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MORPHOLOGICAL SHARED-WEIGHT NEURAL NETWORKS IN FACE DETECTION

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ABSTRACT – This project proposes a classification-based face detection method using Gabor filter features. Considering the desirable characteristics of spatial locality and orientation selectivity's of the Gabor filter, the design filter is used for extracting facial features from the local image. The feature vector based on Gabor filters is used as the input of the classifier, which is a Feed Forward neural network (FFNN) on a reduced feature subspace learned by an approach simpler than principal component analysis (PCA). The effectiveness of the proposed method is demonstrated by the experimental results on testing a large number of images and the comparison with the state-of-the-art method. Here, the image is convolved with Gabor filters by multiplying the image by Gabor filters in frequency domain. The output matrix is reduced in size using MSNN (Morphological shared neural network).

Key words: Face Detection, Gabor Filter, Feed Forward Neural Network, Principal Component Analysis, Morphological shared neural network

I. Introduction

Face detection and recognition has many applications in a variety of fields such as security system, videoconferencing and identification. Face classification is currently implemented in software. A hardware implementation allows us real-time processing, but has higher cost and time to-market. Therefore, the objective of this work is to implement a classifier based on neural networks (Multi-layer Perception) for face detection. The ANN is used to classify face and non-face patterns. The objective not only creates another system that is able to identify a query face image from a database, Most importantly, the delivered prototype maintains its robustness on face images of poorer quality using MSNN (Morphological Shared Neural Network).

The MSNN is a heterogeneous network composed of two cascaded sub-networks, the feature extraction and classification neural networks. The feature extraction layer takes a two dimensional array as input, which is the input sub-image. This input is passed through kernels that can perform a linear or non-linear mapping; these kernels are the morphological structuring elements. Each sub-image input to the network is passed through both the hit and miss kernels. These structuring elements together compose the input weights of the next layer, a feature map. The combination of structuring kernels and feature maps perform the gray-scale hit-miss transform, which is the output result for the feature extraction phase of the MSNN. This output is the direct input to a classic feed-forward neural network. The feature extraction and classification networks are trained together, allowing the MSNN to simultaneously learn feature extraction and classification for a face.

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Besides variations in orientation, expression, and occlusion, the most concerned feature is the ability of the MSNN to perform well even under gray-level shifts. MSNN can recognize successfully under different shifts in light levels as well as handle other kinds of variations.

The certain physical requirements desired for the planning stage are:

(a) It should have a GUI through which the user can execute each task;
(b) The interface should be simple, clear, and systematic: one button, one function;
(c) It should allow the user to select the test image;

Further each subprogram should be straightforward and should not contain functions that overlap;

(a) it should display both the test image and the detected image at the end of the recognition process;
(b) it should display the training process for observation purposes;
(c) It should display recognition results so that we are able to evaluate and analyze.

The things that are considered next are the image processing tasks. Internally, all pattern recognition systems have the following processes.

1. Image acquisition
2. Image enhancement
3. Image segmentation
4. Feature extraction
5. Neural training and classification
6. Detection /Recognition

Since the output of each operation is the input to the next, the functional parts (1-6) must execute in sequence. For the MSNN, Task 4 and 5 and combined. The size of every image (input and output) is to be kept standard so that there is better control and accuracy during matrix computation and parameter training.

The classification FFN phase has a fuzzy output of the confidence that an input sub-image is the desired target face. To utilize this output, a Detection Image Plane (DIP- image black with gray and white pixels) is created and converted to gray-scale. A threshold is applied to this image, with the corresponding high values overlaid onto the input image. The result of this is an image with the target marked by white in the middle of the face (as seen below). Another output image is the

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BOX image; this is accomplished by converting the DIP to a binary image at the threshold point and applying some post processing on this generated image. The result is then used to construct a box the size of the scanning sub-image centered on the target.

II. Methodology

The block diagram of Methodology used in paper is represented in Fig 1.

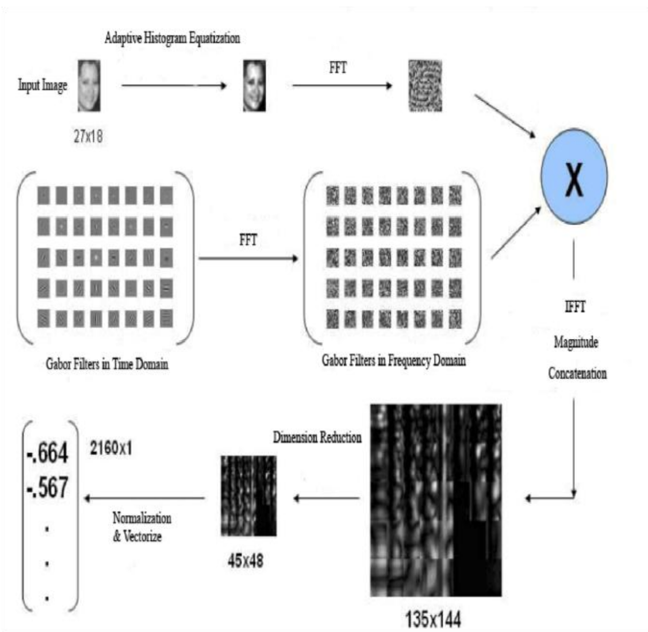


Fig. 1 Block Diagram

The three different sections used to execute the tasks illustrated above are given in Fig. 2 to 9.

FIRST SECTION:

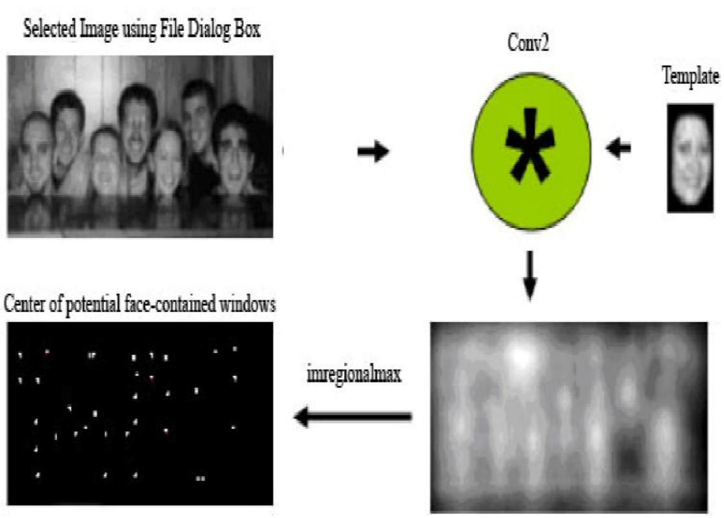


Fig. 2 Feature extraction and Convolution

SECOND SECTION:

In this section the algorithm will check all potential face-contained windows and the windows around them using neural network. The result will be the output of the neural network for checked regions.

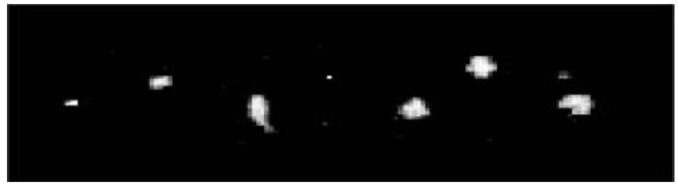


Fig. 3 Cell Net

THIRD SECTION:

Filtering & dilation is carried out taking threshold values in order to determine centers of faces & thereafter highlight faces accordingly.

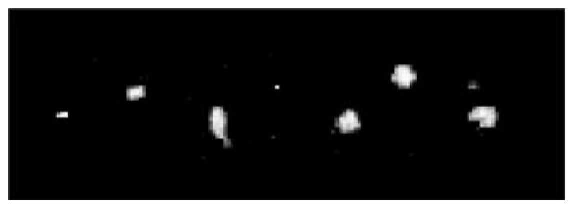


Fig. 4 Filtering above pattern for values above threshold (xy)

Fig.5: Dilating Pattern with a Disk Structure

Fig.6: Finding Centers of each Region

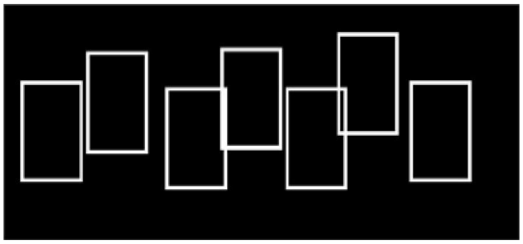


Fig. 7 Draw a Rectangle for each Point

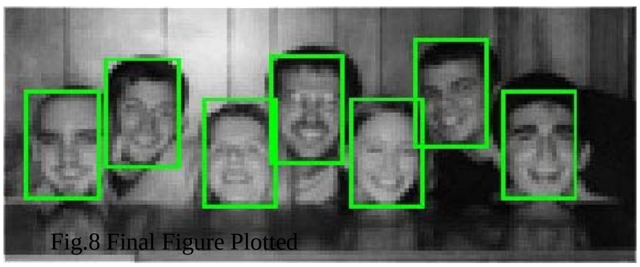


Fig.8 Final Figure Plotted

This architecture is implemented using MATLAB in a graphical environment allowing face detection in a database.

III. Simulation and Results

The MSNN model developed is largely dependent on two issues mainly. These are:

(a) Complexity: How large is our image database? How large should one image be? Should we make them smaller or larger by resizing?

(b)Performance and Reliability: We need to know which neural network is reliable and learns fast. In terms of classification quality, we have to know how these various networks perform their computations. Are these techniques suitable for training digital images?

The experiments were carried out for varying size and shape of the structuring element. The size was increased for structuring element and Results showed that the MSNN is not very sensitive to structuring element size and shape.

However, For the network that uses a "disk" structuring element, recognition accuracy remains constant at 100% until it drops abruptly at the size of 31×31 pixels; the fail size is 29×29 pixels for the network that uses a "diamond" structuring element. Fig. 10 and Fig. 11 show the simulated results on structuring element with two different shapes.

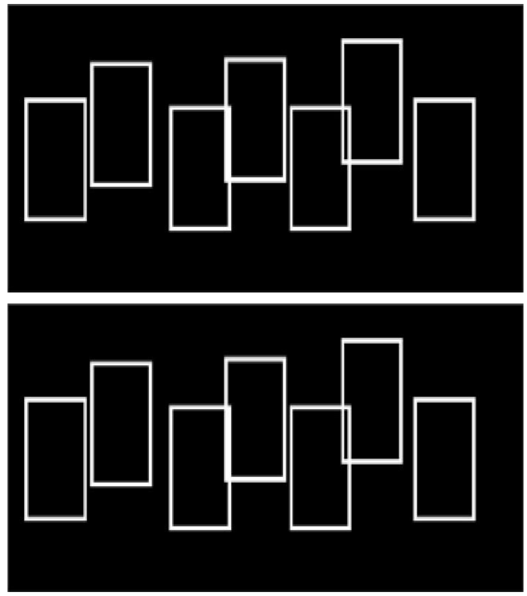
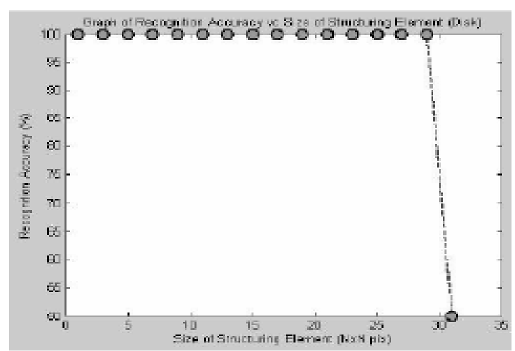


Fig. 10. Graph of recognition Accuracy vs. size of disk structure Element



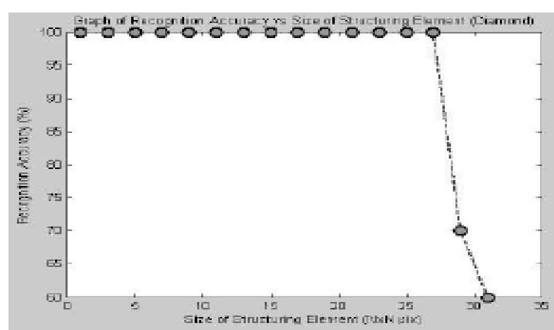


Fig. 11. Graph of recognition Accuracy vs. size of diamond structure Element

These findings indicate that the size of the structuring element must not get too close to the size of the input image. Since, the human face has a nonlinear pattern; hence, the “disk” structuring element should be used to perform hit-miss transform in the feature extraction stage. The performance of the MSNN is very sensitive to the proper setting of the learning rate. It cannot be set too high; otherwise, the network may oscillate and become unstable. Several Learning rates are to be plotted in further stages to show the morphological shared-weight neural work can approach the robustness needed for face recognition.

IV. Conclusion

A good feature set when used in simulation of face recognition and detection can make the training and decision- making simpler and more accurate. The strength of the MSNN is in its translation-invariant extraction layer. It enables the network to learn complex patterns by extracting progressively more meaningful features from the input patterns of a face. The MSNN avoids being too restricted by mathematical metric in its classification process. This increases its ability to generalize. The different structuring elements can be tested and verified for number of images for future researchers and scientists.

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