

# A Face Recognition System Using Template Matching And Neural Network Classifier

Muhammad Firdaus Hashim<sup>1</sup>, Puteh Saad<sup>1</sup>, Mohd Rizon Mohamed Juhari<sup>2</sup> and Shahrul Nizam Yaakob<sup>1</sup>

<sup>1</sup>*School of Computer and Communication Engineering  
Northern Malaysia University College of Engineering, Blok A, Kompleks Pusat  
Pengajian KUKUM, Jalan Kangar-Arau, 02600 Jejawi  
Perlis, Malaysia*

<sup>2</sup>*School of Mechatronic Engineering  
Northern Malaysia University College of Engineering Blok A, Kompleks Pusat Pengajian  
KUKUM, Jalan Kangar-Arau, 02600 Jejawi  
Perlis, Malaysia  
E-mail: firdaush@gmail.com,  
puteh@kukum.edu.my, rizon@kukum.edu.my, ysnizam@student.kukum.edu.my*

**Abstract** - *We develop a technique to identify an unknown person in a face image by using template matching and neural network classifier. The technique is separated into three main steps namely; preprocessing, feature extraction and recognition. In the preprocessing step, we process and normalize the input image using approaches proposed by Kawaguchi et al. [1]. We prepare an intensity image of human frontal face and a cut off region consisting of both eyes and eyebrows from the image as a template and a representative feature. Finally, we use the templates as input to the neural network classifier for recognition purposes.*

**Keywords** – Feature Extraction, Face Recognition, Neural Network.

## 1. INTRODUCTION

Machine recognition of human face is a challenging problem due to changes in the face identity and variation between images of the same face due to illumination and viewing direction. In this paper the issues here are how the features adopted to represent a face under environmental changes and how we classify a new face image based on the chosen representation. In order to recognize the face using template matching and normalization of the image input, we implement the process proposed by Kawaguchi et al. [1]. The process will involve 3 separated parts preprocessing, feature extraction and recognition step. In the preprocessing step we separate the face part from the input image. In the feature extraction step, we are planning to use some methods to extract the effective features. The last step for recognition, we will use the features as input to the neural network classifier for training and testing the input images. The process diagram in Fig 1.

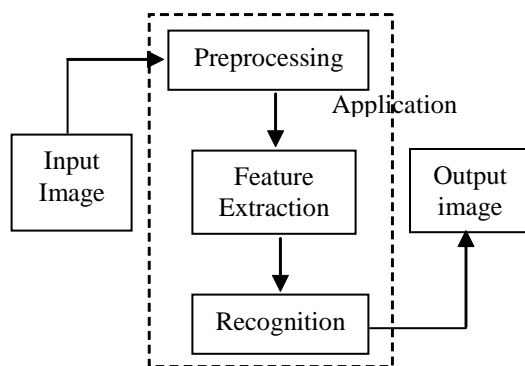


Fig. 1 Diagram of basic concept

## 2. PREPROCESSING

In the processing step, we applied the step proposed by Kawaguchi et al. [1] They propose the system to detect the irises of the both eyes and then normalize the input image. The proposed system is to identify the unknown person in an image by matching the image face to the templates of reference faces stored in a database. In this paper we process the input image by detecting the irises of both eyes. Some of the process involved before the irises can be detected. The processes are extracting the head region, detection of irises, cost of irises and selecting the pair of irises.

### 2.1 Process the Input Image

We consider that the system will identify the input person in a face image which the position, scale, rotation and size of the image are unknown. We proposed to process the input image with the same size because after the preprocessing and feature extraction steps, we will use the neural network for recognition process. When the size of the input image is bigger, the recognition process using the neural network becomes unstable [2]. Furthermore the time of network to process the input will increase. If the size is too small, the neural network may become insensitive to define different expressions.

In the real situations, the input images are from the automatically by digital camera and it is not always the same size. We intend to apply the Mosaic Pattern to change the image into our standard size [2]. Although the Mosaic Pattern is able to absorb the slight difference of the size, it must be better to match the size from the first original image [2]. Fig. 2 shows the process to shrunk the image from 240 x 296 to 120 x 148 pixels [2].

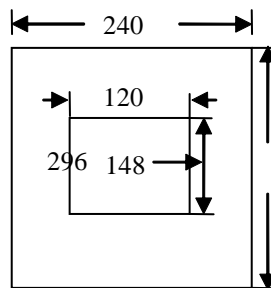


Fig. 2 Pixel Shrinking

### 2.2 Extraction of the Head Region

We consider the input image is a shoulder image with plain background and both of eyes appear in the image. So first we apply the simple steps shown by [3]. They apply Sobel edge detector to the original intensity image.

While the positions of the left, right and upper boundaries of the head obtained by the above procedure are almost exact, the position of the lower boundary is not exact. But the exact the position of the lower boundary is not needed because our purpose is to detect the irises of both eyes. Fig. 3 shown the face region extracted from the image.

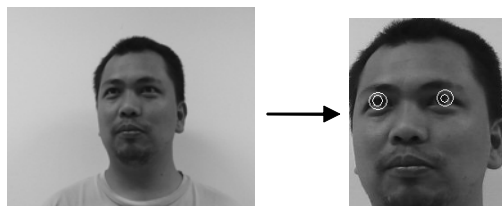


Fig. 3 Face Region after extraction process

## 2.2 Detection of Irises

To detect the irises, we extract the valley regions inside the head region using methods shown in [3]. We modelled the irises by circles, see Fig. 3. Let  $(x, y)$  and  $r$  denote the positions and the radii of the irises modelled by circles. By using the eye template, the algorithm detects from the head region the candidates for the irises. From the template of Fig. 4, the region  $R_2$  corresponds to the iris. The separability  $\eta$  between regions  $R_1$  and  $R_2$  of the eye template is given by [3].

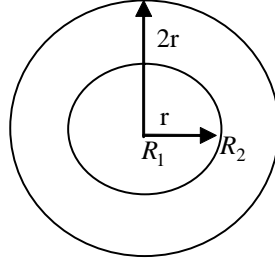


Fig. 4 The template used to detect irises

## 2.4 Cost of Irises

Let  $B_i(x_i, y_i, r_i)$  denote the irises shown in section 2.3. The algorithms apply the Canny Edge Detector to the region and then the algorithm measures the fit of irises to the edge image using the circular Hough Transform. The equation of a circle utilized here is  $(x - a)^2 + (y - b)^2 = r^2$  where  $(a, b)$  is the circle center and  $r$  is the radius.

Then we apply the step shown in [2] to compute the  $B_i$ . Next we using the two template shown in Fig 5(a) to compute the separabilities between  $\eta_{23}(i)$  and  $\eta_{24}(i)$  by using the formula in section 2.3, where  $\eta_{kl}(i)$  denotes the separability regions  $R_k$  and  $R_l$ . Similarly we compute  $\eta_{25}(i)$  and  $\eta_{26}(i)$  using the template in Fig. 5(b). The cost of irises of each iris,  $B_i$  is given by [3].

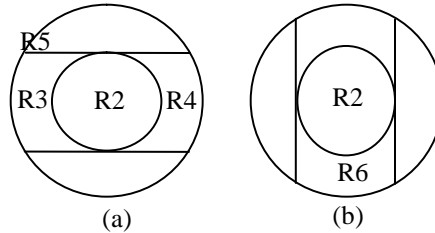


Fig. 5 The template used to compute  $C_2(i)$  and  $C_3(i)$

## 2.5 Select the Pair of Irises

For each pair of irises  $B_i$  and  $B_j$ , let  $d_{ij}$  and  $\theta_{ij}$  denote the length and the orientation of the line connecting the centers of  $B_i$  and  $B_j$ . The algorithm computes a cost of each pair of irises such  $L/4 \leq d_{ij} \leq L$  and  $-30^\circ \leq \theta_{ij} \leq 30^\circ$  where  $L$  is the difference between the x-position of the left and right contours of the face [3].

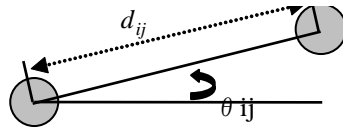


Fig. 6 To select pair of irises

The cost of iris-pair  $B_i$  and  $B_j$  is given by  $F(i, j) = C(i) + C(j) + \frac{1}{R(i, j)}$  where the  $C(i)$  and  $C(j)$  are the cost compute in section 2.4 and  $R(i, j)$  is the normalized cross-correlation value compute by using an eye template shown in [3].

### 3. FEATURE EXTRACTION

After we extract the input image by detection the irises to get the face template. We plan to use the template to get the useful information for recognition using Neural Network. This is done by intelligently reducing the amount of image data with tools we have explored, including image segmentation and transforms [4]. After we have performed these operations, we have modified the image from the lowest level of pixel data into higher-level representations. Image segmentation allows us to look at object features and the image transforms provide us with features based on spatial frequency information. The object features of interest include the geometric properties of binary objects, histogram features and color features [4].

*T.Phiasai et al* [5] used the Principal Component Analysis (PCA) to extract the global feature from the input image to determine the minimum error. If the magnitude of the error is more than the threshold, the system will reject the classification result and accepts the Moment Invariant results. Moment Invariant is used to analyze the local face such as nose and eyes. We proposed to implement these methods with our face template to become the global feature and the irises become the local feature. PCA method is a technique used to approximate an original data with lower dimensional feature vector, which is the best method for the distribution of face images [5]. Moment is quantitative measurement of an object's shape. Moment invariants are robust in terms of scaling, translation and rotation. They are widely used in pattern recognition due to the discrimination power. In local feature analysis, regions of small variation indicate the deformation and displacement of facial features. The moments are the desired feature vectors, since they are invariant to scaling, translation and rotation [5].

### 4. RECOGNITION STEP

We proposed use the Neural Network for training and testing to achieve our objective. For the training the data about 50 template images (each person has 5 images) of inputs. In the learning step, is the process of modifying the weight in order to produce a network that performs some functions [5]. The backpropagation algorithm will be proposed in our system. We have to prepare:

- a) Training Set – a collection of input-output patterns that are used to train the network.
- b) Testing Set - a collection of input-output patterns that are used to access network performance.
- c) Learning Rate  $\eta$  - a scalar parameter, analogous to step size in numerical integration, used to set the rate of adjustment.

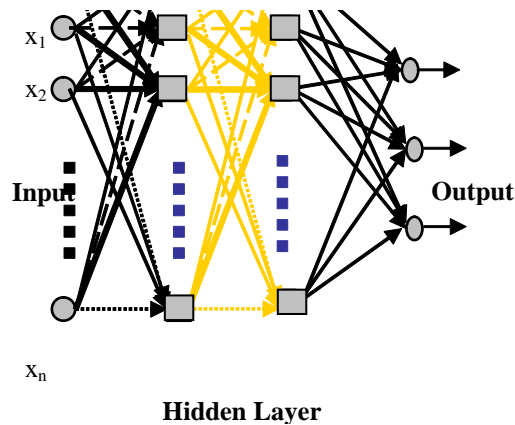


Fig. 7 Multilayer Network

In this paper we also proposed to apply the Genetic Algorithm (GA) in our system. *S. Karungaru* [6], used GA with template matching to automatically test several positions around the target and also adjust the size of the templates as the matching process progress. GAs is derivative-free stochastic optimization methods based loosely on the concepts of natural selection and evolutionary process [7]. GAs characteristics [7]:

- a) GAs are parallel-search procedures that can be implemented on parallel-processing machines for massively speeding up their operations.
- b) GAs are applicable to both continuous and discrete (combinatorial) optimization problems.
- c) GAs are stochastic and less likely to get trapped in local minima. Which inevitably are present in any practical optimization application.
- d) GAs' flexibility both structure and parameter identification in complex models such as Neural Networks and fuzzy inference systems.

GAs and Neural Networks are both optimization algorithms. GAs seek to find one or more members of a populations that represents a solution to the objective function and ANN learning algorithms seek to find a set of synapses (weight) that minimize the number of incorrect classifications [8]. Furthermore, GAs have been used with Neural Network to [8]:

- a) Find an optimal set of weight for smaller MLFF networks.
- b) Construct optimal networks for given applications.
- c) Find optimal network parameters (learning rate, momentum term rate, number of nodes) for given applications.
- d) To even find a set of rules that describes the behavior of trained network.

In most of the cases above, the real problem is in finding an appropriate representation for the variables and translating it into a constrained solution space, one which is tractable for a GA solution [9]. As for the recognition step, we intend to combine the GA and Neural Network for face recognition.

## 5. RESULTS

The system computes a cost by:

$$P(i) = aC(i) + (1 - a) \frac{NN(i) - NN_{min}}{NN_{max} - NN_{min}}$$

Where  $C(i)$ : The cost between the input image and face template of database using template matching.

$NN(i)$ : The cost using neural network classifier computes the degree of the match between input images.  $\alpha$  is set to 0.5. A person which highest cost  $P(i)$  is identified as the person in the input image.

## 6. CONCLUSION

In this paper we propose to apply a few methods for face recognition problems. In the processing step, we propose Mosaic Pattern for image sizes and apply method mention by [1] for the normalization of the input image. In the feature extraction, we propose to extract information from the image using the Principal Component Analysis (PCA) and Moment Invariant. The final step we proposed to integrate the Genetic Algorithm into Back-Propagation algorithm for face recognition purposes .

## REFERENCES

- [1] T.Kawaguchi, M.Rizon & T.Kunihiro," A Face Recognition System Using Template Matching and Iris Detection", *Proceedings of the IASTED International Conference Signal And Image Processing*, 2001, pp.298-303.
- [2] H.Kondo, Sasha, "Human-Face Recognition Using Neural Network with Mosaic Pattern", *IEEE Conference on SMC*, 1999, pp.831-834.
- [3] T. Kawaguchi, D. Hidaka & M. Rizon,"Robust Extraction of Eyes From Face", *IEEE on Pattern Recognition 15<sup>th</sup> International Conference*, 2000, pp.1109-1114.
- [4] Scott E., "Computer Vision and Image Processing: A Practical Approach using CVItools", Prentice-Hall, 1998.
- [5] T.Phiasai, A.Arunrungrusmi & K.Chamnongthai, "Face Recognition System with PCA and Moment Invariant Method", *IEEE Conference on Circuit & Systems*, 2001, pp.165-168.
- [6] S. Karungaru, M. Fukumi & N. Akamatsu,"Face Recognition using Genetic Algorithm based Template Matching", *International Symposium on Communications and Information Technologies ISCIT*, 2004, pp.1252-1257.
- [7] J.-S, R. Jang, C, -T. Sun & E. Mizutani,"Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Prentice Hall, 1997.
- [8] Patterson W. D., "Artificial Neural Network: Theory and Applications", Prentice Hall, 1999.