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PROBABILISTIC NEURAL NETWORK – A BETTER SOLUTION FOR NOISE CLASSIFICATION

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ABSTRACT

Classification is one of the common tasks of human behavior. Classification problems arise when an entity needs to be assigned into a predefined set based on a number of features associated with that entity. Neural Network models prove to be a competitive alternative to traditional classifiers for many practical classification problems. Noise classification in digital image processing is a must so as to identify the suitable filters for smoothing the image for further processing. The use of Probabilistic Neural Network to classify the noise present in an image after extracting the statistical features like skewness and kurtosis is explored in this article. When the noises are classified accurately, identification of the filter becomes an easy task.

Keywords: *Probabilistic Neural Network, Noise classification, Statistical features*

1. INTRODUCTION

Classification is one of the major research areas of neural networks. Classification problems play a major role in the field of business, science, industry and medicine. Neural networks have emerged as an important tool for classification. The recent research activities which use neural networks for classification have established that neural networks are a promising alternative to various conventional classification methods. The advantage of neural networks is that it makes use of self-adaptive methods to adjust to the data without any explicit specification. The use of a Probabilistic Neural Network (PNN) to classify the image noise, based on the statistical features is discussed.

There are different types of image noise, viz. salt and pepper noise, Gaussian white noise, non Gaussian white noise, speckle noise, quantization noise and shot noise. The characteristics of the noise are to be studied to analyze the type of the noise in an image. Noise identification is vital for determining the denoising procedure for an image, which leads to image enhancement for further processing.

The literature reveals that the noise can be identified based on the statistical parameters like the analysis of local variations of the average and the standard deviation of the image, which are uniquely determined from the homogeneous regions [5]. In reference [6] each class of noise can be characterized and estimated by a parameter obtained from histograms computed on several homogeneous regions which is obtained by segmenting images. Vozel *et al.* has proposed an unsupervised variational classification for noise identification and estimation [1]. Chen and Das have isolated the noise samples so as to extract their statistical features and used a simple pattern classifier to identify the image noise [10]. Santhanam and Radhika have used neural network models like Back Propagation Network (BPN) and Multi Layer Perceptron (MLP) to classify the noises [8].

1.1 STATISTICAL MEASURES

Skewness is a measure of symmetry and it is the standardized third central moment of the probability distribution. It can be measured using the equation 1.

$$S = E(X-\mu)^3 / \sigma^3 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution and it is the standardized fourth central moment

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of the probability distribution. It can be measured using the equation 2.

$$S = (E(X-\mu)^4 / \sigma^4) - 3 \;\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where the (-3) term makes the value zero for a normal distribution.

The statistical measures like skewness and kurtosis which has been discussed above are used to identify the nature of the noise in this article. Skewness finds the pixels that are darker or lighter than the mean. Kurtosis finds the over representation or under representation of frequencies. The skewness and kurtosis values are given as input to the PNN which classifies the noise accordingly. Non Gaussian white noise, Gaussian White noise and salt & pepper noise have been identified using this approach.

2. PROBABILISTIC NEURAL NETWORK (PNN)

In 1990, Donald F. Specht proposed a network based on nearest neighbor classifiers and named it as "*Probabilistic Neural Network*" [3]. PNN can be used for classification problems. This network provides a general solution to pattern classification problems by following an approach developed in statistics, called Bayesian classifiers [4][7]. The PNN is used in classifying the cancer [2][9]. The architecture of a PNN is given in Fig. 1. [11] When an input is presented, the first layer computes distances from the input vector to the training input vectors and produces a vector whose elements indicate how close the input is to a training input. The second layer sums these contributions for each class of inputs to produce as its net output a vector of probabilities. Finally, a *compet* transfer function on the output of the second layer picks the maximum of these probabilities, and produces a 1 for that class and a 0 for the other classes. It is assumed that there are *Q* input vector/target vector pairs. Each target vector has K elements. One of these elements is 1 and the rest are 0. Thus, each input vector is associated with one of K classes.

The first-layer input weights, IW1,1 (net.IW{1,1}), are set to the transpose of the matrix formed from the *Q* training pairs, P'. When an input is presented, the || dist || box produces a vector whose elements indicate how close the input is to the vectors of the training set. These elements are multiplied, element by element, by the bias and sent to the radbas transfer function. An input vector close to a training vector is represented by a number close to 1 in the output vector a1. If an input is close to several training vectors of a single class, it is represented by several elements of a1 that are close to 1.

The second-layer weights, $LW^{1,2}$ (net.LW{2,1}), are set to the matrix T of target vectors. Each vector has a 1 only in the row associated with that particular class of input, and 0's elsewhere. The multiplication Ta^1 sums the elements of a^1 due to each of the K input classes. Finally, the second-layer transfer function, compet, produces a 1 corresponding to the largest element of n^2, and 0's elsewhere. Thus, the network classifies the input vector into a specific K class because that class has the maximum probability of being correct.

3. METHODOLOGY

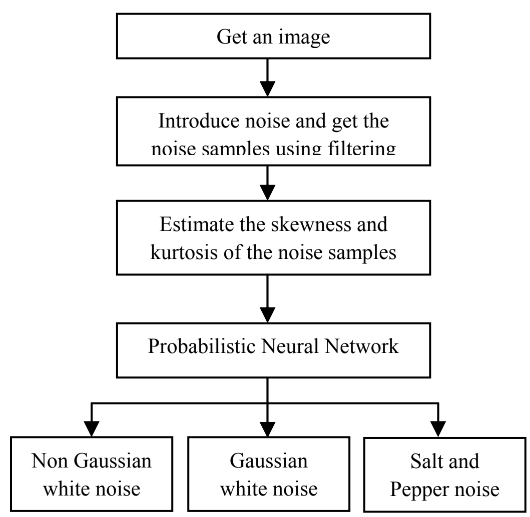

Fig. 2 Steps in the proposed technique

The proposed technique identifies the noise as Non Gaussian white, Gaussian white and salt and pepper. These noises are additive in nature. The steps involved in the methodology used are shown in fig. 2.

A k-fold cross-validation is used in this approach. i.e. the images are partitioned in to k (say 10) partitions at random. Training is carried out with k-1 partitions and testing is carried out with the left out partition. The cross validation process is then repeated k times, with each of the

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k partition being used exactly once for testing. The k results are averaged to determine the resulting accuracy.

The CASIA-Irisv3 database (http://www.sinobimetrics.com) which contains around 4500 iris images has been used for the proposed approach. 250 left eye images and 250 right eye images were selected at random resulting in 500 images. The three types of noises viz. Non-Gaussian white noise, Gaussian white noise and salt and pepper noise were introduced to the 500 images, thus making the mugshot database with 1500 images. MATLAB has been used to perform the experiment.

4. RESULTS

The confusion matrix given in table-I indicates the percentage of images classified correctly by the PNN network for the given type of noise.

Table-I: Confusion matrix – Performance analysis of PNN

	Non-Gaussian white	Gaussian white	salt and pepper
Non-Gaussian white	96.43%	2.38%	1.19%
Gaussian white	5.4%	94.6%	0%
salt and pepper	7.37%	1.05%	91.58%

From the above table it can be easily concluded that the performance of PNN is consistent producing 90% and above. Further its classification accuracy is better than the other two models for all types of noises experimented in [8].

5. CONCLUSION

The use of PNN for classification of noise is explored in this article. CASIA-Irisv3 database have been used to test the performance of the network and the experiments have been carried out in MATLAB. The results show that PNN proves to be a better technique in classifying the noises than the MLP and BPN models. The future work will concentrate on identifying an appropriate filter for removal of each type of noise by using neural network which will further enhance the image for processing.

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Fig. 1: Architecture of a PNN