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Facial Feature Importance Extraction for Facial Impression Analysis

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Abstract—The achievement of the automatic impression evaluation can apply wide area application such as automatic CG generation, portrait generation for a criminal investigation, suggestion of cosmetic surgeries, and smooth man-machine communication. Howenver, the impression evaluation that we are naturally doing in daily life is not treated in conventional research.

Then, we reseach the relationship of the change between facial impression and facial, in this research.

1. Introduction

The face image processing to apply security area are researched in various places. In this area, research were focused on the how to express the features. Moreover, expression analysis is researched in various place, too. This purpose is smooth communication between human and robot. However, these researches do not treat evaluation of facial impression that we are naturally doing in our daily life to see an ones face. This is caused from a problem that facial impression relates human subjectivity very much. If we can evaluate facial impression automatically, wide ranges of applications will be released. For examples, automatically CG generation, portrait generation for a criminal investigation, suggestion of cosmetic surgeries, smooth man-machine communication and so on [1]-[4]. Some researches that evaluate facial impression were already exist. Many of these research evaluate age or gender. Some of research evaluate impression of atmosphere we do in daily life[5], [6]. However, these research did not treat the relationship between evaluation of facial impression in detail. This is important thing to achieves atomatic evaluation of facial impression.

We analyze important facial parts that have strong relationship to evaluate the impression. Evaluation of the facial impression is changed according to the condition, for example, age, gender, and so on. However, this study first, to analyze them without distinction to investigate the presence of features related to changes in any part of the facial impression.

Table 1: Facial impression words

frank	-	surly		intelligent	-	ignorant
generous	-	petty		modest	-	haughty
active	-	quiet		positive	-	negative
kind	-	unkind		realistic	-	fanciful
polite	-	rude		nervous	-	insensitive

2. Facial impression words

We use various words to express facial impression, so many conventional research used some words that are picked up from impression words[7]-[9]. Referring to previous research, we used a following 10 words these were few overlap words in meaning. Evaluation of impression level is measured by comparing a pair of symmetry words by 7 step .

Each face images are evaluated by questionnaire result to the each impression word in Table 1.

3. Processing flow

The flow of our proposal method shows as follows.

- Step 1:Image normalization
- Step 2:Feature extraction
- Step 3:Important feature analysis

4. Image normalization

A face image is changed influenced from photography environment. Therefore, we normalize face image to reduce these influence. We normalized a face image based on the both eyes. First of all, we rotate a photographed image until the slope of the eyes at 0 degrees. Next, we enlarge or shrink a rotated image until the length of both eyes to be 45 pixel. Finally, we cut that image to be 100 by 100 pixels. A normalized image shows in Figure 1.

5. Feature extraction

Gabor features are used extensively in the field of facial recognition as a robust feature for lighting changes,

Figure 1: Normalized image

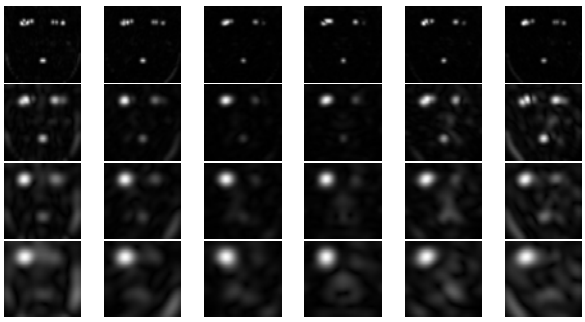

Figure 2: Gabor image in the image H

because of that imitate human vision. Therefore, we used this feature for impression analysis.

Gabor feature calculated from Gabor filter that has the ability to extract the frequency components of any. The function of Gabor filter is as follows.

$$g_{\mathbf{k}}(\mathbf{x}) = \frac{\mathbf{k}^2}{\sigma^2} exp(-\frac{\mathbf{k}^2\mathbf{x}^2}{2\sigma^2})[exp(i\mathbf{kx}) - exp(-\frac{\sigma^2}{2})] \quad (1)$$

$\mathbf{x} = (\mathrm{x}, \mathrm{y})^T$
$\mathbf{k} = (k_v cos\phi, k_v sin\phi)$
$k_v = k_{max}/f^v$
$\phi = \pi\mu/8$

The Gabor features extracted at six direction and four size to an normalized image.

Moreover, the human skin is an important decision could be based impression. So, in order to effectively utilize the information in skin color, we change normalized image to the HSV color space, in this research.

The Gabor images for one image shown in Figure2-Figure4.

We cut the facial features by as follows.

- Step 1: Extraction of 10 by 10 pixels area from a Gabor image.
- Step 2: Move five pixels at the extraction area by raster scanning.
- Step 3: Step 1 and Step 2 process are repeated until the end of the image.

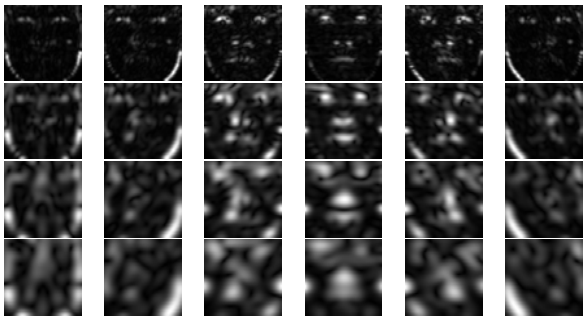

Figure 3: Gabor image in the image S

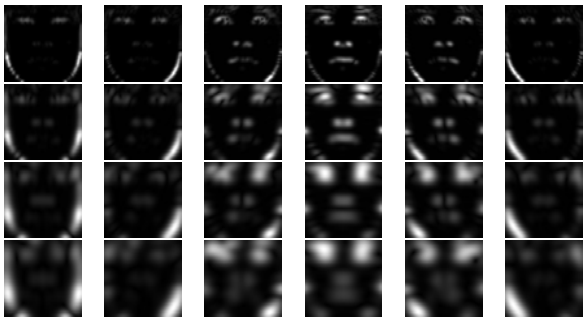

Figure 4: Gabor image in the image V

- Step 4: Processes from Step 1 to Step 3 are repeated until the end of all Gabol feature image.

At the end of these process, we can extract 25992 facial features.

6. Important feature analysis

Our purpose in this research is investigation of importance in facial parts. Therefore, we needed importance investigation method at facial features. We used 25992 facial features in this research, because whether which part of the face the feature to the impression exists is not understood. Therefore, we had to choose importance investigation method that is possible to verify with the limited sample and is effective for large number of features. Then, we adopted Random Forest as a investigation method [10]. The Random Forest is one of machine learning method. This method can give good results even if the number of explanatory variables, and can be also calculated the contribution of the explanatory variables.

7. Computer simulation

In order to show the effectiveness of proposed method, we performed computer simulation. 20 persons that include 12 men and 8 women answered for questionnaire. Moreover, 252 face images (man : 113, woman : 139) that include between teenage and sixty are used for the simulation. In order to compare the result of another tree method, we use Adaboost that is effective for pattern recognition.

Table 2: Investigation accuracy (Random Forest)

frank-surly	72.5%	intelligent-ignorant	76.5%
generous-petty	72.5%	modest-haughty	74.5%
active-quiet	62.7%	positive-negative	62.7%
kind-unkind	78.4%	realistic-fanciful	80.4%
polite-rude	72.5%	nervous-insensitive	62.7%

Table 3: Investigation accuracy (Adaboost)

frank-surly	65.9%	intelligent-ignorant	82.5%
generous-petty	66.7%	modest-haughty	67.55%
active-quiet	52.4%	positive-negative	58.7%
kind-unkind	77.8%	realistic-fanciful	77.8%
polite-rude	71.4%	nervous-insensitive	67.5%

Then, the both hands method identifies both prediction accuracies of result of the questionnaire (seven classes from 1 to 7) to the impression.

Investigation accuracy shows in Table 2, Table 3.

The results in Table 2 and Table 3, Random Forest better than Adaboost (the average of Fandom Forest result was 71.5% and Adaboost result was 68.8%). Adaboost tends to be weaker to the noise than Random Forest. Impression is dependent on human subjectivity, so there have individual variation, this cause Adaboost negatively impacted as the noise. Conversely, Random Forest is so strong compared with the Adaboost to the noise, so considered a good result.

Then, the images shown in Figure 5 - Figure 14 Random Forest showing the importance of the each features. A white pixel shows important area.

8. Conclusions

This study evaluated the importance of face parts in Impression. Here, we use Gabor features to take advantage of the appearance of facial features. In addition, visual evaluation of individual variability could be generated to accompany a subjective evaluation. Therefore, we used Random Forest as a evaluation method that is a robust method for noise.

The result of computer simulation, we can recognized approximately 72 % accuracy. Therefore, the extracted features are considered to be useful to assess the impression. Finally, we made importance map about impression feature by using Random Forest result. In the future, quality is improved by adding more features useful Impression.

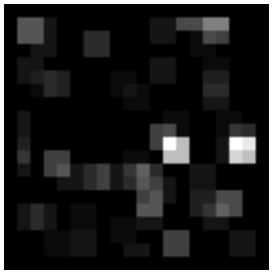

Figure 5: Frank

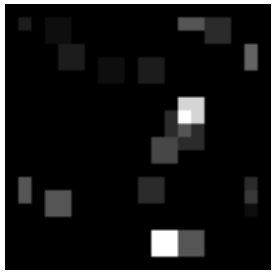

Figure 6: Intelligent

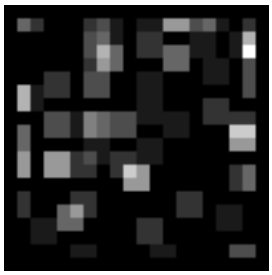

Figure 7: Generous

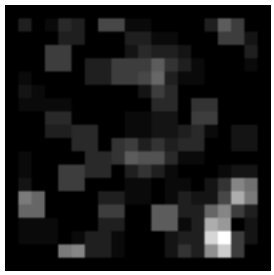

Figure 8: Modest

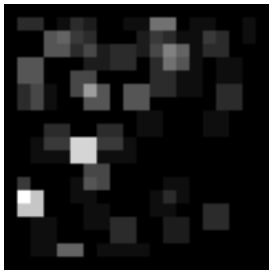

Figure 9: Active

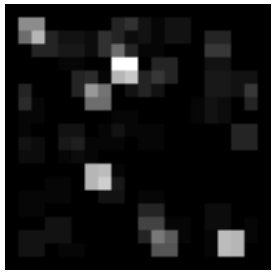

Figure 10: Positive

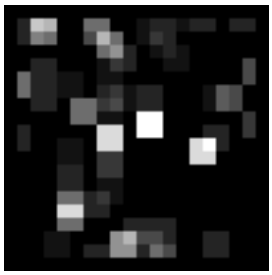

Figure 11: Kind

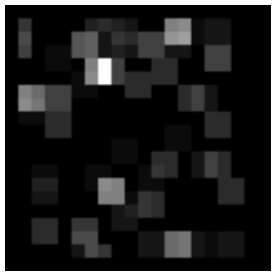

Figure 12: Realistic

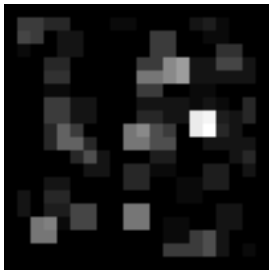

Figure 13: Polite

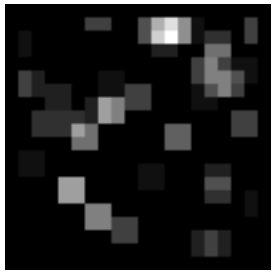

Figure 14: Nervous

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