Expression recognition of "quiet beauty"

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Expression is a non-linguistic communication means to express inner feelings of human; the basic expressions such as anger, hate, fear, sorrow, joy and surprise are studied in depth in the research field, but there are relatively fewer literatures on quantitative research of microexpression. In the Paper, the Internet catchword of "quietly handsome boys (beautiful girls)" is the object for expression research and there are three steps for realization: (I) Accurately and quickly detect the human face under natural background through Adaboost algorithm cascade skin color detection. (II) Through key feature extraction of two kinds of faces. (III) The hypopaper is given and verified through perception experiment and modeling of average standard expression.

Keywords: Expression recognition; Face detection; Face recognition; Average face.

1. Introduction

Expression is a non-linguistic communication means to express inner feelings of human; the emotion is understood through acquisition and analysis of face message to further promote the communication effect. But in the research field of expression, the construction of main expression database and relevant work are based on the six basic face expressions put forward by Ekman and Friesen-American psychologist- in 1971.

The theoretical basis for expression research based on computer science field is consistency of the expressions. Darwin first disclosed the consistency of expressions in different genders and races in 1871. Meanwhile, the research object of the Paper is the non-basic expression for which there is no clear definition, so the definition for expression first involves the decision on the designated non-basic expression in psychology. The expression definition first depends on the consistency recognized by appraisal individual for the expression image meaning. The research on microexpression possesses not only theoretical significance, but also extensive prospect in application field. The Author thinks that microexpression is of excellent future in the following fields through self experiences and creativity:1) In intelligent robot field, carry out intelligent man-

machine dialog based on expression analysis, capture the face expression features of the counseling object in a real-time way and input to the decision system to realize on-line psychological counseling in a private way.2)In animation design field, the expression image can be created more quickly to enrich out recreational life. 3) As the non-linguistic communication means, whether it can serve as another linguistic tool based on expression besides "sign language" to lower the communication threshold between special group and us.

In summary, microexpression cognition and recognition through machine vision is of important research value and application prospect.

2. Face Detection Research under Natural Background

According to the investigation and research results, we have not found the public database applicable to project experiment, so the image library required in research is built. In the research, the face images are successively collected in the total 14 mobile phones of 9 types owned by individuals are adopted to shoot under natural background, but partial shooting direction is limited; the faces of 14 Chinese people from 22-33 (4 males and 10 females) are collected with each people having two postures and two different expressions (including neutral expression). It is called Co_Face because of the colleagueship.

Table 1 Self-built image database

Database	Description
Co_Face	Fourteen persons in total; faces under multiple illuminating conditions, given dimension, differently worn glasses and specified expression words; three pieces for each person

2.1. *Implementation of skin color detection algorithm*

Skin color feature based face detection in the Paper, taken as the second stage of cascade upon Adaboost algorithm, is used to detect the face region. The skin color model is established in the YCbCr color space through the use of simple chroma space model. The thresholds of segmented skin color and non-skin color pixel are respectively $66 \leq Cb \leq 135$ and $123 \leq Cr \leq 181$ based on the skin color point pixels in the face image statistics of self-built image library. It is obtained as follows for the self-built image library is obtained through Adaboost algorithm and the following processes: decided threshold $0.2 <$ skin color pixel / total pixels <0.6.

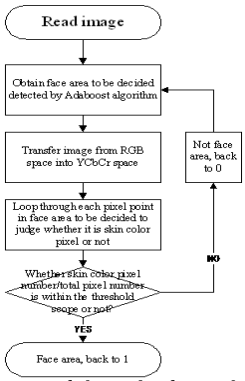

Fig. 1 Second-level face detection process of skin color feature based cascade adaboost algorithm

2.2. *Face detection experiment*

The experiment is based on Windows 7 and the CPU of its running computer is I3-5020U/2.20GHz with 4GB RAM. Specific algorithm process is shown in the following figure:

Self-built image library is adopted in the experiment, Part detection results are shown in the following figure:

Fig. 2 Part experimental detection results

3. Face Posture and Expression Message Obtained by Using Feature Points Location

3.1. *Implementation of cascade-depth convolutional network algorithm*

Facial feature point's location in the posture estimation herein adopts cascade-depth convolutional network algorithm. It is published by YI SUNet al. and there is open programmed algorithm on the network. For its positioning performance, such algorithm is high in accuracy; although the experiment pictures are rotated sharply in posture, people wearing glasses and even sunglasses can accurately localize the feature points.

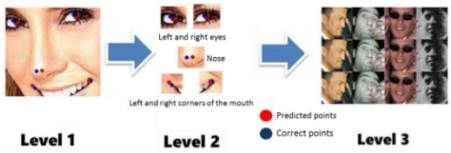

Fig. 3 Schematic diagram for effect of cascade-depth convolutional network algorithm

3.2. *Implementation result*

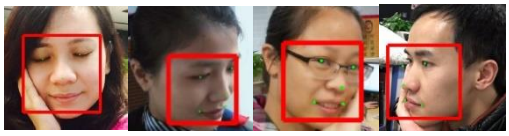

Fig. 4 Diagram for experiments results of cascade-depth convolutional network algorithm

3.3. *Key feature points' location of shape features in facial expression*

Facial key points' location is to further localize the profiles of eyes, eyebrows, nose and mouth on human face based on the face detection. It main idea is to utilize the information adjacent to the key points and the interaction between all key points to localize.

Experimental result of facial key feature point location algorithm based on regression tree:.

Fig. 5 Diagram for experimental results of regression tree algorithm

The screenshots of experimental results show that the coordinate values of 68 key points, including eyebrows, eyes, bridge of the nose, wing of the nose, mouth and profile are obtained by algorithm with high accuracy. It lays a foundation for identifying micro-expression change at the quantitative angle by using arithmetical operation.

4. Micro-expression Hypopaper and Verification

4.1. *Calculation shape change in micro-expression*

Perception anticipation is conducted according to the preset micro-expression in the Paper and the research mainly focuses on the shape change of two organs of

eyes and mouth. The standard expression deconstruction is completed through three steps of shape normalization of eyes and mouth, change value calculation and correlation of individual feature changes.

Shape normalization includes center justification, scale normalization and rotation justification. Firstly the coordinate vector of feature points is written as matrix form:

$$\mathrm{G} = \begin{bmatrix} x_1 & \dots x_I \\ y_1 & \dots y_I \end{bmatrix}^T \tag{1}$$

The coordinates of feature points are moved to the original point and the result of center justification is achieved and it is formulated and defined as the following matrix:

$$\mathrm{C} = I_I - \frac{1}{I} 1_I 1_I^T \tag{2}$$

Then, the structure matrix upon center justification is:

$$G_c = \mathrm{C}\,\mathrm{G} \tag{3}$$

Upon scale normalization, then:

$$\hat{G} = G_C / \|G_C\| \tag{4}$$

Where the scale of matrix is:

$$\|G_C\| = \sqrt{trace(G_C^T G_C)} \tag{5}$$

We express structure matrix upon center justification and scale normalization as $\{\widehat{G^{(1)}},\dots,\widehat{G^{(n)}}\}$.

Table 2 Summary of one-to-one distance between shapes in Co_Face image library

Features	Statistics	Female-female	Male-male
Eyes	Average value	0.02058	0.02230
	Variance	0.0190	0.0093
Mouth	Average value	0.2120	0.2226
	Variance	0.0011	0.0013

4.2. *Perception experiment verification*

In order to verify the public recognition of predicted standard expression picture, we carried out the perception experiment. The image library used in this experiment is also the self-built *Co_Face* image library. We showed all of the impression pictures and neutral pictures in the image library to 80 volunteers we have invited, and asked the volunteers to respectively pick out one group of impression pictures which they think mostly close to the theme words -- “Quiet

Beauty" from the male pictures and female pictures in 14 groups of facial images. The statistical result of vote is as follows:

Table 3 Schematic diagram of shape space location in the unit sphere

Female groups	1	2	3	4	5	6	7	8	9	10	11
Votes	4	15	5	21	9	13	2	4	14	3	3
Male groups	11	12	13	14							
Votes	18	44	5	13							

In the top three of female groups in perception experiment, 2 groups are the same with the top three in the hypopaper of machine vision system, while 1 is different. In male groups, only one group is the same with the hypopaper of machine vision system.

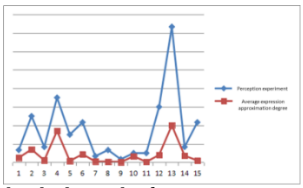

Fig.6 Schematic diagram of individual trend of perception experiment and average expression approximation degree

5. Chapter Summary

According to the experimental result, we provided the following expression feature description based on "Quiet beautiful male (female)".

Table 4 Qualitative description of microexpression

Expression	Mouth	Eyes	Eyebrow	Nose
Quiet beauty	Closed mouth, grins slightly, the lower lip uplifts a little	The upper and lower eyelid folded but not fully closed	No big changes	No big changes

Table 5 Qualitative description of microexpression

Item	Key organs	
	Mouth	Eyes
The correlation between changes of individual characteristic shape of the same sex	Female-female: 0.0010 Male-male: 0.0013	Female-female: 0.0191 Male-male: 0.0093
Average expression	Female: 0.2120 Male: 0.2226	Female: 0.02058 Male: 0.02230

Acknowledgement

*This work was supported by the National Key Research and Development Program of China with No.2016YFB0101001 in part and the Special Foundation for the Development of Strategic Emerging Industries of Shenzhen under Grant No.JCYJ20150831192224146.

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