Implementation of Neural Network Algorithm for Face Detection Using MATLAB

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Abstract- In this paper, a new approach of face detection system is developed. This system develops the algorithm for computing the accurate measurement of face features. The task of detecting and locating human faces in arbitrary images is complex due to the variability present across human faces, including skin color, pose, expression, position and orientation, and the presence of 'facial furniture' such as glasses or facial hair. In this system, a neural network-based upright frontal face detection system is presented. A retinally connected neural network examines small windows of an image, and decides whether each window contains a face. The system arbitrates between multiple networks to improve performance over a single network. A straightforward procedure for aligning positive face examples for training was presented. It uses a transformer that converts an image of human face into a feature vector, which will then be compared with the feature vectors of a training set of human faces to classify the image. Some mathematical concepts are used to calculate the distance and angles between feature points. And histogram equalization is used to enhance the selected feature. In this paper, faces are chosen because it can generate the significant features for human face than other techniques. Finally, matching is accomplished by detecting the test photo. For programming and simulation of this system, MATLAB software is applied. The neural network toolbox "nntool" is called from the main function for training system. This research develops a simple face detection system for to provide the security system.

Index Terms- Face Detection, MATLKAB, image Processing, Neural network, Algorithm

I. INTRODUCTION

Pattern recognition is a modern day machine intelligence problem with numerous applications in a wide field, including Face recognition, Character recognition, Speech recognition as well as other types of object recognition. The field of pattern recognition is still very much in its infancy, although in recent years some of the barriers that hampered such automated pattern recognition systems have been lifted due to advances in computer hardware providing machines capable of faster and more complex computation.

Face recognition, although a small task for the human brain has proved to be extremely difficult to imitate artificially. It is commonly used in applications such as human-machine interfaces and automatic access control systems. Face recognition involves comparing an image with a database of stored faces in order to identify the individual in that input image. The related task of face detection has direct relevance to face recognition because images must be analyzed and faces identified, before they can be recognized. Detecting faces in an image can also help to focus the computational resources of the face recognition system, optimizing the systems speed and performance.

Face detection involves separating image windows into two classes; one containing faces (targets), and one containing the background (clutter). It is difficult because although commonalities exist between faces, they can vary considerably in terms of age, skin color and facial expression. The problem is further complicated by differing lighting conditions, image qualities and geometries, as well as the possibility of partial occlusion and disguise. An ideal face detector would therefore be able to detect the presence of any face under any set of lighting conditions, upon any background. For basic pattern recognition systems, some of these effects can be avoided by assuming and ensuring a uniform background and fixed uniform lighting conditions. This assumption is acceptable for some applications such as the automated separation of nuts from screws on a production line, where lighting conditions can be controlled, and the image background will be uniformed. For many applications however, this is unsuitable, and systems must be designed to accurately classify images subject to a variety of unpredictable conditions.

A variety of different face detection techniques exist, but all can be represented by the same basic model, depicted in Fig.1. Each technique takes a slightly different approach to the face detection problem, and although most produce encouraging results, they are not without their limitations**.**

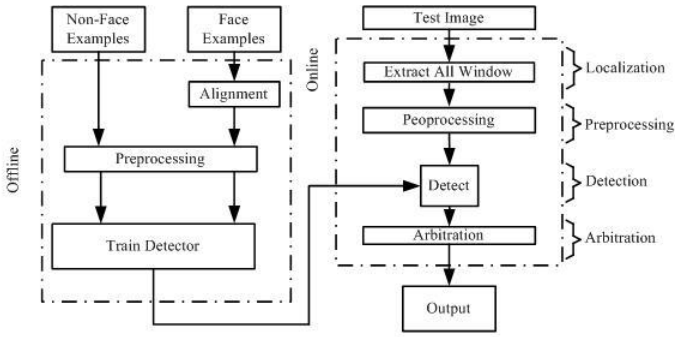

Fig.1. Block Diagram of Face Detection System

II. OPERATION OF A FACE DETECTION SYSTEM

Most detection systems carry out the task by extracting certain properties of a set of training images acquired at a fixed pose in

an off-line setting. To reduce the effects of illumination change, these images are processed with histogram equalization or standardization. Based on the extracted properties, these systems typically scan through the entire image at every possible location and scale in order to locate faces. The extracted properties can be either manually coded (with human knowledge) or learned from a set of data as adopted in the recent systems that have demonstrated impressive results. In order to detect faces at different scale, the detection process is usually repeated to a pyramid of images whose resolution is reduced by a certain factor from the original one. Such procedures may be expedited when other visual cues can be accurately incorporated (e.g., color and motion) as pre-processing steps to reduce the search space.

As faces are often detected across scale, the raw detected faces are usually further processed to combine overlapped results and remove false positives with heuristics or further processing. Numerous representations have been proposed for face detection, including pixel-based, parts-based, local edge features. A large and representative training set of face images is essential for the success of learning-based face detectors. From the set of collected data, more positive examples can be synthetically generated by perturbing, mirroring, rotating and scaling the original face images. On the other hand, it is relatively easier to collect negative examples by randomly sampling images without face images. As face detection can be mainly formulated as a pattern recognition problem, numerous algorithms have been proposed to learn their generic templates or discriminate classifiers. Typically, a good face detection system needs to be trained with several iterations. The overview of the algorithm of face detection method is shown in Fig. 2.

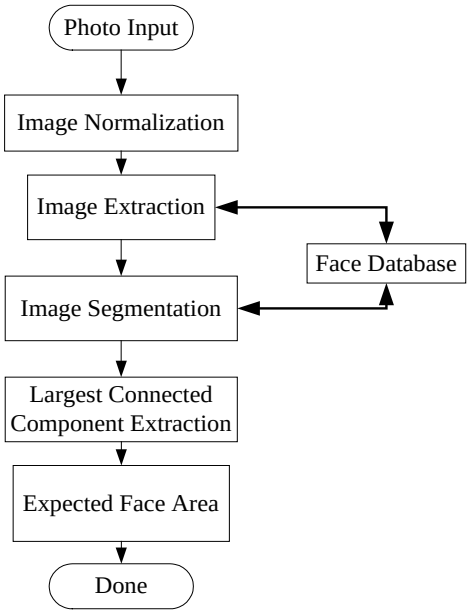

Fig.2. Algorithm of The Face Detection Method

III. Structured Programming with Functions

MATLAB comes with a large collection of functions. The 'main' script itself will then look very much like a first-level structure plan of the problem. And the other functions and MAT files have been called from the main script.

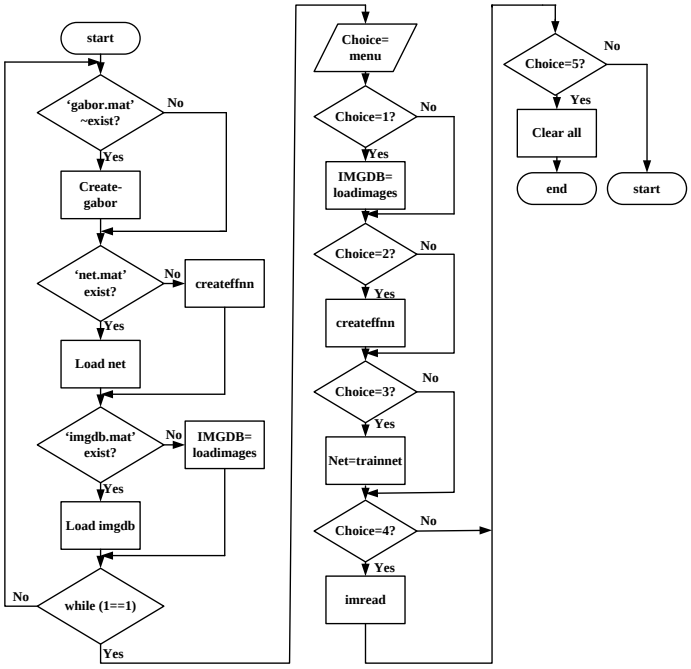

Fig.3. Main Function for Neural Network Based Face Detection

In the main function, the three mat files: gabor.mat, net.mat, and imgdb.mat are main condition for running stage of this system. If the conditions are matched, it may be linked between main function and the other functions and the menu will be displayed on the monitor. If the choice-1 is pressed, the loading of data based system will be accomplished. If the choice-2 is selected, the initializing the network will be appeared. If the choice-3 is elected, the neural network system would be trained by appropriate training algorithm. If the choice-4 is preferred, the testing the system will be worked. If the choice-5 is special, the network will be exited. The procedure has been illustrated by Fig.2.

IV. Test Procedures Results of Test Photos

A number of experiments are performed to evaluate the system. Neural Network based Face detection system consists of five functional applications. They are:

- Create Database
- Initialize Network
- Train Network
- Test on Photos
- Exit

When the main function has been run in MATLAB command window, the following MENU would be displayed. The result is as shown in Fig. 4.

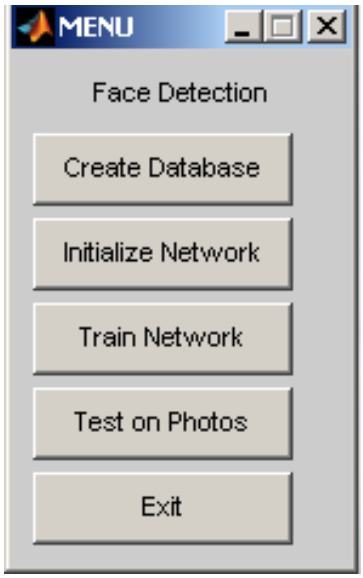

Fig.4. Result of Main Function on the Command Window

If the create database button is pressed, the faces and non-faces would be created by loading faces and non-faces results as shown in Fig.5. The two databases in this research have two folders: face and non face folders. Each folder contains 69 faces and 69 non faces.

Fig.5. Result of Create Database

If the initialize network button is pressed on the menu, the specified neural network algorithm would be displayed on the command window as shown in Fig.6. The number of input “numInputs” ; 1, the number of layers “numLayers” ; 2, the size of layer one ; 100, the size of layer two is 1,the transfer function “transferFcn” is “tansig”, the initial function “ initFcn” is “initnw”, the performance function “performFcn” is “msereg”, and the train function “trainFcn” is “trainscg” must be assigned to the appropriate function of face detection system. The result of initialize network is shown in Fig.6. In this figure the necessary information for the user would be displayed and helped.

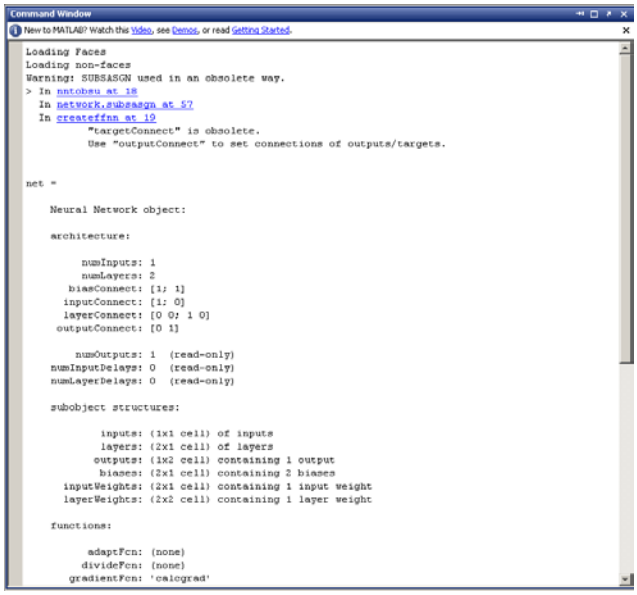

Fig.6. Result of Initialize Network

If the train network button is pressed on the menu, the neural network training (nntraintool) would be activated from the neural network toolbox. The result of train network is shown in Fig.7. In this figure the neural network algorithm would be displayed with one input, two layers with weight and bias, and one output. According to the present result of training system, the epoch is 185 iterations for 400 epochs, running time is 0:01:58 hours, the performance is 0.00987 for 0.00100 target, the gradient is 0.0127 for 1.00e-06, and validation checks is 0 for 6 must be displayed on the command window. To match the performance goal, the plot interval must be reached to 100 epochs. According to the Fig.7 the neural network training system has been accomplished and known by user. Neural network toolbox is very useful to simulation of this face detection system by calling function from the main program on the command window.

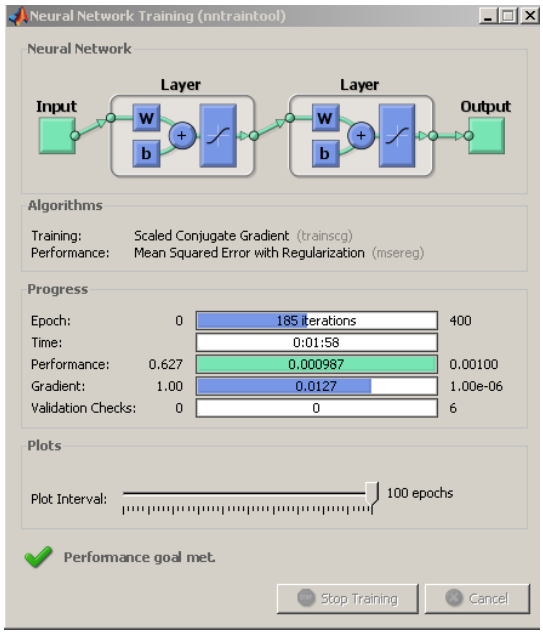

Fig.7. Result of Train Network

V. Experimental Results of Face Detection System

Some photographs are used for face detection and all sample photos and test results are illustrated in the following figures. The current research uses 69 faces and 69 non-faces.

Fig.8. Original Photo of Image 1

If the user chooses the test photo image 1, according to the starting condition the place where the face located on the photo image 1 is detected by red spots. The result is shown in Fig.9.

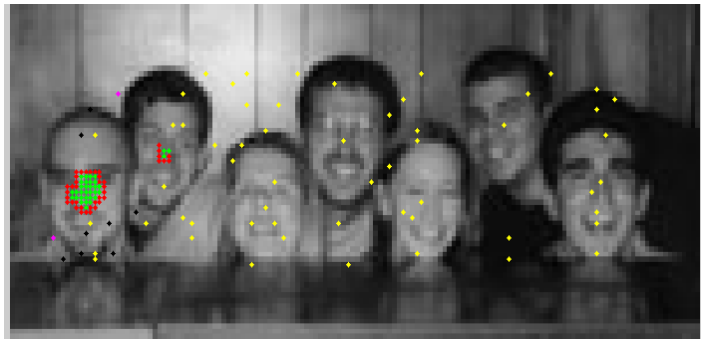

Fig.9. Result of Test on Photo for Starting Condition of Image 1

And then the red spots are placed on the photo image 1 the following Fig.10 is displayed on the computer monitor. The red spots are created by the template photo.

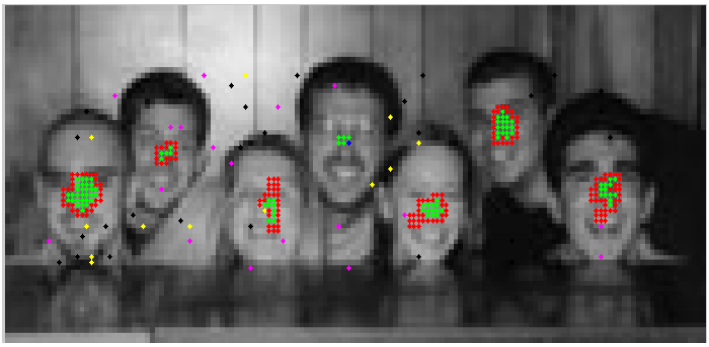

Fig.10. Result of Test on Photo for Ending Condition of Image 1

When the detection condition has been completed the white color would be displaced on the detection marks. The result is shown in Fig.11.

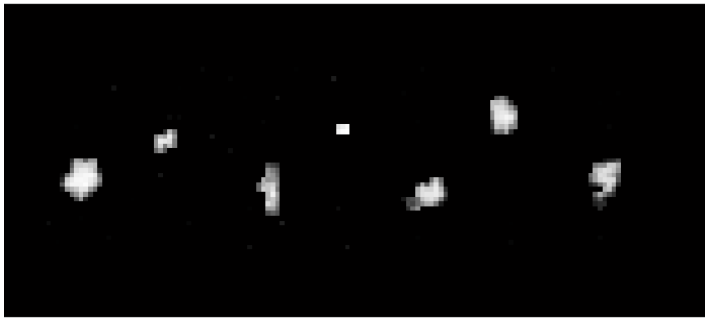

Fig.11. Result of Test on Photo for Gray Scale of Image 1

When the white color has been created on the photo image 1, the 27×18 windows is displaced on the detection marks of the test photo image 1. The result is shown in Fig.12.

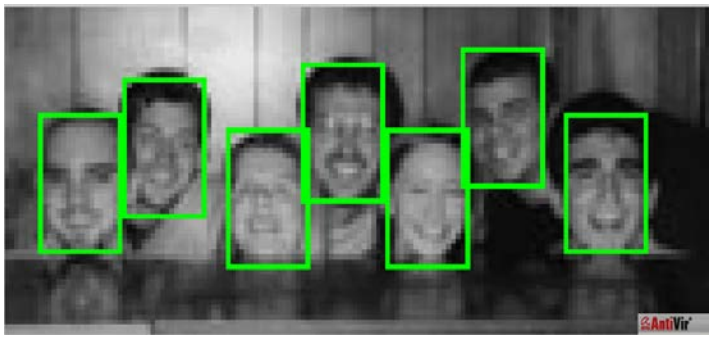

Fig.12. Result of Test on Photo for Detecting Condition of Image 1

It is thought that any complexity of problem can be solved with just a single layer of hidden neurons. With a greater number of hidden neurons, there are more weights to tune during training, and thus a more complex a decision boundary can be formed (although too many neurons can lead to over fitting of the

boundary to the training set, thus poor generalization). The number of hidden neurons will be varied from 1 through to 1000 (25 being the default number in the original design), and the "imscan" function will be used to see how well the system learns the training set. Table.1 shows the results of these experiments.

Table.1. The effect on performance of varying the number of hidden neurons

No. hidden neurons	Face detection rate %	Non-Face detection rate %	Total detection rate
1	99.2	97.5	98.1
10	100	99	99.4
20	98.3	100	99.4
25	99.2	99.5	99.4
30	99.2	98.5	98.8
40	100	100	100
50	100	100	100
100	100	100	100
1000	100	100	100

VI. Conclusion

Although the developed system has recorded good results with the data sets presented, there are still some factors to consider if the software is used. A high-resolution photograph of a human face could also be presented to a detection condition, resulting in an unauthorized match. This system can work for viewing because the proposed method can find the matching only in front of the face image. So, it can work well for face detection system. The system presented in this research is able to perform accurately, however there are still a number of issues which need to be addressed. First of all, the automatic segmentation is not perfect, since it cannot successfully segment the face regions for all of the images in databases. In order to improve the automatic segmentation algorithm, a more face detection system could be implemented. Since the system is implemented in MATLAB R2008b, which is an interpreted language, speed benefits could be made by implementing computationally intensive parts in C or C++. Speed is not one of the objectives for developing this system, but this would have to be considered if using the system for real-time recognition.

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