OPTIMIZING IMAGE CLASSIFICATION USING A NEURAL NETWORK

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Abstract: *The paper analyzes the images belong to someone classification using self-organizing neural network, proposing solutions for optimizations. From considerations of reducing the size of the input space of neural network and also to reduce the amount of computation is proposed using principal component analysis (PCA). The method proposed Karhunen-Loeve transform matrix calculation.*
Keywords: *artificial neural networks, Bayesian method, number of correct classifications, self-organization, the confusion matrix*

1. INTRODUCTION

The paper proposed the use of the input dataset, a personal database.It contains 552 photographs belonging to a group of 46 different people. By altering the neural network size and number of features stored in conditions using a standard step in the several tests we set the number of images correctly classified from a given number.

Processing the database have been performed in Matlab by implementing functions of principal component analysis, testing, reading data, training, classification, distance, respectively Bayes classification, which received several parameters. He aimed to obtain quantitative results, as a percentage of their graphical representation. Thus were established the number of correctly classified images, the average number of correct classifications, both as a percentage and graphically.

Through successive runs were analyzed cases of confusion between classes containing images of different subjects.

Thus, using different imaging compared classes were conducted workmanship SOM and Bayesian method.Comparative analysis aimed at making noise matrices calculated for correct classification using neural network sizes in both cases.Finally, some conclusions were proposed following experiments.

2. THEORETICAL CONSIDERATIONS

The principal technique for component analysis (PCA) transforms a number of original variables into a small set of uncorrelated variables, the transformation vectors $X_i \epsilon R^n$ (i=1…L) belonging to an n-dimensional space, the vectors of the form $Y_i \in R^m$ (i=1…L) , at an m-width of the space where m $<$ n [1],[2].

Karhunen-Loeve transform is a linear method for selecting features. Let X be a n-dimensional random vector. Wanted orthogonal transformation enabling optimal representation vector X with respect to minimum mean square error criterion. This transformation is called Karhunen-Loeve transformation. It describes the set of vectors V={X_1, X_2 ,…, X_L}. Each element of the set is a point in n-dimensional Euclidean space. Set V can be considered a cloud of points in space.

The main components of the set V of R^n are directions along which the cloud elongation is greatest. Knowledge of these directions can serve both for classification purposes and for detecting the most relevant features of the cloud of points [2]. Cloud projecting the directions given by the principal components provides a compression information from the original data set.Been shown to reduce the size of an input space is accompanied by loss of a quantity of information, so in order to reduce data dimensionality is to keep as much information from initial information [5], [6].

Principal Components Analysis (PCA) is a simple statistical method for dimensionality reduction (compression) which has become probably the most frequently used to achieve recognition of portraits [7]. Eigenvectors could be regarded as a set of general characteristics of images in the database changes [3]. Once the portraits are normalized (to the standard size), they can be treated as one-dimensional array of pixel values. Each image is an exact representation by a linear combination of these eigenvectors [4].

3. EXPERIMENTS

Database

Training was performed with a database of images of size 90 * 120 pixels, a part of which is shown in the figure below.

The database was made personally and contains a number of 552 pictures in JPEG format, or photographs of 46 subjects, men and women, young and old, of different ethnicities.

Each subject and were asked to simulate many emotions that were labeled in the database as x.y.JPEG respectively subject's number and the position where it was photographed.

The subjects were photographed in these 12 positions, numbered:

1 / Normal, front, eyes open;
2 / Normal, front, eyes closed;
3 / Normal, side, facing left, look on, eyes open;
4 / Normal, side, facing left, look on, eyes open;
5 / Happy, happy, smiling;
6 / Sad, gloomy;
7 / Amazed, surprised;
8 / Disgust, loathing, disgust;
9 / Anger, frowning;
10 / With glasses;
11 / Withe cap, hat, scarf (head covered);
12 / With glasses, and head coverings

Figure 1 Selection of photos from the database used

The photos were taken the day normal lighting conditions, against a light colored uniform with a standard camera Samsung WB 100, with linear filter.

Images taken were transposed in format 90/120 pixels (vertical / horizontal) using Photo Paint, achieving a total of 552 photos.

The second database consisted of filmmaking containing multitudes crowded it was intended to be included or not people photographed, contained in the first database.

The crowd was surprised at a crowded school event, dedicated to the Open Day at a secondary educational institution in the municipality of Calarasi and shooting screen shooturile that were made with a camcorder Panasonic SDR-S70 standard-without using corrected image.

Thus, 8 of the 10 subjects of the photographs were taken video footage busy crowd, for an application to recognize them in real time.

Were made more photo-screen during shooting with them.

The tests included:

1. studies of neural network size in different cases (10x10 neurons 15x15neuroni, 20x20 neurons, neurons 25x25neurons and 30x30)
2. studies on the retention characteristics by changing them one step given that performing several tests for each step above, the presentation of results and number of images correctly classified in a table (neural network size / step).

Finally I followed which is the best result, the highest number of correctly classified images of all images in the database, for a number of features retained.We draw conclusions about the results using RNA opposite Bayes method, and the optimization of classification.

Matlab source code implementation took place in several stages, as follows:

4. IMPLEMENTATION OF PRINCIPAL COMPONENT ANALYSIS FUNCTION

• Parameter input can be of two types: a string representing the name of the file to be loaded training data

Matlab source code implementation took place in several stages, as follows:

Implementation of principal component analysis function

Principal components analysis function has been following parameters:

• The parameter X is a matrix containing resized images to half and arranged in columns.• nec parameter is the number of elements in each class.

• The parameter file is an optional parameter string and is the name of the file to be saved Karhunen-Loeve transform matrix.

Implementation function test

Test function receives the following parameters:

• The parameter m can be of two types: the number of components retained after applying Karhunen-Loeve transform or a string representing the name of the file to be loaded Karhunen-Loeve transform matrix.

• Parameter M is a vector with two elements specifying the number of neurons per line and the number of columns of neurons in the neural network.Test function returns a single parameter, namely the number of correct classifications.

Implementation of data read function

Data read function receives the following parameters:

• The parameter path is the path to the directory containing the images to be loaded. The path can be absolute or relative to the current directory.

• The parameter m is the number of components retained after applying Karhunen-Loeve transform.

Data read function returns the following parameters:

• The parameter x contains images resized by half and arranged like columns vectors.

• ETX variable is a vector containing images read labels, namely the class of which each image.

Implement the training tool

Drive function receives the following parameters:

or a structure containing two fields: a field x and a field ETX. File from which to load the training data must also contain a variable x and an ETX. Variable x contains the set of training data. ETX variable is a vector containing the labels figures in the data set.

• Parameter M is a vector with two elements specifying the number of neurons per line and the number of columns of neurons in the neural network.

• The parameter file is an optional parameter string and is the name of the file to be saved weights and labels neurons in the neural network.

Drive function returns the following parameters: Parameter w is an array with 4 dimensions. The first two dimensions form a matrix representing the weights of a neuron. The other two dimensions are neuron position in the matrix of neurons.

Implementation of the classification function

Function classification receives the following parameters:

• Parameter input can be of two types: a string representing the name of the file to be uploaded to your class or a structure containing two fields: a field and a field etxt xt.

File from which to load the training data must also contain a variable and a xt etxt. Variable xt contains classified data set. This is a 3-dimensional array representing a digit, and the third dimension represents the annual index data.

Etxt variable is a vector containing the labels figures in the data set.

• Parameter som can be of two types: a string representing the name of the file to be load weights and labels neurons or neural network structure contains two fields: a field and a field w et.

File from which to load the training data must also contain a variable and a w et.

Et variable is an array that contains the label associated with each neuron in the neural network.

• handle parameter is an optional parameter and is a handle to a figure that will be displayed confusion matrix.

Classification function returns the following parameters:

• correct parameter is the number of correctly classified images.

• The parameter c is the noise matrix

• Parameter hits the number of times each neuron was activated in the classification process.

Implementation distance function

Function distance receives two parameters that turns them into vectors if they are arrays or arrays with larger then calculate Euclidean distance between the two vectors.

d(x,y) = $\sqrt{\sum_{i=1}^{n}(x_i - y_i)^2}$

Implementing Bayes classification function

Bayes classification function receives the following parameters:

• Train parameter can be of two types: a string representing the name of the file to be loaded training data or a structure containing two fields: a field x and a field ETX.

Variable x contains the set of training data. ETX variable is a vector containing the labels figures in the data set.

• Parameter test can be of two types: a string representing the name of the file to be loaded or classification data structure that contains two fields: a field and a field etxt xt. File from which to load the training data must also contain a variable and a xt etxt.

Variable xt contains classified data set.

Etxt variable is a vector containing the labels figures in the data set.

• The parameter m can be of two types: the number of components retained after applying Karhunen-Loeve transforms or a string representing the name of the file to be loaded Karhunen-Loeve transform matrix.

• The parameter nc is the total number of classes. Bayes classification function returns a single parameter, of correct classifications.

	25	50	75	100	125	150	175	200
10x10	76,80	78,30	79,10	79,00	80,50	80,60	81,30	82,17
12x12	79,50	79,80	78,30	79,50	77,00	79,30	80,00	80,40
15x15	80,00	83,80	80.80	78.15	77.15	77,30	77,80	78,50
20x20	82,00	84,70	84,50	81,80	81.10	75,10	82,10	82,80
25x25	84.00	85,80	85,60	84,60	84,60	84,00	84,00	83,00
30x30	85,80	86,80	**88,30**	85,20	85,30	85,00	87,30	86,30

Table 4.1Average number of correct classification percentage

5. EXPERIMENTAL RESULTS

The problem is how to change the test results based on neural network size and the number of features selected using principal component analysis [8], [9].

Thus, we considered the following tests:

• We modified neural network size by considering the following cases: 10x10 neurons, neurons 12x12, 15x15 neurons, neurons 20x20, 25x25 neurons, 30x30 neurons.

• We changed the number of features from 25 to 200, with an increment of 25.

For each variant were driven by three tests. The results are given in percent in Table 4.1

For each test is given the number of images correctly classified a maximum of 200.

The best result is images correctly classified 184 out of 200 was obtained with a neural network of 30x30 neurons, for a total of 75 characteristics preserved.

Given in Table 4.1 is an average of the three tests performed for each variant. Results are given in percent.

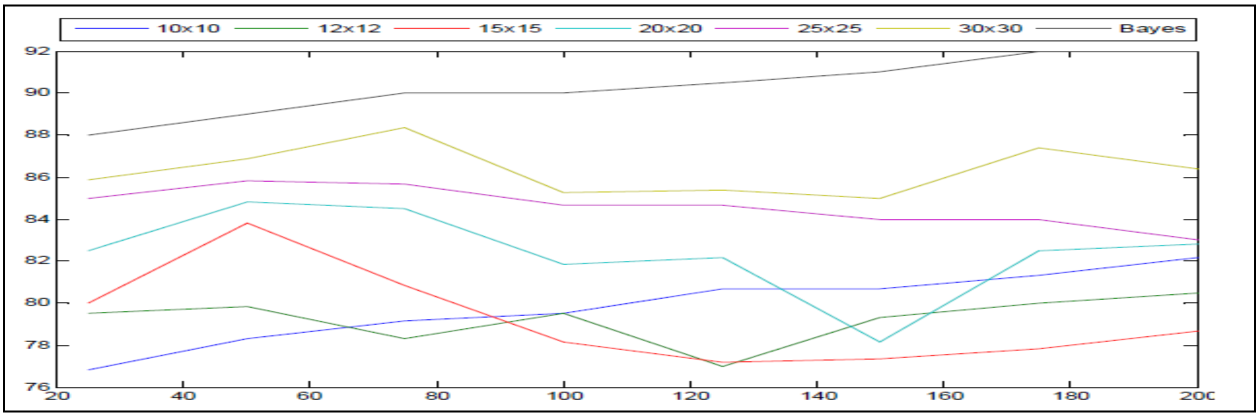

Figure 4.1-Average number of correct classifications

It is noted that the results obtained with method Bayesian network are better than those obtained for neuronal networks.The motivations of this network is that the data set is too small for the neural network to produce results all too well.

Another set of results were obtained noise matrices.They have provided comparative data on the optimal classification matrices obtained overlapping neural network, over matrices obtained Bayesian classifier:

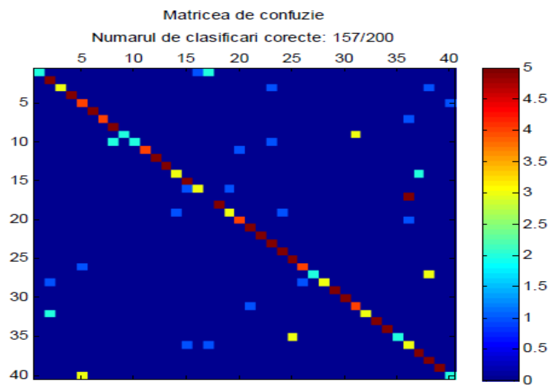

Figure 4.3 – SOM 10x10

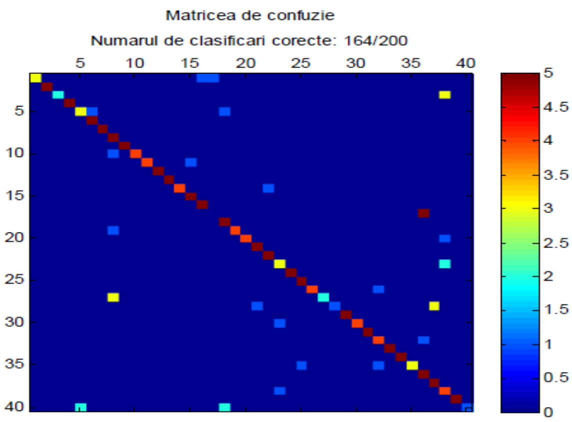

Figure 4.4 – SOM 12x12

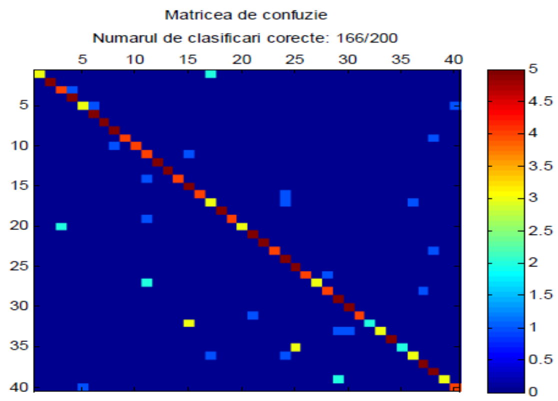

Figure 4.5 – SOM 15x15

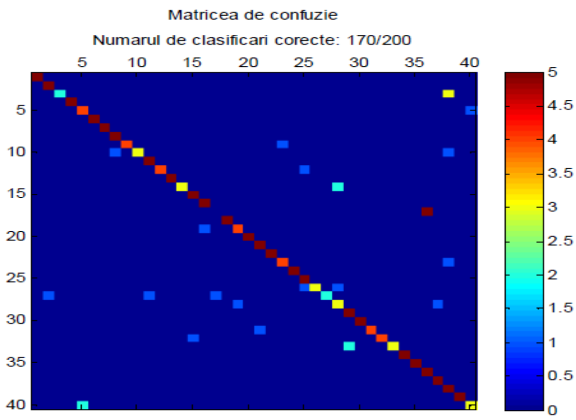

Figure 4.6– SOM 20x20

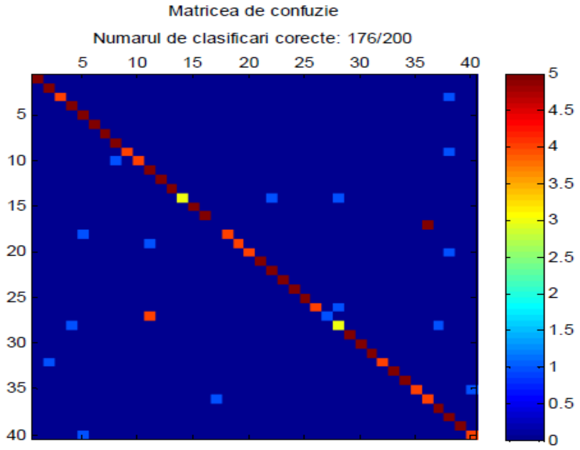

Figure 4.7– SOM 25x25

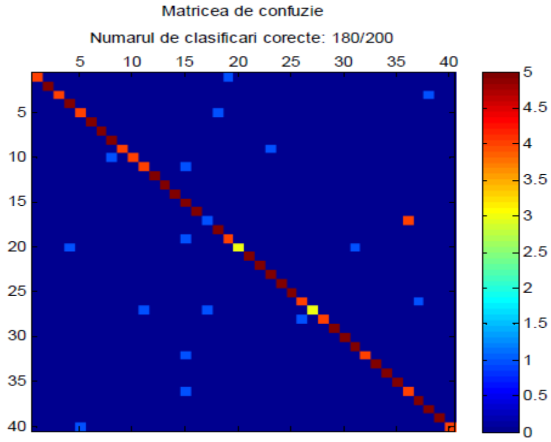

Figure 4.8 – SOM 30x30

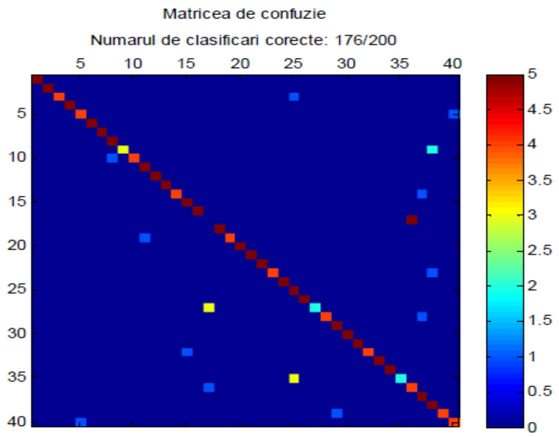

Figure 4.9 – Bayes m=25

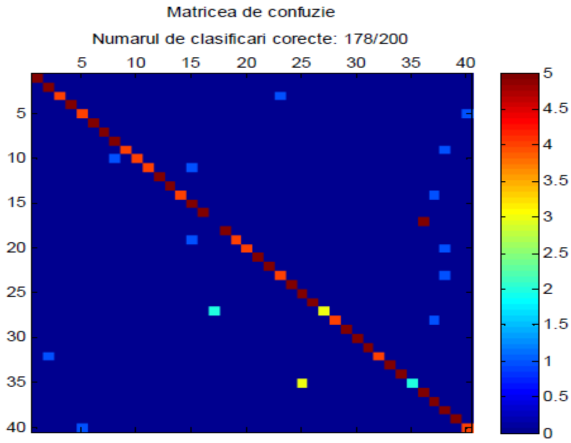

Figure 4.10– Bayes m=50

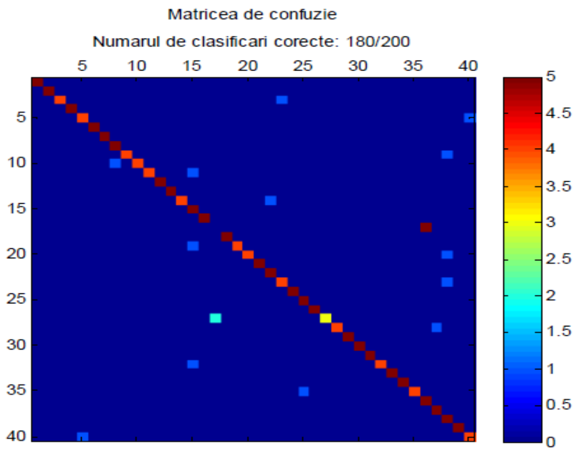

Figure 4.11– Bayes m=75

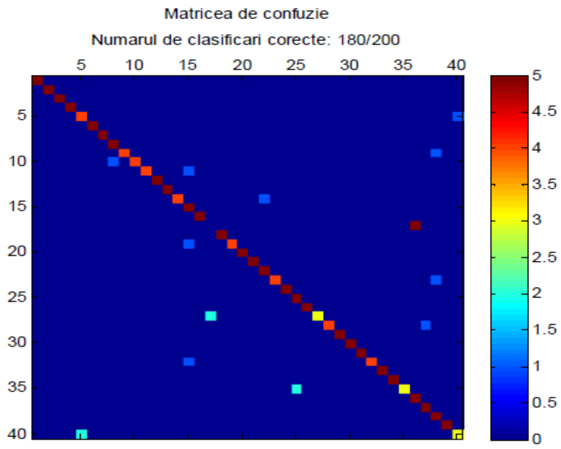

Figure 4.12– Bayes m=100

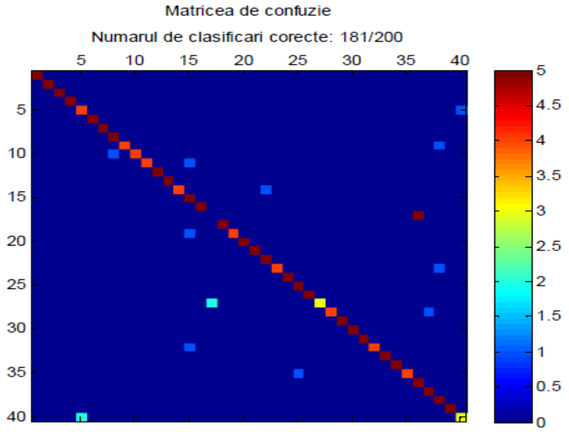

Figure 4.13– Bayes m=125

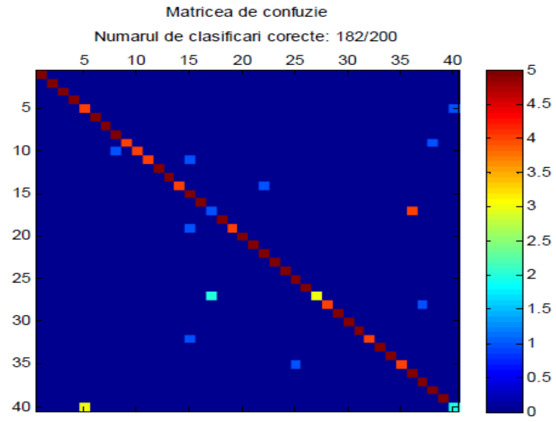

Figure 4.14 – Bayes m=150

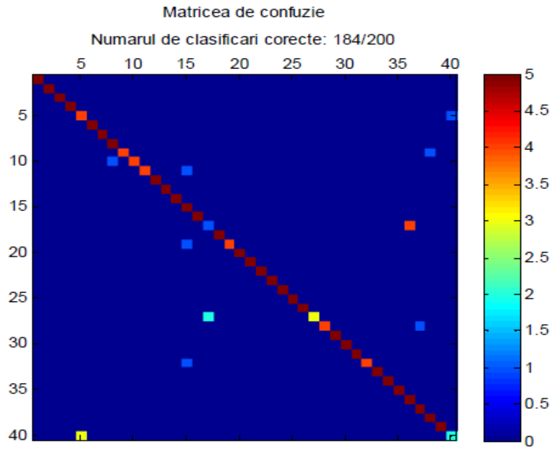

Figure 4.15– Bayes m=175

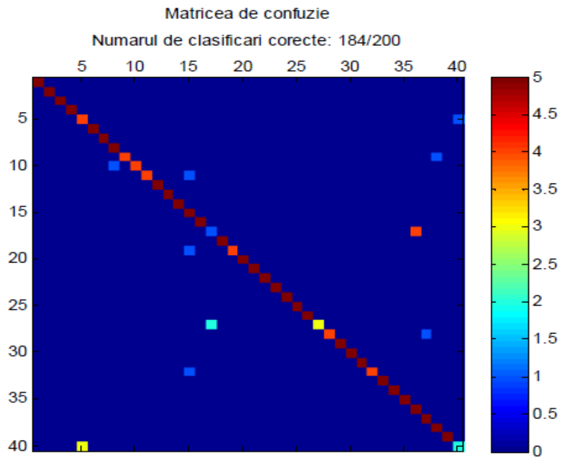

Figure 4.16– Bayes m=200

6. CONCLUSIONS

• By calculating matrix using Karhunen-Loeve transform, the image size is halved analyzed, leading to a minimum to reduce memory usage or processing time.
• By implementing Bayes function, it provides the same accuracy of classification with principal component analysis method.
• The comparative study allows to determine precisely the best choice depending on the size classification neural network, observing that the same size of the network, the best classification obtained in certain situations.
• However, comparative study to establish the best classification result on the number of images classified into variants tested.

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