Regular paper

Multi-Layer Perceptrons Approach to Human Face Recognition

Amar Merrad and Noureddine Goléa

This article, presents some results obtained in the face recognition using Multi-Layer Perceptrons (MLP) Neural Networks for classification. Two designs are studied: single network model and multi networks model. The input images are resized, and converted to a vector of pixels before they are applied to the input of the MLP Network. The back propagation algorithm is used to train the MLP network. The best performance achieved with a single neural network is 99.375%. We use a data base of 400 images of 40 individuals which is the ORL (Olivetti Research Laboratory) [1].

Keywords: face recognition, Neural Networks, Multi-Layer Perceptrons, The back propagation algorithm.

1. INTRODUCTION

Biometrics is the technology of the automatic recognition of a person while being based on the physiological characteristics (fingerprint, the shape of the hand, face…) or Behavioral (voice, signatures step…) [2- 6]. This technology is more reliable and able to differentiate between an authorized person and a fraudulent impostor, than the traditional methods which are based on the possession or the knowledge of external identifier (password, PIN , badge and key…) very likely to be lost, forgets or stolen.

Nothing is more natural than to use the face for identification. The facial images are probably the biometric characteristic most commonly employed by the man to carry out a personal identification [7]. The face recognition is one of the biometric techniques most used, because of its simplicity and the availability of equipment. In addition the face recognition system does not require any human co-operation, sort of putting the finger or the hand on a specific device or to speak in a microphone. Practically, a person has only to remain or walk in front of a camera so that he can be identified by the system. Moreover, this technique is very effective for the nonstandard situation, it is the case where the person to identify is not cooperating, for example during an arrest of the criminals [8].

In this paper, we present our contribution in face recognition with multi layers perceptions (MLP) neural networks; it's very effective in the field of the recognition [9, 10]. The goal is simply to determine the personal identity through a face image [11]. The artificial neurons networks are able to learn the association input/output, and because of this capacity, they will be used to solve this kind of problem. Two neuronal techniques are used; the first is based on only one network and the second on several networks.

2. FACE RECOGNITION BY SINGLE NETWORK.

We use a Multi-Layer Perceptrons (MLP) Neural Networks, with only one hidden layer. The inputs of the network are the values of the pixel in grayscale levels (from 0 to 255) converted to real values between 0 and 1. The number of neurons in the output neural
network equal to the number of people to be classified. Each neuron uses sigmoid as function transfer. When a person is recognized, the neuron corresponding in the last layer will have a value 1, and the other neurons will have a value 0. The training of the weights of neural network will be done with back propagation algorithm.

![Single network model of the recognition](image)

**Figure 1**: single network model of the recognition

### 2.1 Classification

The method of classification influences on the quality of the results obtained. There are two tested methods of classification: *threshold method* and *maximum method*.

**Threshold method**: In this method, we seek to define, for each person, or all persons, a *threshold*. This threshold will determine the minimum of resemblance between two images to admit that it is about the same person. The threshold is adjusted until obtaining the best possible result. In general, if all the outputs are lower than this threshold no classification is obtained (rejection of the person test).

**Maximum method**: In this method the output of network which has the greatest value, will take the classification obtained of the tested person. Maximum method gave us the best results.

### 3. FACE RECOGNITION BY MULTI MLP NEURAL NETWORKS.

The second method is based on series of Multi-Layer Perceptrons (MLP) Neural Networks. The number of Neural Networks equal to the number of people to be identified. Each network has a number of outputs equal to the number of inputs. The goal is to define which output is the most near to the input image; each MLP network is trained to recognize only one person. (figure2).

#### 3.1 Classification

For classification, the image will be given to each network; the outputs of each network will be compared with the input image by the Euclidean distance. The recognized face will correspond to the network which has given the smallest distance.
4. EXPERIMENTS

4.1 data base:
Experimental studies are carried out on the ORL database image, which contains a set of faces taken between April 1992 and April 1994 at Olivetti Research Laboratory in Cambridge (is available free of charge see[1]). There are 10 different images of 40 distinct subjects. For some of the subjects, the images were taken at different times. There are variations in facial expression (open/closed eyes, smiling/non smiling), and facial details (glasses/no glasses). The images are grayscale with a resolution of 92x112. There are 240 images were randomly selected as the training set and another 160 images as the testing.

4.2 Experiment results
The results of the experiments are summarized in Tables 1, 2, 3 and 4 shows the recognition rate obtained.

We tested the influence of the various parameters as:

- The influence of the number of neurons in the hidden layer.
- The influence of the dimension of the image.
- The influence of the threshold of classification.

The parameters of neural network (the number of neurons in the hidden layer, step of training, the threshold of recognition) in experiments gave:

- step of training: 0.2
The error: 0.01

The threshold of recognition: 0.5

Table 1 shows how varying the number of neurons in the hidden layer and dimension of image affects performance.

Table 1: Recognition rate according to the dimension of the image, and the numbers of neurons in the hidden layer.

<table>
<thead>
<tr>
<th>Hidden neurons</th>
<th>recognition rate (%)</th>
<th>10×10</th>
<th>15×15</th>
<th>20×20</th>
<th>25×25</th>
<th>30×30</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>93.1250</td>
<td>90</td>
<td>91.2500</td>
<td>88.1250</td>
<td>88.1250</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>92.5000</td>
<td>93.1250</td>
<td>90.6250</td>
<td>93.1250</td>
<td>89.3750</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>90.6250</td>
<td>93.1250</td>
<td>88.7500</td>
<td>91.8750</td>
<td>87.5000</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>93.1250</td>
<td>91.8750</td>
<td>91.8750</td>
<td>91.8750</td>
<td>87.5000</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>92.5000</td>
<td>94.3750</td>
<td>92.5000</td>
<td>89.3750</td>
<td>93.7500</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>93.1250</td>
<td>94.3750</td>
<td>92.5000</td>
<td>90</td>
<td>91.8750</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: recognition rate according to the dimension of the image, and the numbers of neurons in the hidden layer.

Influence threshold of classification:

In this second phase, we seek to evaluate the influence of the threshold on the quality of classification and to determine an optimal value. For this experiment, the structure of the network and the size of the images are fixed at the optimal values found in previous phase.

Number of hidden neurons: 70
The dimension of image: 15×15.

The recognition rates for various thresholds are given by table 2.
Table 1: recognition rate for various thresholds

<table>
<thead>
<tr>
<th>threshold</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
<th>0.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rec. rat (%)</td>
<td>95</td>
<td>95.625</td>
<td>95.625</td>
<td>95</td>
<td>95</td>
<td>94.375</td>
<td>91.250</td>
<td>87.500</td>
<td>80</td>
</tr>
</tbody>
</table>

Figure 4: recognition rate for various thresholds

There is a range of optimal recognition rate corresponding to a threshold located between 0.2 and 0.3; then the increase in the threshold involves a very fast reduction in the rate recognition.

**Maximum Method:**

Now, we will explore the influence of using the Maximum Method as tool of discrimination on the recognition rate. Table 3 shows the results obtained.

Table 3: recognition rate obtained with Maximum Method.

<table>
<thead>
<tr>
<th>Hidden neuroses</th>
<th>10×10</th>
<th>15×15</th>
<th>20×20</th>
<th>25×25</th>
<th>30×30</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>98.750</td>
<td>98.750</td>
<td>97.500</td>
<td>95.6250</td>
<td>95.6250</td>
</tr>
<tr>
<td>50</td>
<td>96.8750</td>
<td>98.750</td>
<td>98.750</td>
<td>98.1250</td>
<td>98.1250</td>
</tr>
<tr>
<td>60</td>
<td>97.500</td>
<td>99.3750</td>
<td>97.500</td>
<td>98.1250</td>
<td>96.250</td>
</tr>
<tr>
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<td>98.750</td>
<td>98.750</td>
<td>98.1250</td>
<td>98.750</td>
<td>99.3750</td>
</tr>
<tr>
<td>80</td>
<td>98.1250</td>
<td>98.750</td>
<td>97.500</td>
<td>98.1250</td>
<td>98.1250</td>
</tr>
<tr>
<td>90</td>
<td>98.750</td>
<td>98.750</td>
<td>98.1250</td>
<td>98.750</td>
<td>98.1250</td>
</tr>
</tbody>
</table>
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Figure 5: recognition rate obtained with Maximum Method.

Table 4, gives the results obtained in the case of the approach Multi networks

Table 4: Recognition rate with respect to image dimension and the number of hidden neurons.

<table>
<thead>
<tr>
<th>Hidden neurons</th>
<th>recognition rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10×10</td>
</tr>
<tr>
<td>30</td>
<td>96.8750</td>
</tr>
<tr>
<td>50</td>
<td>94.3750</td>
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<tr>
<td>60</td>
<td>96.2500</td>
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<tr>
<td>70</td>
<td>95.6250</td>
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<tr>
<td>80</td>
<td>96.8750</td>
</tr>
<tr>
<td>90</td>
<td>95</td>
</tr>
</tbody>
</table>

Figure 6: Recognition rate according to the dimension of the image, and the number of hidden neurons.
The analysis of the results confirms the effectiveness of the single network approach when using the maximum method as tool of classification. The results obtained with this technique are almost perfect (recognition rate equal 99.375%) with the network structure more reduced (dimension of image 15x15 and 60 neurons in the hidden layer). This method involves a better performance compared with threshold method, where the rate of recognition equal 95%. The technique of recognition multi networks gives a suitable recognition rate (97%). The great advantage for the use of the Multi network technique is the simplicity and the speed of incrementing, when a new person is added to the faces base. It is enough to add a network and to get it trained to recognize the person; whereas nothing is changed for the networks previously trained.

5. CONCLUSION

We obtained experimental results showing that very high recognition rate can be achieved using single network with Maximum Method (recognition rate equal 99.375%), although Multi MLP Neural Networks also gave good results (97%). Compared with other works like: Chang Richard and Eric Para [12] obtained a recognition rate equal 99%, by a single network model with 75 neurons in the hidden layer, and dimension 10x10 and recognition rate more than 99% in dimension 10x10 with Multi MLP Neural Networks of 50 neurons in the hidden layer for each network. Lawrence and all using convolutional Neural Network approach [13] obtained a recognition rate equal 96.17%. The proposed approach results are a tremendous improvement over the result of [13].

References:


Appendix:
Sample images from the ORL base (http://www.cam-ori.co.uk/facedatabase.html.)
B) quelques faces de la base ORL (http://www.cam-ori.co.uk/facedatabase.html.)