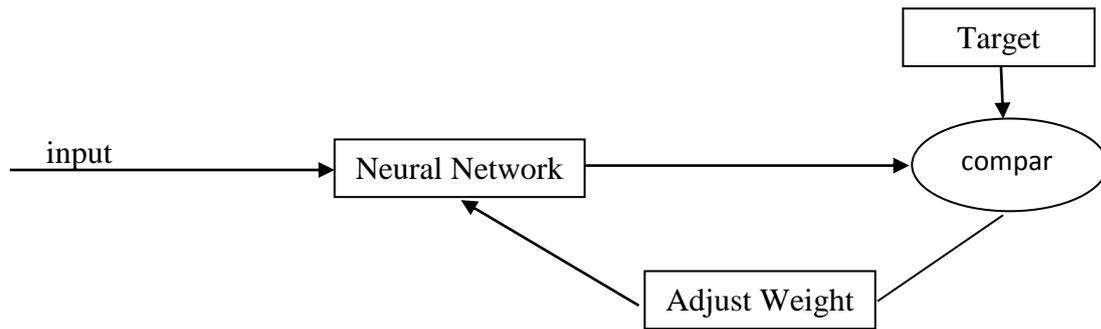


Figure 2. Neural Network Block Diagram

Neural Network has many applications in many fields, and it is very simple in manual computation in algorithm steps view.

The continuous or discrete data that need to be associated, or hetero - associated, are used for batch mode learning. The weights of such networks remain fixed following the recording. The reader should be aware that because there are few standards for neural network terminology, some authors consider memories trained by recording, or in batch mode, as networks trained with supervision [1].

Back propagation wavelet neural network (BPWNN) is an ANN that is integrated with wavelet techniques and has been used successfully in many fields. Instead of conventional nonlinear sigmoid transfer functions, the transfer function of the nodes in a wavelet neural network is wavelet bases. Because wavelet bases have the characteristics of time precision in high frequency domains and frequency precision in low frequency domains due to dilating and translating the mother wavelet, the ability of a WNN in mapping complicated nonlinear functions is enhanced considerably [8].

## 5. Wavelet Neural Network

Wavelet neural network is a new kind of network which covering advantages of wavelet and neural network.

Wavelet neural networks strong adaptive ability could be effectively used approximation of a function, System identification from input output pairs can be viewed as an application of function approximation .In specific, defect characterization can be cast as a problem of finding the mapping between signal and defect space and falls in this category [9].

The wave nets structure is shown in figure 3. Approximates any desired signal  $y(t)$  by generalizing a linear combination of a set of daughter wavelets  $h_{a,b}(t)$  where  $h_{a,b}(t)$  are generated by dilation,  $a$ , and translation,  $b$ , from a mother wavelet  $h(t)$  [10].

$$h_{a,b}(t) = h\left(\frac{t-b}{a}\right) \quad (2)$$

The approximated signal of the network  $\hat{y}(t)$  can be represented by:

$$\hat{y}(t) = u(t) \sum_{k=1}^K W_k h_{a_k b_k}(t) \tag{3}$$

where K is a number of windowing wavelets, and  $W_k$  is the weight coefficients.

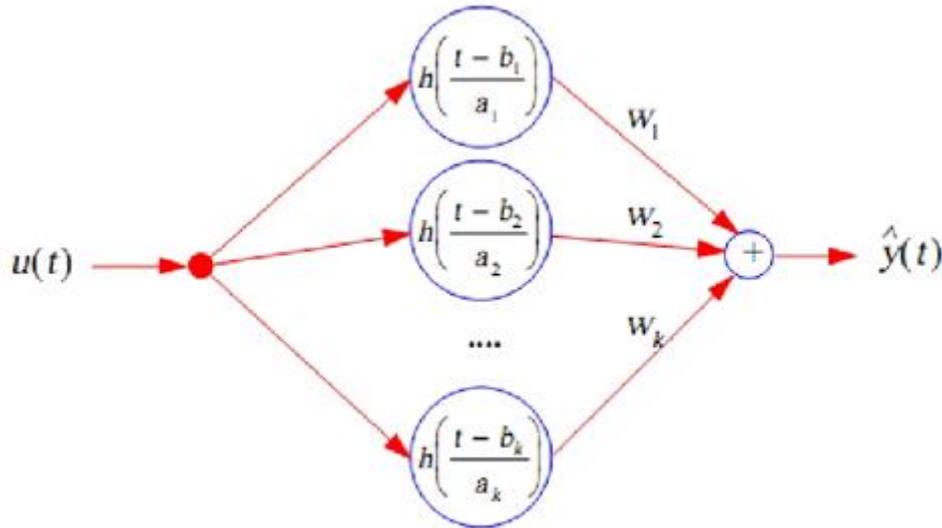


Figure 3: Adaptive Wavenets Structure [10].

The neural network parameters  $W_k$ ,  $a_k$  and  $b_k$  can be optimized in the LMS sense by minimizing a cost function or the energy function, E, over all time t. Thus by denoting.

$$e(t) = y(t) - \hat{y}(t) \tag{4}$$

be a time-varying error function at time t, where y (t) is the desired (target) response. The energy function is defined by:

$$E = \frac{1}{2} \sum_{t=1}^T e^2(t) \tag{5}$$

To minimize E we may use the method of steepest descent.

### 6. The Proposed Method

This paper aimed to produce different advanced result from past results in past methods [4], [5],[11]. However, any applied signal passed across the following steps:

- Preprocessing
- Normalization
- Feature Extraction
- Classifier

As used in [4], perceptron rules be applied:

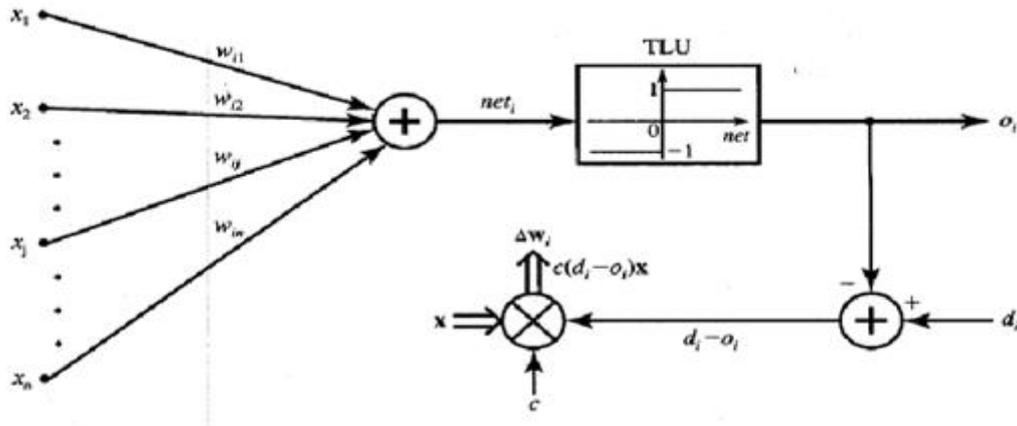


Figure 4: Perceptron learning rule [4].

$$r_i = d_i - o_i \tag{6}$$

Where  $o_i = \text{sgn}(w_i^t x)$ , and  $d$ , is desired response.

Briefly, the perceptron convergence algorithm can be described as following steps:

Step 1: Initialization

Step 2: Activation

Step 3: Computation of Actual Response

Step 4: Adaptation of Weight Vector

Step 5: Increment time  $n$  by one unit and go back to step 2.

Our thought in this paper in computation and ASL application in using wavenet algorithm.

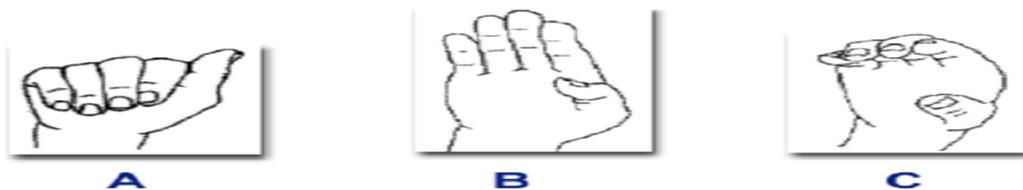


Figure (5): American Sign Language [4].

As said, Matlab 2011a be used in this paper, and our goal is to take the same examples used in [4], and finally compare our result with past techniques





## 7. Experiments And Comparison Results

As explained the system has been tested using Matlab 2011a, the final form of the database is this:

### Stage 1: Training

Four training sets of images, each one containing two images. Each image is treated using paint application program for images treatment, and feature vectors for each image extracted using Matlab function tools.

### Step2: Testing

In this step take cases for each gesture, occasionally, noise may be appear such as, uniform, binomial, normal.

Gesture that taking is the same as gestures took in the past papers to compare our result with them.

✓ : correctly classified

X: not classified

W: classified as 'W' (wrongly)

L-a: classified as either an 'L' or 'A' (Upper case correct)

Train-testing (0)



Figure 6: Zero



Figure 7: L



Figure 7: V

Table 1: Zero Test Result

Image	Radius	Noise	Same image	Translated	Classified
1	-	-	Yes	Yes	✓
2	-	18	Yes	-	✓
3	1.0	20	Yes	Yes	✓
4	1.2	-	Yes	Yes	✓
5	1.4	23	Yes	Yes	✓
6	1.6	-	Yes	Yes	✓
7	1.8	-	Yes	Yes	✓

Testing – L

Table 2: 'L' Test Results

Image	Radius	Noise	Same image	Translated	Classified
1	-	8	Yes	Yes	✓
2	0.8	-	Yes	Yes	✓
3	1.0	10	Yes	-	✓
4	-	-	Yes	Yes	✓
5	1.2	13	Yes	-	✓
6	1.4	-	Yes	Yes	✓
7	-	-	Yes	Yes	✓

Testing – V

Table 3: 'V' Test Results

Image	Radius	Noise	Same image	Translated	Classified
1	-	3	Yes	-	✓
2	0.6	8	Yes	Yes	X
3	1.0	-	Yes	-	✓
4	1.2	11	NO	Yes	✓
5	-	13	Yes	Yes	✓

By comparison , this paper present new advanced results clarified by tables showed , that accurate image after processing appeared , this method can be enlarge to another fields and techniques.

As shown result differs from gesture to another in amount of noise, congruence of images, and translation.

Finally, must remember that effects of new network (wavenet) be clear and recognizable from ordinary neural network, another examples and images taken and gave good result with work data base and work first hand.

## 8. Conclusions

This paper introduced type of image proceeding which use hand gesture (American Sign Language) ,in fact this field explained investiture advantages for wavelet and neural network in training and image processing. This lead researchers, internet users, and special people for relabeling use.

These points encourage us (may be readers ) to use wavenet in another applications, as a future work it can be use wavelet network in compression of images , recognition, and use of multi-wavenet network which related multi-wavelet with neural network.

Briefly, decrease of: noise, complexity, and time need for any operation most extracted points in this paper.

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