효과적인 얼굴 인식을 위한 특징 분포 및 적응적 인식기

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Feature Variance and Adaptive classifier for Efficient Face Recognition

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요 약

Face recognition is still a challenging problem in pattern recognition field which is affected by different factors such as facial expression, illumination, pose etc. The facial feature such as eyes, nose, and mouth constitute a complete face. Mouth feature of face is under the undesirable effect of facial expression as many factors contribute the low performance. We proposed a new approach for face recognition under facial expression applying two cascaded classifiers to improve recognition rate. All facial expression images are treated by general purpose classifier at first stage. All rejected images (applying threshold) are used for adaptation using GA for improvement in recognition rate. We apply Gabor Wavelet as a general classifier and Gabor wavelet with Genetic Algorithm for adaptation under expression variance to solve this issue. We have designed, implemented and demonstrated our proposed approach addressing this issue. FERET face image dataset have been chosen for training and testing and we have achieved a very good success.

1. INTRODUCTION

Human face recognition and detection has been an active research area for the last 2 decades. It has many practical applications, such as surveillance system, bank card identification and security monitoring [1]. Face recognition is a biometric system that employs automated methods to verify or recognize the identity of a living person based of his/her physiological characteristics [2]. The existing and emerging technology in face detection and recognition is attempting to challenge the different environmental and non-environmental factors that come as a hazard to efficient face recognition. Out of these hazards, expression, pose, occlusion and illumination are the basic challenges while designing efficient and effective face recognition system. Many tools and techniques have been invented to handle these issues, yet face recognition is still a challenging problem till now [3].

A number of novel approach like Principal Component Analysis [4] [5], Independent Component Analysis [6] and Gabor based approaches [7] [8] along with some other approached are applied for face recognition.

In this research work, we have proposed a novel method of handling the facial expression issue. Facial expression causes the different facial feature to change its shape from normal pose. Out of these facial features, mouth region is the most affected region of face region since the variance of shape is soaring at this part and recognition is a difficult task since the number of environmental and non-environmental factors exist. We have to give special attention to handle mouth facial feature under facial expression. In this paper, we have applied the Adaptable Gabor Wavelet at Mouth facial feature. At first stage, we treat the entire image using general purpose classifier which is Gabor wavelet. At second stage, for the image with maximum variance due to expression, the recognition rate considerably below the threshold (recognition rate), we treated these entire image as rejected image by general classifier and apply adaptable classifier to improve recognition rate. We use Gabor Wavelet using Genetic Algorithm [9] for adaptation purpose. For simplicity and to avoid more computation, we have employed nearest neighbor [10] for classification during this approach. We have proposed the adjusted Gabor kernel for mouth facial feature and have investigated the result through extensive experiment on FERET [11] face image.

This paper is organized as follows: Section 2 describes our proposed classifier. Section 3 describes the proposed system to handle the facial expression issue. Section 4 describes the experimental result for the propose system. Conclusion is given in Section 5.

2. Proposed adaptive classifier

We provide weight to each facial feature of mouth area. The GA is employed to search among the different combinations of feature representations. The optimality of the chromosome is defined by classification accuracy and generalization capability. Each Mouth feature point is represented by combination of these chromosome bits. As the GA look for genospace, the GA makes its choices via genetic operators as a function of probability distribution driven by fitness function. The genetic operators used are selection, crossover and mutation [9].

We adjust the weight for facial expression of Mouth (as shown in fig. 1(a)) using 4 bit chromosome on feature points 21, 22, 23 and 24 respectively for expression variance adaptation as shown inTable1.

Table.1 Chromosome Description of the proposed scheme for Adaptation

Mouth feature point-21	Mouth feature point-22	Mouth feature point-23	Mouth feature point-24

The overall mouth features can be represented using this scheme. The presence and absence of certain bits in a chromosome encoding resembles inclusion and exclusion of certain fiducial points for the proposed GA encoding for expression variation adaptation.

The GA requires a salient fitness function to evaluate current population and chooses offspring for the next generation. Evolution and adaptation will be guided by a fitness function defined in terms of the system accuracy. The fitness function is as follows:

$$\eta(V) = \lambda_1 \eta_s(V) + \lambda_2 \eta_g(V) \qquad (1)$$

Where $\eta_k^{(V)}$ is the term for the system correctness, i.e., successful recognition rate and $\eta_k^{(V)}$ is the term for class generalization. λ_1 and λ_2 are positive parameters that indicate the weight of each term, respectively.

3. Proposed system

A. Facial expression detection

Fig.1 shows the recognition rate at each facial feature during training of the system. As Gabor receptive field produce less effect at mouth facial feature, the recognition rate at mouth facial feature decreases and due to facial expression, the recognition rate at mouth area decreases considerably due to interference of non-facial feature such as teeth.

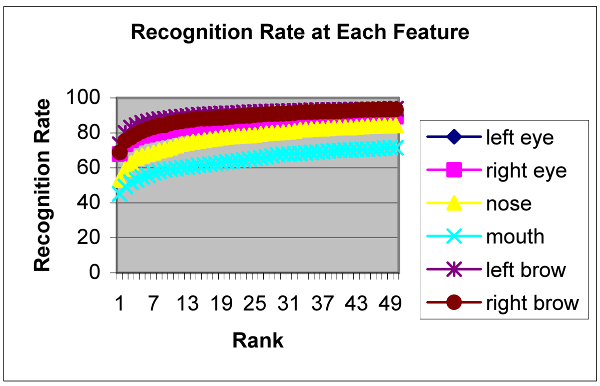

Fig. 1 Recognition Rate at Each facial feature

Due to large variation in mouth region due to noise factor, we propose an adjusted classifier for mouth region for effective recognition which is also shown in Fig.2. The influence of mouth under expression variance is controlled by using Genetic algorithm where we apply weight to each feature or we apply adaptive method to increase the recognition rate at mouth area using Genetic Algorithm for expression variance.

Fig.2 roughly shows our proposed scheme for adaptive robust face recognition for expression changing. Gabor Wavelet is used as the general classifier for feature extraction task. The recognition rate is set as the threshold for the system. If the recognition rate is acceptable (>0.9), we assume matching occurs between training and test image. If the recognition rate is not acceptable that is below the threshold, we apply adaptable Gabor wavelet to the image for expression variance. Facial feature under face expression posses variation and during training of the system, we treated mouth variation and make adaptable to the system using GA. We apply weight at mouth feature for adaptation under variation. We apply Gabor Based adaptable feature extraction for robust face recognition.

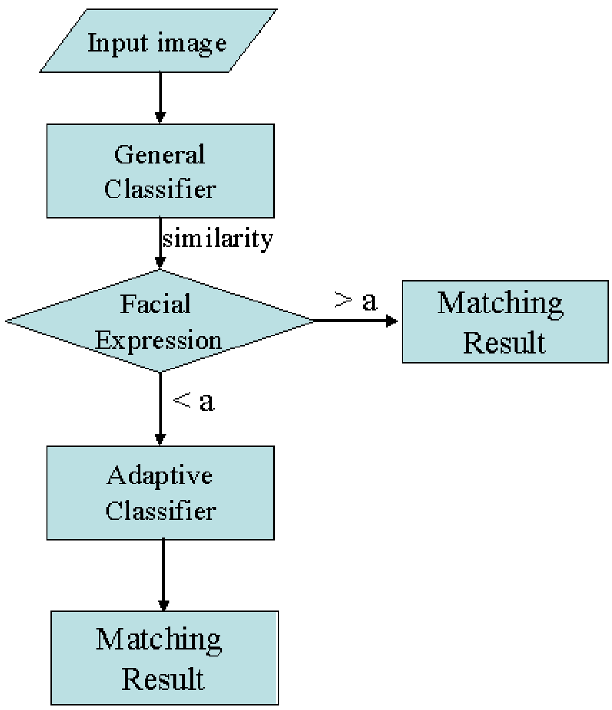

Fig. 2 The proposed adaptive system

B. Classification

Cosine distance measurement is based upon the vector space model. Every image in the collection is represented by a multidimensional vector and the distance between two images is calculated as a dot product of appropriate vector. The distance measurement between the feature vector of training image and test image is compared using cosine distance measurement. The similarity measure between vectors A and vector B is given as,

$$D_{\cos}(A, B) = \frac{\sum_i match(a_i, b_i)}{|A|.|B|} \qquad (2)$$

Where,

$$match(a_i, b_j) = \begin{cases} 1 & |a_i - b_j| \le \tau \quad and \quad match(a_k, b_j) = 0, \forall k \,|\, 1 \le k \le i \\ 0 & otherwise \end{cases}$$

4. Experimental Results

We test the proposed method for face recognition using the FERET data set, which is the standard test data set for face recognition technology. 1209 frontal face images were extracted from the database for the experiments. The 1209 face images were acquired under facial expression. Each face image is cropped to the size of 128×128 to extract facial region. At this facial region we apply our Gabor wavelet and adaptable expression decision.

The general method of recognition is explained here. Gabor Encoding is used to generate the feature matrix of each input face image. The feature matrix generated by Gabor encoding produces number of feature information. The entire input images are treated by general classifier at first stage. The recognition rate (>0.9) is used as threshold. If the threshold is up to defined value, we assumes that matching between training and testing system occurs otherwise we assume that the image have higher variance under facial expression. So we treat these entire images by adaptive approach where GA along with Gabor Wavelet is used as adaptive measure. We used GA encoding at mouth area of facial feature. 4-bit chromosome is used to represent four fiducial points of mouth area. The lookup table contains the best ranking method information for the image ranking. Cosine distance measurement is used for the comparison of distance between the best solution and best ranking feature of the image. The image ranking index table with higher values represents the least distance measurement between the best solutions generated using genetic algorithm and image ranking index table. Fig.3 shows the decision for facial expression and application of 2 different classifiers for non-facial expression and facial expression for facial feature. The facial expression with higher cosine distance (>0.95) is treated by general classifier while less cosine distance is treated by our proposed system for adaptation. The normal face is treated by general classifier while the expression based face is treated by adjusted classifier for adaptation. We adapt the classifier consisting of general classifier and adjusted classifier which is variance weight Gabor.

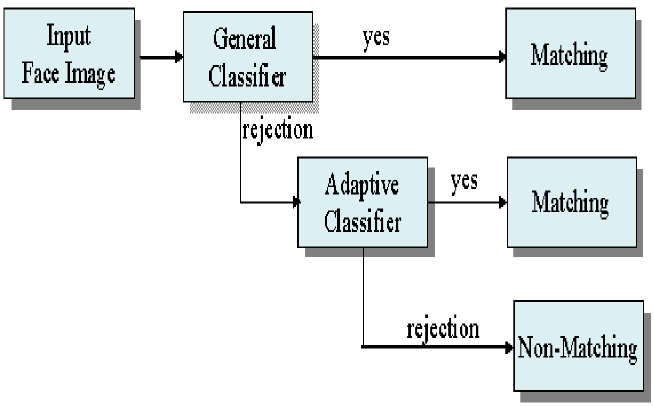

Fig.3 Facial expression evaluation method

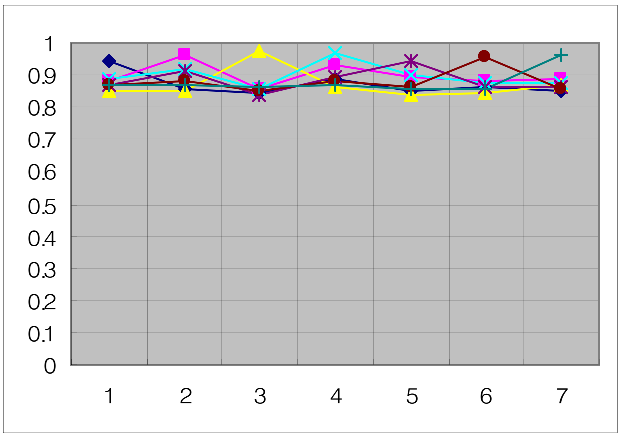

Fig. 4 Corrected face recognition correlation

Fig. 4 shows the corrected face recognition correlation using general classifier under facial expression. The recognition rate increases considerably due to convergence on matching between training and testing image.

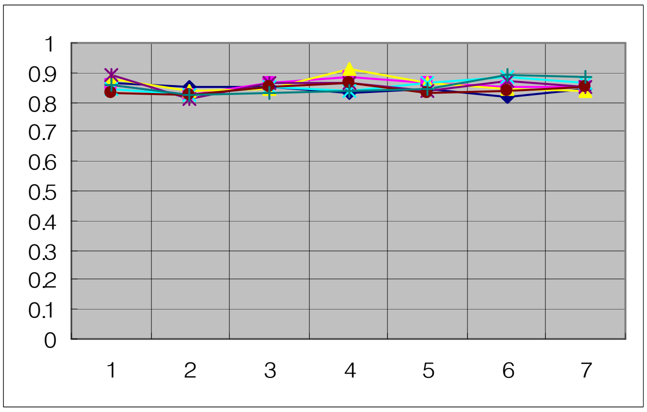

Fig 5 Incorrect face recognition correlation

Fig. 5 shows the incorrect face recognition correlation. The divergence in matching between test images and training image produces a low recognition rate, which are under prone effect of facial expression. Since the recognition rate is below the threshold value (<0.9), we need to treat these result using adaptive measures. So we apply adaptive Gabor wavelet classifier to improve the recognition rate of the system.

Table 2. Face recognition result comparison

	Enroll images	Test images	Acceptance rate
Using General Classifier	1209	1100	90.9
Our Proposed System	1209	1143	94.5

Table 2 shows the recognition rate using the general classifier and our proposed classifier system after adaptation. We enrolled 1209 FERET face image for training while 1100 and 1143 images under facial expression are successfully accepted by general classifier and our proposed system respectively. By applying our proposed scheme, the recognition rate increases considerably and we can find our system better that general classifier scheme.

5. Conclusion

In this paper, the idea of improving recognition rate under facial expression is explored. The facial expression is affected by environmental and non-environmental factors and the way of improving face recognition using adaptive measure is explored in this paper. We have proposed an adaptive face recognition scheme using Gabor based feature extraction and evolution for mouth area using GA for controlling variance under facial expression. The experimental results show the encouraging result for FERET image data set. We have designed and implemented our system addressing these issues.

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