Neutral Facial Image Recognition Using Parallel Hopfield Neural Networks

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Abstract

This paper presents an approach to perform neutral facial image recognition through facial expression image. The differential of this work is the previous images processing. First, the dimension is reduced. Next, the image is sliced into gray levels, from the most significant bits to the less significant bits. Finally, eight parallel hopfield neural networks are applied, one for each gray level. So far, the results are encouraging, demonstrating better recognition rates in relation to other approaches.

1. Introduction

The literature has some works related to facial expressions recognition, such as MLP (Multi-Layer Perception) [1], RBF (Radial Base Function) [2], and also works that apply the Hopfield network to detect changes in faces expressions [3,4] and nominal color coding of classified images [5].

Ma et al. [1] propose facial expression recognition using an MLP architecture allied to image compression techniques, optimization algorithms such as quasi-newton and pruning methods. In an attempt to simplify this approach, and yet keeping the rate results between 93% and 100% of recognition, we decided to use a Hopfield neural network.

Ma et al.'s work attempts to recognize what is the facial expression on each image that is presented to the neural network. Our work, which is presented on the next section, attempts to, beyond recognize, to recover the image of a face without facial expression (neutral) corresponding to the image of a face with an expression, using Hopfield neural network like associative memory.

The function of the associative memory is to recover a stored pattern that corresponds to the incomplete pattern that is presented. Besides, the associative memory is self-corrective. It can correct inconsistent information of patterns that are presented by the network.

2. Methodology

The neutral faces images to be presented to the neural model receive previous processing: first, a dimension reduction, from 350x275 to 32x32 pixels (this do not cause great losses in the image characteristics), and next, the creation of a vector formed by the lines of the reduced image matrix (32x32), lined up in a single vector column with 1024 positions. The initial idea was to use the vector as an input to a single Hopfield network composed by 1024 neurons. This model was tested and proved its inefficiency due to confusion in relation to the gray levels, providing unsatisfactory results.

It was necessary to separate the gray levels and to create a network for each level. Thus, the vector with 1024 positions was sliced into 8 bits, one for each gray level (Fig. 1).

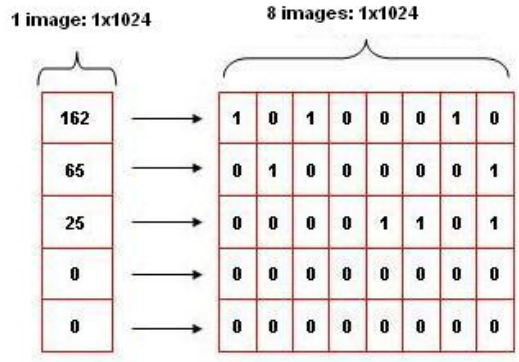

Figure 1 – Sliced vector.

Since we now had eight times more data than before, changes on the network topology were needed. Following this idea, we decided to test a model with 8 parallel networks, one for each gray level. Each network works only in one level of the image and retrieves only the same level of the image. The inverse process to the previous processing is then applied to reconstruct the images that were recovered from the neural networks (see Fig. 2).

To test the proposed model, a base with 100 images, divided in 10 groups, was used. Each group has one neutral image and nine images with face expressions or some changes in the positioning or illumination.

In the network storage phase, the neutral images are applied, and later, the images with expressions are submitted.

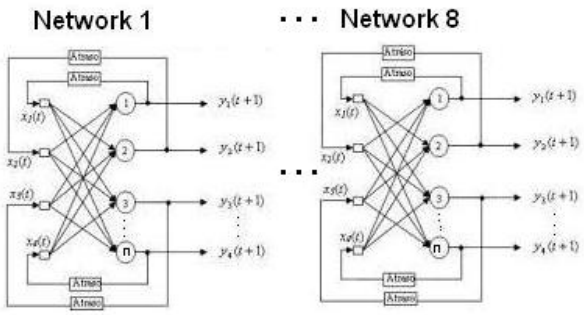

Figure 2 – Hopfield networks

3. Results

The results of performed tests show that the proposed model recovers the neutral image, which is similar to the image with facial expression (see Fig. 3). The Euclidian Norm among the stored neutral images and the recovered images allowed us to classify the results as satisfactory, encouraging the continuity of this research.

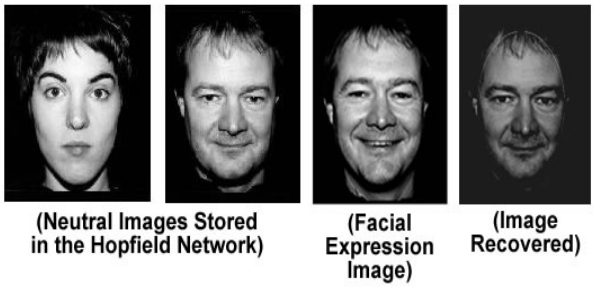

Figure 3 – Facial images

The tests also revealed that when the two less significant bits are removed, the network retrieves an image that is more similar to the neutral image. Therefore, we conclude that these bits cause some confusion (due to the excess of low significant patterns in the storage phase). By using only the three more significant bits it is possible to obtain sufficiently satisfactory results.

4. Conclusions

The approach presented in this paper consists of a simple technique for neutral facial image recognition and retrieval through facial expression images. Performed tests demonstrate acceptable results, with low computational cost and easy implementation.

All the techniques and applications developed for facial image recognition contribute to a research line that has as final goal to join all the techniques in a powerful tool for control and recognition.

5. References

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