

Image Reconstruction using Wavelet Transform with Recurrent Neural Network

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Abstract

Wavelet Transform in 1992 recently as a combination with elman recurrent neural network. These are found very useful for time scale representation and widely used in signal processing and computer vision. In this research proposed an algorithm to reconstruct image that had lost some of its parts or uncompleted and some of wavelet transform properties in analysis to represent things. The algorithm depend on 8-level of wavelet decomposition with feature extraction and elman recurrent neural network for uncompleted image in small and big losing blocks. The reconstruction done in 100% accurate with the existing of original image even if the losing is 75% from the original image.

Keyword

Discrete wavelet Transform, Elamn Recurrent Neural Network, Feature Extraction.

1. Introduction

Image Reconstruction using wavelet decomposition Feature Extraction with Recurrent Neural Network:The idea of combing neural networks with multiscale wavelet decomposition has been proposed by a number of authors.

The idea proposed here is based on discusses the main contribution of the proposed algorithm namely the novel combination of the feature extraction capability of wavelets. With dynamic classification properties of recurrent neural networks this combination is called wavelet network. Experimental analysis of the discriminatory power of the new proposed. Its using an Elman recurrent neural network (ERNW), or, if necessary, an ensemble of such networks,to detect and classify process event through the recognition of the reconstruction generated in a set of texture image. The Elman has one output for each considered event class, and 25 input stream for each texture image. The inputs are the consecutive value of feature extracted by 'db4' wavelet decomposition.

2. Two-Dimensional Wavelet Transform

Wavelet transform is a transform whose basic function are shifted and expanded versions of themselves. The wavelet transforms break an image down into four sub-sampled, or decimated, images. In this study the field of texture analysis using wavelet transform will be examined for the reconstruction task. This transform is typically implemented in the spatial domain by using one-dimensional convolution filters. The *convolution theorem* states that convolution in the spatial domain is the equivalent of multiplication in the frequency domain. A particular set of wavelet is specified by a

particular set of number, called wavelet filter coefficients. Here, will largely restrict to wavelet filters in a class discovered by [3].

The first wavelet transform operates in horizontal direction and the second wavelet transform operates in vertical direction [9,5]. A one level of two-dimensional wavelet decomposition and reconstruction are depicted in figure 3,a &b respectively. After each one stage two dimensional wavelet decomposition, the two-dimensional input signal is projected onto four subspaces of low-low (LL), low-high (LH), high-low (HL), high-high (HH) band frequencies. Further decompositions are applied over the low-low (LL) sub-band, see figure

3. The Proposed Image Reconstruction Algorithm:

The procedure of image reconstruction that dependent here is in two phases:

3.1 Generation of Reference Image Templates

The section deals with the problem of how to create reference templates from a large number of image sets via wavelet transform, feature extracting and recurrent neural network.

System data work with is a grayscale images of size 256 x256 each, with any type of image file format.

3.1.1 Procedure of Generating Images Templates:

1. Input an image to the generating algorithm.
2. Apply the wavelet transform up to 8-level of decomposition using daubchies discrete wavelet transform 'db4' or any basic function:-

Decomposition the image using 'db4' wavelet transform into 8-level, the levels are the low-low, low-high, high-low & high-high, Three images are of size 128 x128 which is the result from the 1-level of decomposition. Three of size 46 x 46 which is the result from the 2-level of decomposition. Three of size 32 x 32 which is the result from the 3-level of decomposition. Three of size 16 x 16 which is the result from the 4-level of decomposition. Three of size 8 x 8 which is the result from the 5-level of decomposition. Three of size 4 x 4 which is the result from the 6-level of decomposition. Three of size 2 x 2 which is the result from the 7-level of decomposition. Finally Three of size one element which is the result from the 8-level of decomposition.

The result will be 25 sub images from 8-decomposition. Shows the convention of each level of decomposition for displaying the 'db4' daubchies wavelet transform of an image.

3. Calculation of energy feature of the wavelet coefficient for the result sub images:-

The energy feature will be computed for the 25-subimages, one value of energy is computed, the feature vector will have 25 energy values. This feature vector will be used in the reconstruction procedure.

This means that each sub-image will have one energy value only. Energy calculation equation is as follows [6, 7]:

$$E = \frac{1}{N} \sum_{i,j} x_{i,j}^2 \quad \dots (1)$$

The elements of the feature vector will be ordered like (energy value of sub-image 1, energy value sub-image 2, energy value sub-image 3, ..., energy value of sub-image 25).

4. Construction of a structure for the image:-

This structure contains image class label, image name and energy feature vector for each of the 25-subimages result from step 3. for example:

Image Struct= (class label, name, feature vector (of 25 elements)).

5. Repeat the steps:-

From 1-5 for all images concerned with the reconstruction system application.

3.2 The Reconstruction Phase:

The three aspects of the image reconstruction approach are:

1. The selection of features.
2. The choice of a measure of similarity.
3. A method for creating reference templates.

3.2.1 The Proposed Reconstruction Procedure:

A block diagram for the proposed reconstruction procedure is given in figure (6).

1. Input the Image:

The given image to the reconstruction system is application .

2. Application of the discrete Wavelet Transform to the unknown Image:

In this stage the given image to the system will be decomposed using tow-dimension discrete wavelet transform using 'db4' basic function. The image will be decomposed into 8-levels. The results of the decomposition will be 25 sub-images.

3. Feature Extraction:

In this stage the energy feature (explained in the previous section) will be computed for the 25-subimage resulting from the previous stage. Hence the resultant feature vector of size 25 elements will be constructed.

4. Reconstruction:

Having defined as feature vector per image, the remaining problem is to reconstruction them, i.e. associate each vector with an index that corresponds to a particular class. One of the important steps in the image reconstruction task is that classification process. A feature vector is then assigned a class label according to its position in feature space. Testing the performance of the classifier require an independent test set of labeled samples. Then it will be reconstruction to the lost blocks image from the original image of the reference set. The reconstruction is used depends on the Elman Recurrent Neural Network (*ERNW*). The input to the network will be sequence of feature extraction input vector consist of 25 value will be trained & test, when Elman networks can be trained with either of two functions, train as the following occurs at each epoch:

1. The entire input sequence is presented to the network, and its outputs are calculated and compared with the target sequence to generate an error sequence.
- 2 .For each time step, the error is back propagated to find gradients of errors for each weight and bias. This gradient is actually an approximation since the contributions of weights and biases to errors via the delayed recurrent connection are ignored.

3. This gradient is then used to update the weights with the backprop training function chosen by the user. The function `trainigsig` is recommended.

Then to unknown image, the reconstruction procedure will be the calculation the some squire error among the set of the images in the reference set find the minimum result in the test phase in the ERNW on the feature vector of the image reference and matching it with unknown image and the smallest number of the results set will be the original image for the unknown image. So will go to the next stage to know the reconstruction image.

5. Logical Decision:

In this procedure a comparisons is to be performed on the reconstructed image with a reference set, in order to reach a logical decision and find the original image complete the uncompleted image with the original image to find the missing parts of the uncompleted image. Display the uncompleted image or missing parts of image and reconstructed the image.

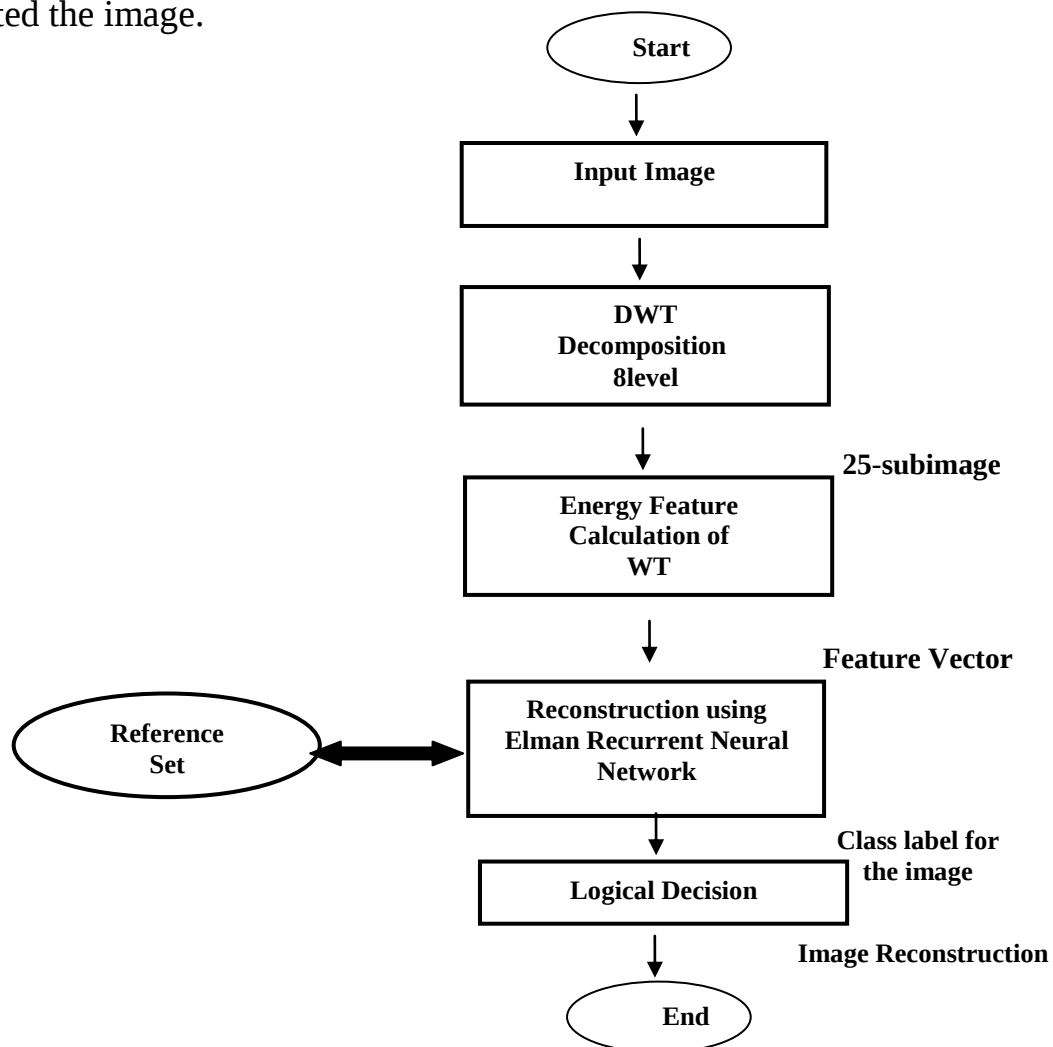


Figure 1 Block diagram for the image reconstruction using Wavelet Transform & ERNW

4. Experimental Result:

In this experiment m12a1i is considered after lost small blocks in different area pixels.

1. The entered unknown image, figure 8-a.

2. Daubiches “db4” DWT decomposition into 8-level, figure 8,b,c,d,e,f,g,h,i.

3. Feature extraction: the completed energy vector for 25-subimage is= (1.0e+007 *
0.0002 0.0003 0.0000 0.0002 0.0001 0.0000 0.0010 0.0010 0.0001
0.00150.0019 0.0011 0.0057 0.0067 0.0091 0.0393 0.0126 0.0262
0.0645 0.08920.0131 0.2262 0.2236 0.0283 1.8450)

4. Classification: calculate some square error between energy of the unknown image and all the feature vector of the images stored in the reference set .The unknown image classified as class label I12 the test result of some square error between image energy .

5. Reconstruction : this label class that comes from the pervious stage must be reconstructed, by using logical decision. In this experiment, the unknown image will be reconstructed we complete the lost block of missing unknown image , as Struct=(m12a1, c:\MATLAB6p1\toolbox\indemo\m12a1, 1.0e+007 * (0.0002 0.0003
0.0000 0.0002 0.0001 0.0000 0.0010 0.0010 0.0001 0.0015 0.0019
0.0011 0.0057 0.0067 0.0091 0.0393 0.0126 0.0262 0.0645 0.0892
0.0131 0.2262 0.2236 0.0283 1.8450)) the reconstruction result was true.

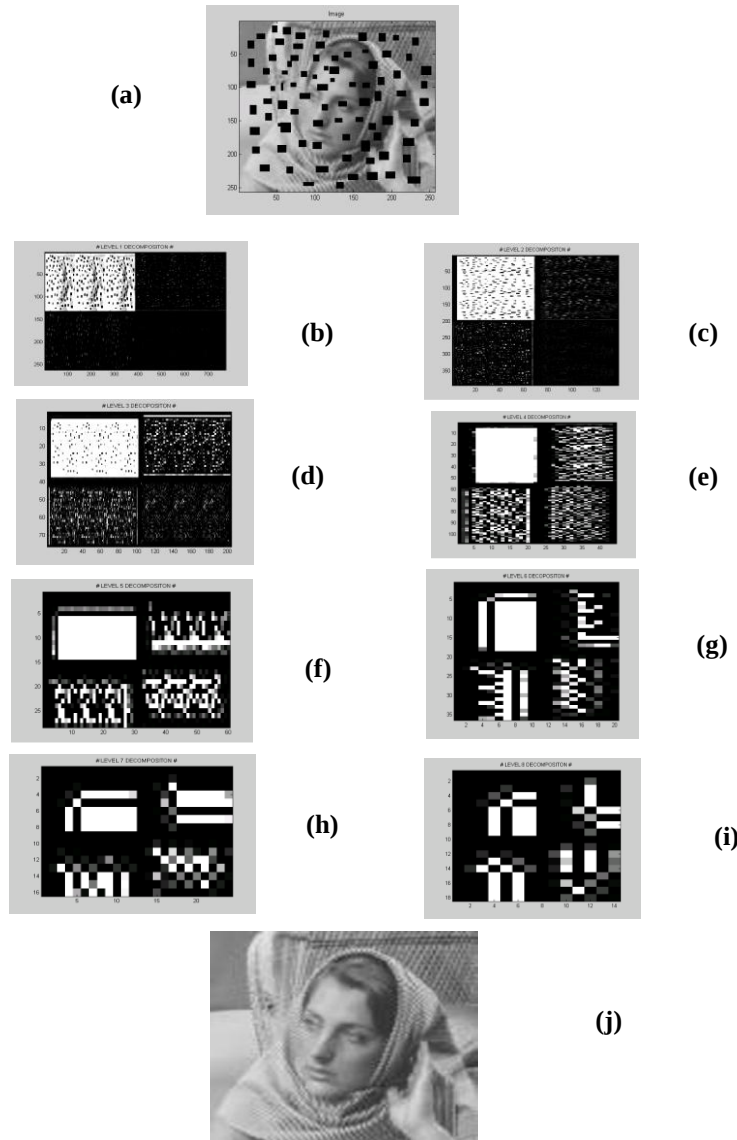
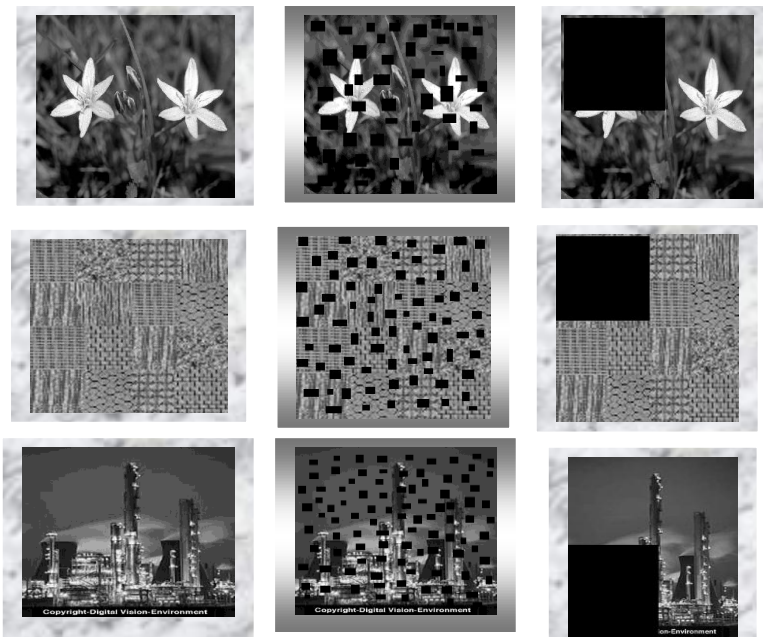


Figure 2: a) The lost block image, b) the first level of decomposition, c) the second level of decomposition, d) the third level of decomposition, e) the forth level of decomposition, f) the fifth level of decomposition, g) the sixth level of decomposition, h) the seventh level of decomposition, i) the eighth level of decomposition, j) the Image Reconstruction.

5. Summary:

To reconstruct uncompleted image with missing blocks or parts, the image must be classify correctly to lead to good reconstruction. The wavelet energy by implementing the 2-DWT into 8-level and computing the energy for the result. The result is computed only once and saved in a file as training information. Wavelet transform Daubchies “db4” basic function has advantage that provide a good energy localization in the frequency domain as other wavelet transforms. This makes Elman networks useful in such areas as signal processing and prediction where time plays a dominant role.

Test these images using the proposed algorithm are done by using wavelet transform, feature extraction with elman recurrent neural network (ERNW), and the result of testing was 100% accuracy. It gave good reconstruction uncompleted images automatically.



(a)Original Image (b)Uncomplete Image (c)Missing Parts Image

Figure 2: samples of Generated Versions of some Images. (a) Original Image, (b) Uncomplete Image, (c) Missing Parts Image

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