

# Wavelet Features Based War Scene Classification using Artificial Neural Networks

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## Abstract

This paper addresses the problem of war scene classification. Scene classification underlies many problems in visual perception such as object recognition and environment navigation. Scene classification, the classification of images into semantic categories (e.g. opencountry, mountains, highways and streets) is a challenging and important task nowadays. In this paper we are trying to classify the war scene category from the natural scene category. For this purpose two set of image categories were taken i.e., opencountry & war tank. By using Haar and Daubechies(db4) wavelets the features are extracted from the images. The extracted features are trained and tested with the help of feed forward back propagation algorithm using Artificial neural Networks. The complete work is experimented in Matlab 7.6.0 using real world dataset.

**Keywords:** *scene classification; haar and Daubechies wavelet; back propagation; artificial neural networks*

## I. INTRODUCTION

Scene and object classification is an important research topic in robotics and computer vision. Number of research problems have been studied and reported by the research community. Scene classification is a term that is usually used to classify the images into semantic categories (e.g. street, bedroom, mountain, or coast) [1], [2], [3], [4]. Classification is one of several primary categories of machine learning problems [5]. For the indoor-outdoor scene retrieval problem, the authors addressed how high-level scene properties can be inferred from classification of low-level image features [6]. In paper[7], authors propose an automated method based on the boosting algorithm to estimate image orientations. In [8], Bosch et al. present a scene description and segmentation system capable of recognizing natural objects (e.g., sky, trees, grass) under different outdoor conditions. In paper [9], the

authors propose a new technique for the classification of indoor and outdoor images based on edge analysis. Analysis of texture [10] requires the identification of proper attributes or features that differentiate the textures of the image. Authors [11][12] analyze the efficiency of commonly used feature extraction methods such as haar features, invariant moments and co-occurrence matrix by using Artificial neural networks and support vector machines classifiers.

This paper presents the war scene classification using Haar and Debauchies wavelet feature extraction methods using Artificial neural networks with feed forward back propagation algorithm.

The organization of the paper is as follows: Section 2 describes Haar and Debauchies wavelet Features, Section 3 describes Artificial Neural Networks, Section 4 explains the proposed work, Section 5 deals with implementation of ANN, Section 6 deals with discussion, and finally Section 7 concludes with conclusion.

## II. HAAR AND DAUBECHIES WAVELET FEATURES

Haar [11] and Daubechies [13] wavelets are widely used techniques for feature extraction, which are single-level one-dimensional wavelet decomposition and gives both an approximation and detailed coefficients. Approximation coefficients which are of size 128x1 for Haar wavelet and 131x1 for Daubechies wavelet are considered as the feature set for our problem domain. Pictorial representation of approximation coefficients and detailed coefficients of the above mentioned wavelets are shown in the Fig. 2.1. Hence, features F1 to F128 and F1 to F131 are considered as feature sets for Haar and Daubechies wavelets respectively.

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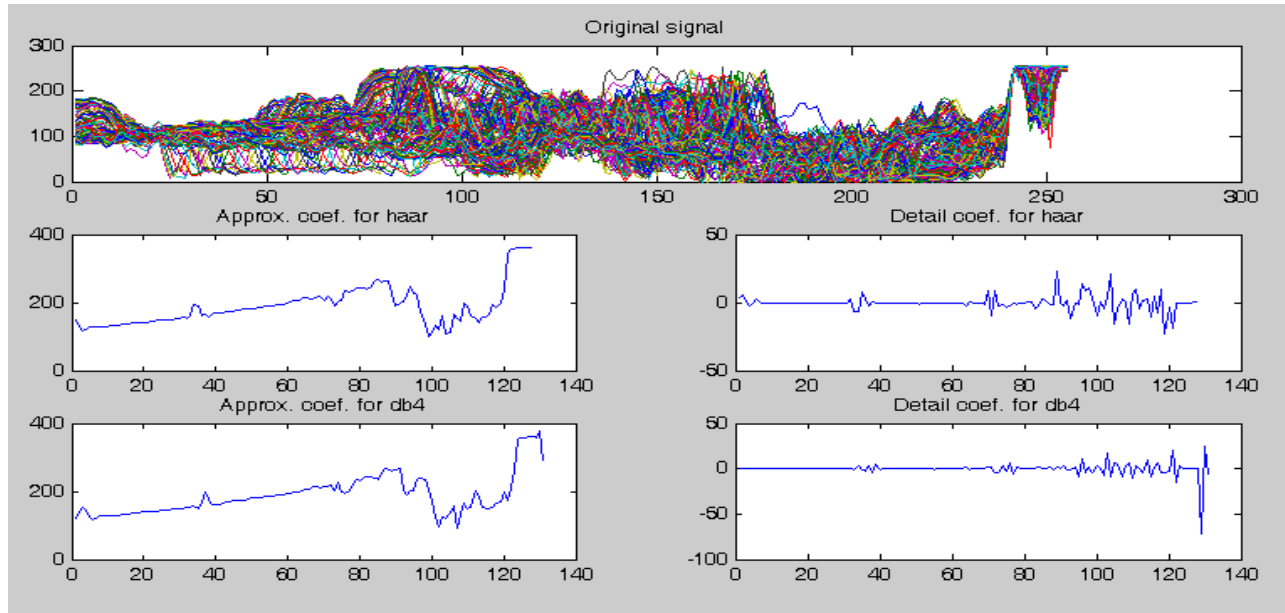


Figure 2.1 Original, Approximation and Detailed Coefficients of Haar and Daubechies Wavelets

### III. ARTIFICIAL NEURAL NETWORKS

The number of types of ANNs and their uses is very high. Since the first neural model by McCulloch and Pitts [14] there have been developed hundreds of different models considered as ANNs. The differences in them might be the functions, the accepted values, the topology, the learning algorithms, etc. Also there are many hybrid models where each neuron has more properties than the ones we are reviewing here. Because of matters of space, we will present only an ANN which learns using the back propagation algorithm [15] for learning the appropriate weights, since it is one of the most common models used in ANNs, and many others are based on it. Since the function of ANNs is to process information, they are used mainly in fields related with it. There are a wide variety of ANNs that are used to model real neural networks, and study behavior and control in animals and machines, but also there are ANNs that are used for engineering purposes, such as pattern recognition, forecasting, and data compression.

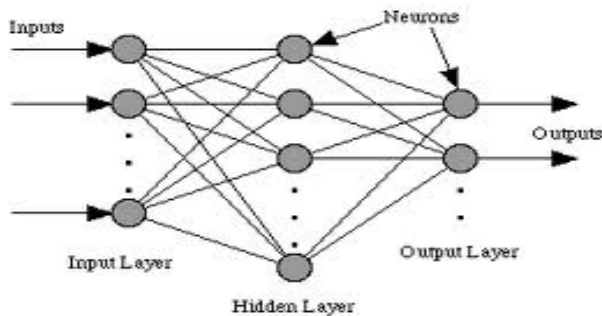


Figure 3.1 Simple Neural network Structure

In this work we used feed-forward artificial neural network. This is the most widely used neural network model, and its design consists of one input layer, at least one hidden layer, and one output layer as shown in figure 3.1. Each layer is made up of non-linear processing units called neurons, and the connections between neurons in successive layers carry associated weights. Connections are directed and allowed only in the forward direction, e.g. from input to hidden, or from hidden layer to a subsequent hidden or output layer. Back-propagation is a gradient-descent algorithm that minimizes the error between the output of the training input/output pairs and the actual network output. Therefore, a set of input/output pairs is repeatedly presented to the network and the error is propagated from the output back to the input layer. The weights on the backward path through the network are updated according to an update rule and a learning rule. ANNs are solely specified by the characteristics of their processing units and the selected training or learning rule. The network topology, i.e., the number of hidden layers, the number of units, and their interconnections, also has an influence on classifier performance.

Back propagation algorithm is applied for learning the samples, Tan-sigmoid and log-sigmoid functions are applied in hidden layer and output layer respectively, Gradient descent is used for adjusting the weights as training methodology.

### IV. PROPOSED WORK

In classification, a classifier is trained to identify a type of example or differentiate between examples that fall in separate categories. In the case of computer vision, the examples are

representations of photographic images and the task of the classifier is to indicate whether or not a specific object or phenomena of interest is present in the image. In order to successfully accomplish this, the classifier must have sufficient prior knowledge about the appearance of the image/scene. This paper is trying to recognize the scenes of two different categories called ‘Opencountry’ and ‘War tank scene’ i.e. War tanks in opencountry. The detailed work flow of the proposed system is shown in figure 4.1.

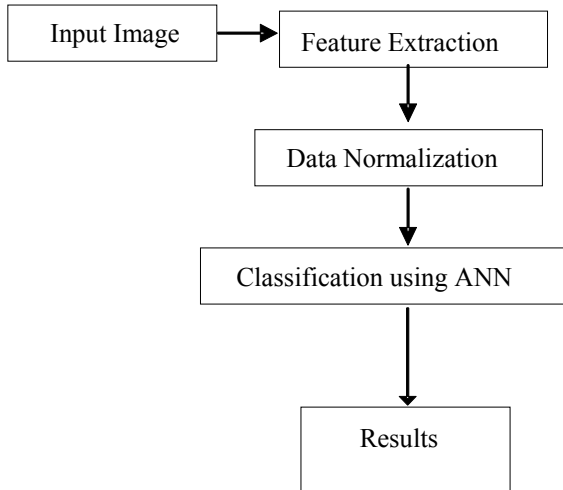


Figure 4.1 Detailed Description of Proposed Work

The sample images are taken from the Computational Visual Cognition Laboratory (opencountry) [16] and (War Tank scenes) [17][18] is collected from the sources [19][20] and google images, with 200 samples each. Sample scenes are given in Fig.4.2 and 4.3.



Fig. 4.2 Sample images of ‘Opencountry’ category



Fig. 4.3 Sample images of ‘War Tank’ category

Haar and Daubechies wavelets are used for extracting the features from the images/scenes. Normalization is then applied using Zero-mean normalization method in order to maintain the data within the specified range and also found suitable to improve the performance of the classifier.

**Zero-Mean Normalization:** By using this type of normalization, the mean of the transformed set of data points is reduced to zero. For this, the mean and standard deviation of the initial set of data values are required. The transformation formula is  $v' = (v - \text{mean}A) / \text{std\_dev}A$  where  $\text{mean}A$  and  $\text{std\_dev}A$  are the mean and standard deviation of the initial data values. The following are the other techniques normally used by our research community for normalization of data.

**Decimal Scaling:** This type of scaling transforms the data into a range between [-1 to 1]. The transformation formula is  $v'(i) = v(i)/10k$  for the smallest  $k$  such that  $\max(|v'(i)|) \leq 1$ .

**Min-Max Normalization:** This type of normalization transforms the data into a desired range, usually [0,1]. The transformation formula is  $v'(i) = (v(i) - \text{min}A) / (\text{max}A - \text{min}A) * (\text{new\_max}A - \text{new\_min}A) + \text{new\_min}A$  where,  $[\text{min}A, \text{max}A]$  is the initial range and  $[\text{new\_min}A, \text{new\_max}A]$  is the new range. The normalized data is given to Artificial Neural Networks and are trained and tested to recognize the scene categories.

V. IMPLEMENTATION USING ANN

Using the above feature vector representations, neural classifier is trained and tested to recognize and classify the scenes. In Training phase, 200 samples are used including 100 samples from ‘Opencountry’ and 100 samples from ‘War Tank Scenes’. In testing phase, 200 more samples are used including 100 samples from ‘Opencountry’ and 100 samples from ‘War Tank Scenes’. The input images are resized into (256x256) pixel size. Zero-mean normalization method is applied to the extracted Haar and Daubechies wavelet features. Normalized features are given as input to Artificial Neural Networks to recognize the scene category. Backpropagation algorithm is used to train the neural classifier. The structure of the neural network is 128-8-2 and 131-8-2. Fig. 5.1 and 5.2 depicts the converging training graph of neural classifier for Haar and Daubechies wavelet features respectively.

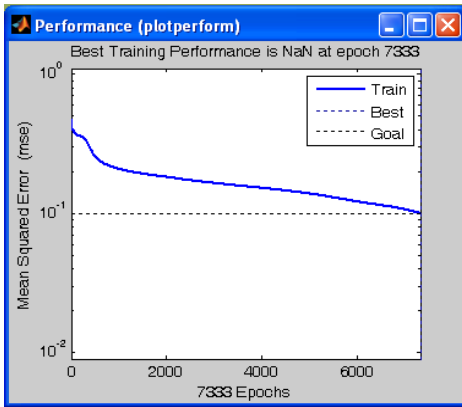


Figure 5.1 Haar Wavelet Features Based ANN

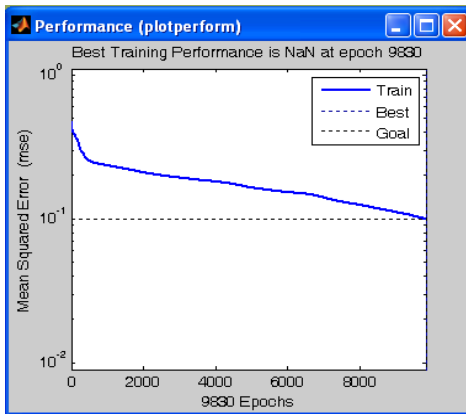


Figure 5.2 Daubechies wavelet features based ANN

VI. DISCUSSION

This paper discusses wavelet based scene classification problem using Artificial Neural Networks using backpropagation algorithm. The sample images are taken from

the Computational Visual Cognition Laboratory [16] and [17]. Features are extracted from all the scene categories, from raw images, without any preprocessing steps to make the system robust to real scene environments. The results show that haar wavelet features based ANN is giving 82.5% classification rate in 53.90 seconds, but Daubechies wavelet features based ANN is giving 80% classification rate in 70.19 seconds. The time consumption is minimal in by using haar wavelets than Daubechies wavelets. The comparative results of haar and Daubechies wavelets is given in Table 6.1.

Table 6.1. Comparative Results of Haar and Daubechies Wavelet

Feature Extraction Method	Open Country		War Tank Scene		Classification Rate	Execution Time (in Sec)
	TP	TN	TP	TN		
Haar	85	15	80	20	82.5 %	53.90
Daubechies	86	14	74	26	80.0 %	70.19

TP-True Positive, TN- True Negative

VII. CONCLUSION

This paper concentrates on the categorization of images as ‘War Tank’ scenes and ‘Opencountry’ scenes. The results are proving that haar wavelet features based ANN is performing better than Daubechies wavelet features based ANN in scene categorization problems in terms of not only by the classification rate but also by the less execution time. This work can be further extended to classify other war scene categories using various feature extraction methodologies. This complete work is implemented using Matlab 7.6.0.

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