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Facial Emotion Recognition based on Eye and Lip Features

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Abstract. Facial expression recognition technology requires emotion-sensitive feature vector extraction and accurate learning algorithms. In this paper, we constructed the learning data by extracting the features of eyes and lips from human faces, and implemented the system to recognize facial expressions by applying Naive Bayesian classifier. Also we proved the efficiency through experimental results.

Keywords; Facial Emotion Expression; Bayesian Classifier; Learning Algorithm

1. Introduction

User authentication technology is mainly focused on face recognition and iris recognition, and the recognition rate is gradually increasing due to the development of the machine learning technologies. There have been focused on research to recognize human emotions through stabilized vision-based user authentication technology. This is because emotion recognition is an input medium for interaction between a person and a computer, and nonverbal expressions such as facial expressions, gestures, and gaze are easier to convey meaning than language expressions[1-2]. In addition, it can supplement current face recognition technology such as face tracking and body part detection.

However, emotion recognition has difficulty in correctly recognizing emotions because the degree of expression differs for each person. In order to recognize the correct

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emotion, learning data should be constructed using data that characterize each emotion, and the emotion is classified by applying a classifier of good performance.

There are many studies to increase the recognition rate, but the processing time and accuracy are still insufficient due to the complicated calculation process[3].

The amount of computation should be reduced through a detection algorithm that can easily detect facial regions sensitive to emotional changes. In addition, it is necessary to study that can improve accuracy without complex calculation process with good performance classifier.

In this study, we constructed the learning data by extracting the features of eyes and lips from the human face, implemented the system to recognize facial expressions by applying Naive Bayesian classifier, and proved the efficiency through experimental results.

2. Facial Emotion Recognition Method

In order to recognize emotions, this study defined eye and mouth as a feature vector that are sensitive to emotional changes. The extracted feature vectors are classified into human's representative emotions [angry, happy, no expression] by applying the Naive Bayesian classifier. The proposed system is shown in Fig. 1, which consists of the candidate region detection for human face, face feature vector extraction, and emotion recognition steps.

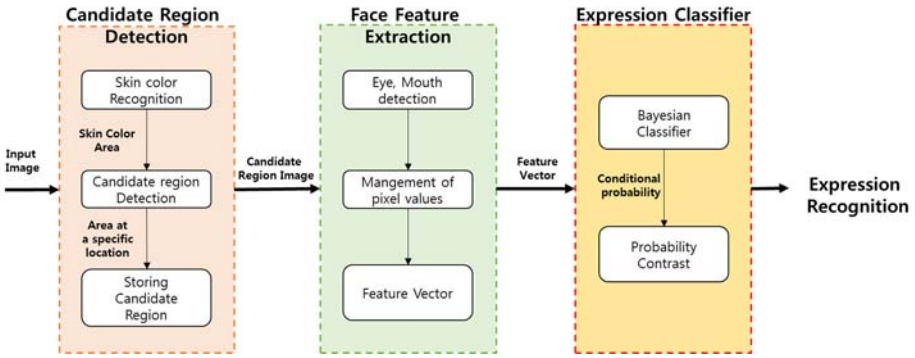

Fig 1. Facial exmpression recognition processe

A. *Feature Extractions*

The input data for recognizing the human emotion is intended to use the data of the human face area. First, a preprocessing process is required to detect an object. This is to obtain the data of the face area by giving a condition recognizable as a face in the input

image. The detected face area normalizes the size of the image for learning data construction and comparison operations.

After the normalization, it should be discriminated the facial expression of the detected face. Eyes and mouth shapes are sensitive to changes in emotion. The proposed system defines and classifies three expressions [angry, happy, no expression] using the sensitivity of the face region. In particular, lips respond most sensitively to emotional changes, so it is possible to roughly judge the emotion of the person[4-5]. In this study, the emotion recognition is performed by defining the pixel information of the eye and the mouth area as the feature vector.

Eye and mouth detect feature vectors using Haar-like Feature. The Haar-like Feature basically maintains the geometric information of the object and uses the brightness difference of the area unit, so it can compensate the change of the shape of the object in the region and the slight change of the position to some extent. In this study, eye and mouth of face are detected using Haar-like Feature, and information obtained from each feature vector is applied to beige classifier to classify three facial expressions.

B. Expresstion Classifications

After then the feature vectors are extracted, the data formed as vector type are applied to Naive Bayesian classifier[6] to classify facial expressions.

The input of the Naive Bayesian classifier are composed of the fixel values of eye and mouth area from human face extracted with Haar-like feature. The horizontal component of the detected mouth is defined as x_1, and the vertical component between the two lips is defined as y_1. The vertical component between eye and mouth is defined as y_2, and finally the area of mouth is defined as A. The random vector $\mathrm{X} = (x_1, y_2, A)$, summarizes the four data.

The facial expression defines classes (C_0, C_1, C_2) for [angry, happy, no expression], and discriminates the appropriate expression for the input image. When the feature vector X is presented, the Bayes theorem for facial expression classification can be defined as Eq. (1).

$$\mathrm{P}(C_i|X) = \frac{P(C_i)P(X|C_i)}{P(X)}, i = 0, 1, 2 \qquad (1)$$

In Eq. (1), we find the likelihood $\mathrm{P}(X|C_i)$ which has the highest probability of X, and classify the facial expression as C_i. At this time, P(X) can be omitted because it is the normalize value. Therefore, Bayesian classification equation for facial expression classification can be defined as Eq. (2).

$$C_{MAP} = argmax P(X|C_i)P(C_i) \qquad (2)$$

In this study, we used 480 images of [Angry, Happiness, Expressionless] as the learning data for the facial expression classification, and we prove the efficiency of the Bayesian classifier through experiments.

3. Experimental Results

In this study, we apply facial feature vector which is sensitive to emotion change to Naive Bayesian classifier for recognize facial expressions. We conducted experiments to demonstrate the efficiency of the proposed system. The database of facial expression images used in the experiment is shown in Fig. 2. It consists of JAFFE(Japanese Female Facial Expression)[7], KDEF(Karolinska Directed Emotional Faces)[8] and FEI Face Database[9]. In this study, each database is the frontal face of a man and a woman of white and yellow and black, and each person did not wear glasses.

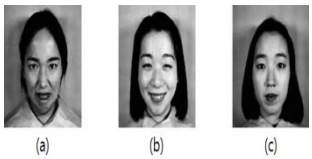

Fig 2. JAFFE Image example (a) angry image, (b) happy image, (c) expressionless image

First, the face database to be used in the experiment is 600 images, and 480 images are used as training data. The Haar-like feature was used to obtain feature vectors for the vertical and horizontal components of the mouth, the area, and the distance between the eyes and mouth. The remaining 120 facial images were used as test data.

We analyzed the characteristics of the feature vectors to verify the validity of the feature vectors. The mouth area of [angry] and [no expression] has a similar range of values. However, [no expression] can distinguish expression because the distance between eyes is larger than [angry]. [happy] has a different range of values from the other two expressions. As a result, facial classification is done well.

The experimental results are shown in Table 1. Experimental results showed average recognition rate of 90.8%. [happy] is the most characteristic expression, recognition rate is 95%. [no expression] has a constant change of facial expression, and the recognition rate is 90%. Finally, the recognition rate of [angry] is 87.5%, which is lower than other expressions.

TABLE I. FACIAL RECOGNITION RESULT JUDGED BY 120 IMAGES FOR TEST PHASE

Classified Results / Real expression	Recognition Results		
	Angry	***Happy***	***No expression***
Angry	35	2	4
Happy	0	38	0
No expression	5	0	36
Total precesion	87.5%	95%	90%

4. Conclusion

In this study, we proposed a technique to recognize human emotions by applying the feature of facial region that is sensitive to facial expressions and applying it to Naive Bayesian classifier, one of learning models.

We applied a Bayesian classifier to the information about eyes and lips detected from the face, and confirmed that it has a good facial recognition rate by a relatively simple calculation process. It is expected to be able to quickly and accurately classify user's perception and emotion in various areas requiring real-time analysis.

The future goal is research on the development of responsive contents industry technology that reflects the industrial needs to grasp the change of emotions about the environment that is used in mobile devices and so on, and to positively influence emotions that users take unconsciously.

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