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NEURAL NETWORKS FOR ACCESS CONTROL*

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Abstract

A Multilayer Perceptron Neural Network (NN) is considered for access control based on face image recognition. We studied robustness of NN classifiers with respect to the False Acceptance and False Rejection errors. A new thresholding approach for rejection of unauthorized persons is proposed. Ensembles of NN with different architectures were studied too. Advantages of the ensembles are shown, and the best architecture parameters are given. The usage of negative examples was explored. We have shown that by using negative examples we can improve performance for access control task. The explored NN architectures may be used in real-time applications.

1. Introduction

An access control task by face recognition using neural nets is studied. There is a limited set of persons (one person is one class) to access some resource, all other people must be rejected. This task is very actively developing in applied recognition. Such control systems are non-intrusive and can be based on cheap video cameras. In spite of the fact that such systems are not the most effective now, the face recognition based technology is very promising and may be easily used for access control based on face thermograms as input.

We studied various system configurations evaluating their recognition performance, False Rejection Rate (FRR), False Acceptance Rate (FAR) and Equal Error Rate. Several strategies for the system performance improvement were considered. As a classifier we tested Multilayer Perceptron Neural Networks (MLPs) and ensembles of such Networks.

2. Experiments

We have made several experiments with the ORL face database. In the first experiment we tested two thresholding strategies for "aliens" rejection. The first strategy ('min') compares value of the maximal output unit ("winner") with a predefined threshold. When the output is lower than the

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threshold, the person whose image is analyzed is considered as "alien" and rejected. The second strategy ('sqr') calculates the Euclidean distance from a real output of our Neural Network to the desired output corresponding to a person-candidate. Then, similar to the previous case, we compare the distance with the threshold and accept or reject the person. As can be seen from Fig.1, the proposed 'sqr' strategy gives lower FRR and FAR.

In the second experiment we explored performance of widespread MLP (architecture 1 in Fig.2) and ensembles of MLPs (architectures 2-4). We tested three types of the ensembles based on various principles. The last ensemble gives the best recognition performance (see Fig.2) and its details will be given in the paper.

In the third experiment we studied training with both positive and negative examples. Some predefined faces from the same database were used as negative examples, which were always "aliens". We tested three variants of training:

- no negative examples were used,
- negative examples of K people were used as a negative class for all output units of the neural network,
- negative examples of K people were used and classified by K additional output units and when a test image was recognized as negative, it was considered as alien too.

As can bee seen from Fig. 3, the third strategy works better. We have found that the best performance was achieved when every network in an ensemble had different initial weights and different order of examples during the training stage.

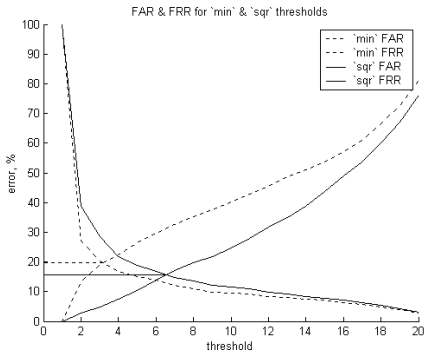

Fig. 1. FAR and FRR for both thresholding strategies

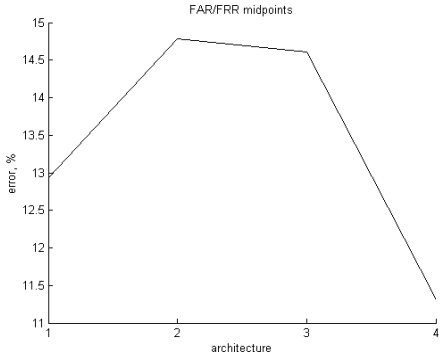

Fig. 2. Equality errors for four architectures

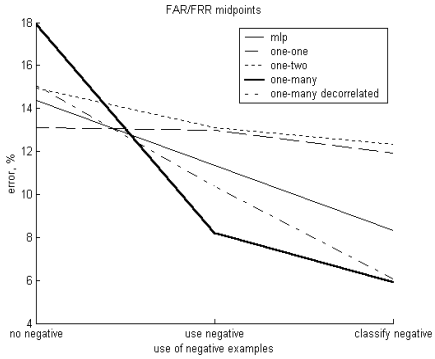

Fig. 3. Equality errors for different use of negative examples

3. Conclusion

As can be seen from the experimental results, the more different goals NN have to learn, the better performance is. A collective decision is better than a decision of one network. Also the introduced 'sqr' thresholding rule has better performance for rejection an unauthorized persons than 'min' thresholding rule. By using negative examples, we can significantly improve the performance for access control task.