Image Processing in Face Detection through Morphological Shared-weight Neural Networks

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Abstract – **Face detection can be regarded as one of the special classifications under object-class detection in areas of image and signal processing. In object-class detection, the task is to explore locations and sizes of all objects in an image that belong to a given class. Face detection can be regarded as a more general case of face localization. In face localization, the task is to find the locations and sizes of a known number of faces (usually single). In face detection, one does not have this additional information.**

In this paper, image processing technique on Face Detection is implemented using MSSN (Morphological Shared weight Neural Networks). The technique overcomes drawbacks of earlier used face-detection algorithms that focused on the detection of frontal human faces only. The algorithm used is an attempt to solve more general and difficult problems related to multi-view face detection. That is, the detection of faces that are either rotated along the axis from the face to the observer (in-plane rotation), or rotated along the vertical or left-right axis (out-of-plane rotation), or both. The proposed system takes into account variations in the image or video by factors such as face appearance, lighting, and pose. The simulation is carried out using Image processing tool box in MATLAB.

Keywords: Face Detection, Face Localization, Morphological Shared weight Neural Networks, MATLAB.

I. INTRODUCTION

FACE DETECTION and recognition has many applications in a variety of fields such as security systems, 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.

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.

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:

- It should display both the test image and the detected image at the end of the recognition process;
- It should display the training process for observation purposes;
- 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 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

Block diagram of Methodology used in paper is shown in Fig 1.

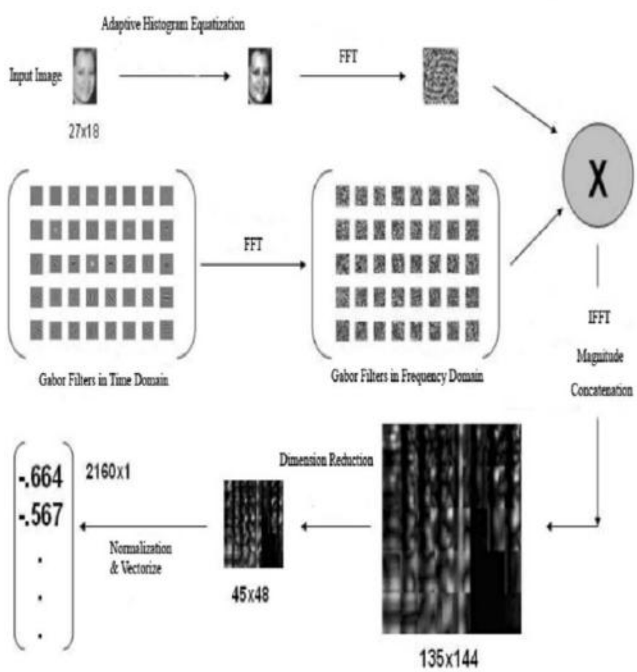

Figure 1. Block Diagram.

Three different sections used to execute the tasks illustrated above are given in figures 2 to 8.

First section:

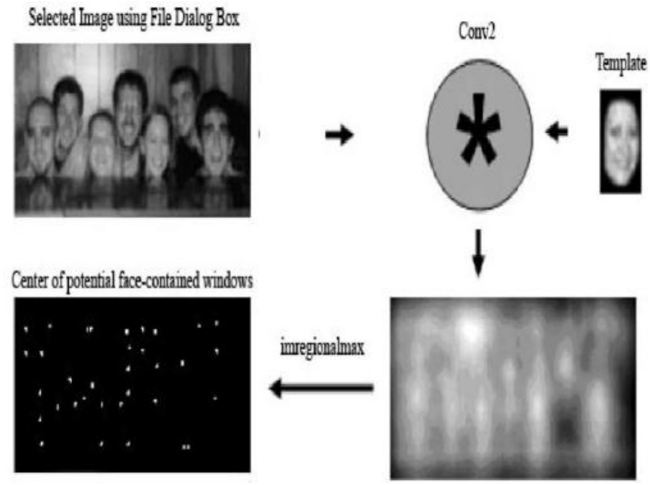

Figure 2. Feature extraction and Convolution.

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.

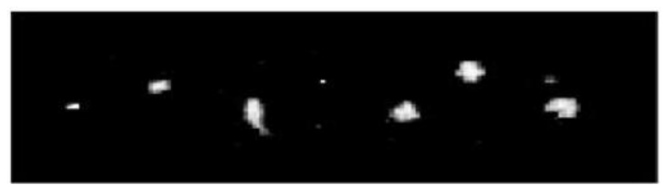

Figure 3. Cell Net.

Third section: Filtering and dilation is carried out taking threshold values in order to determine centers of faces and thereafter highlight faces accordingly.

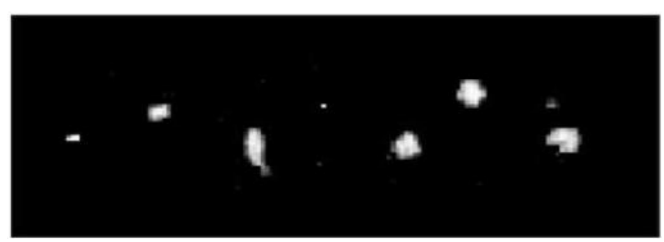

Figure 4. Filtering above pattern for values above threshold (xy).

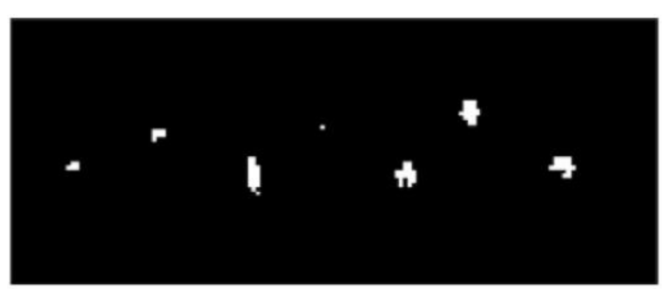

Figure 5. Dilating pattern with a disk structure.

Figure 6. Finding Centers of each Region.

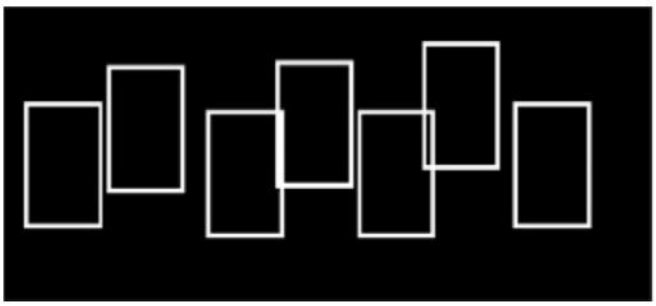

Figure 7. Draw a Rectangle for each Point.

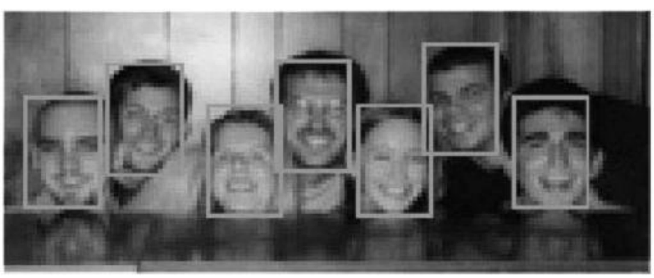

Figure 8. Final figure plotted.

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:

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

(*ii*) *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?

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. Figures 9 and 10 depict simulated results on structuring element with two different Shapes.

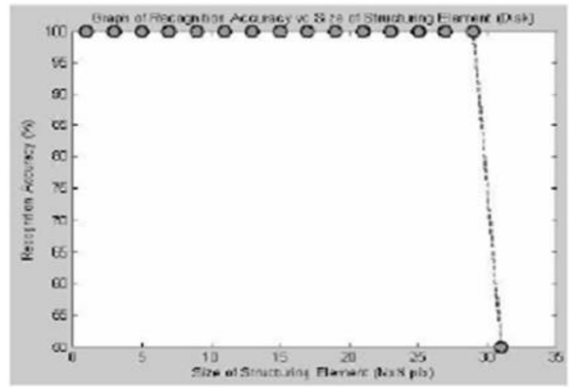

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Figure 9. Graph of recognition accuracy vs. size of disk structure element.

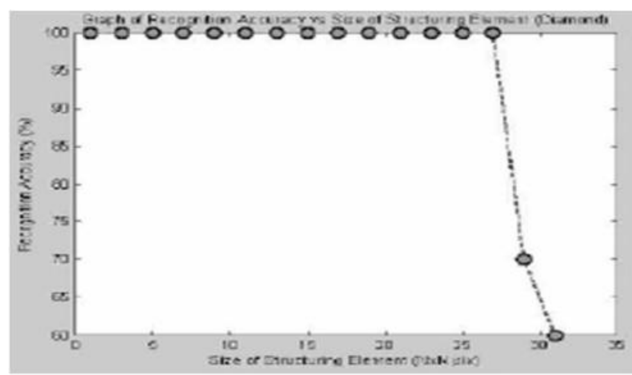

Figure 10. Graph of recognition accuracy vs. size of diamond structure element.

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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