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RESEARCH ARTICLE

FACIAL EXPRESSION RECOGNITION: Machine Learning using C#

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Abstract: Facial expression is an important channel for human interaction and can be applied in many real applications. One precarious effort for facial expression recognition (FER) is to precisely extract emotional features. While we know that the current approaches on FER in static images have not fully considered and utilized the features of facial element and muscle actions, which represent geometric and appearance physiognomies of facial expressions. So in this paper we propose a methodology to resolve this limitation using prominent 'salient' distance features, and these are obtained by mining patch-based 3D Gabor features, selecting the 'salient' patches, and performing patch matching processes. The experimental results validate high correct recognition rate (CRR), noteworthy performance improvements due to the consideration of facial element and muscle movements, and quick processing time. The comparison with the state-of-the-art performance confirms that the proposed approach achieves the highest CRR on the JAFFE database and is among the top performers on the Cohn-Kanade (CK) database.

Keywords: Feature selection, Facial expression, Human communication, Pattern recognition

INTRODUCTION

Emotional information is very important way of information transmission in interpersonal communication. It can convey a lot of information which words cannot convey. 54% of emotional information is communicated through facial expressions. The Information contained in human face accounts for a substantial proportion in image understanding. Facial expression recognition is the process of extraction and classification about facial expression information by computer. The computer can infer

a person's mental state according to the facial expression. And it completes the interaction of intelligent human-computer. Facial expression recognition system consists of four basic parts: expression image acquisition, image preprocessing, face expression feature extraction and classification. So, in recent years, the facial expression analysis has attracted attentions from many computer vision researchers. The facial emotions recognition has been one of the dynamic research interests in the field of pattern recognition. People extract the stretch eyebrows, frowned, giggle, half smile, frown, smiling and common human facial expressions in much rich expression. People solve a series of problems of facial expression by environmental interference. The passions will be reflected in facial expression. Expression solves many practical problems especially in face expression.

In human-to-human conversation, the articulation and perception of facial expressions form a communication channel in addition to voice which carries vital information about the mental, emotional, and even physical state of the persons in conversation. A person's facial expressions in its simplest form is a more subtle happy or angry thoughts, feelings or understanding of the speaker expected or unexpected response from listeners, sympathy, or even what the speaker is saying no signal can provide to computing background, brings our everyday human user to remain at the forefront in the fabric will move to absorb. This set up a generally prediction, pervasive computing and ambient intelligence such as needed to achieve the next generation of computing. It's easy to naturally occurring multimodal human-human communication focused response to the user interface will need to be developed to identify such interfaces and intentions and as expressed by feelings of social and emotional indicators will need to have the ability. This vision of the future motivates the research for automated recognition of nonverbal actions and expression.

My work presents an expression recognition method by manifesting the facial characteristics through false geodesic distance and remodeling the facial expressions in the 3D space and verifies this method being able to identify different expressions from static facial images in a more effective and remarkable manner. The algorithms demonstrate that this method achieves better results of expression recognition than traditional methods and shows stronger robustness to changes of illumination.

Facial Expression can deal with the studies related to psychology, driver state surveillance, patient monitoring etc. In the developed countries the hospitals use the facial expression tool to study the emotional states of patients who are deaf dumb or blind , or in many cases the patients who are not able to explain their emotional state due to injury, disease etc. This can help the doctors to monitor them and regulate the medications and proper care.

Thus the objectives of present work were to:

a) To be able to recognize the platform to develop a software tool such as php, java, dot net etc.
b) To design the algorithms.

c) To locate the face from a static picture.

d) To generate the binary image and train the data sets from databases available online.

e) To detect human emotions.

f) To be able to improve the algorithms for further research.

Why use it?

- The tool to recognize Facial Expression can be used to analyze the facial expressions of deaf and blind people.
- More than 10.000 manually annotated images used for training the software.
- Objectivity in observations.
- Accurate modeling of the face by describing various key points.
-

Who uses it?

The tool can be used worldwide at universities, research institutes, and companies in many markets, such as consumer behavior research, usability studies, psychology, educational research, and market research.

- Patient monitoring system
- Market research: How do people respond to a commercial's new design?
- Driver surveillance system
- And much more!

Facial expression is an important channel for human communication and can be applied in many real applications. One critical step for facial expression recognition (FER) is to accurately extract emotional features. Current approaches on FER in static images have not fully considered and utilized the features of facial element and muscle movements, which represent static and dynamic, as well as geometric and appearance characteristics of facial expressions. The approach is to solve this limitation using 'salient' distance features, which are obtained by extracting patch-based 3D Gabor features, selecting the 'salient' patches, and performing patch matching operations. The experimental results demonstrate high correct recognition rate (CRR), significant performance improvements due to the consideration of facial element and muscle movements, promising results under face registration errors, and fast processing time. The comparison with the state-of-the-art performance confirms that the proposed approach achieves the highest CRR on the JAFFE database and is among the top performers on the Cohn-Kanade (CK) database. **(Ligang Zhang, et al, 2011)**

DATABASES:

Six basic expressions were based on descriptions of prototypic emotions. Image sequences from neutral to target display were digitized into 640*480 or 490 pixel arrays with eight-bit precision for gray scale

values. In this proposed project, all the images of six basic expressions from the JAFFE database will be used. For the CK database, 1,184 images that represent one of the six expressions are selected, four images for each expression of 92 subjects. The images are chosen from the last image (peak) of each sequence, then one every two images. The images of 10 subjects in the JAFFE database are classified into 10 sets, each of which includes images of one subject. Similarly, all images in the CK database are classified into 10 similar sets and all images of one subject are included in the same set.

- The Japanese female facial expression (JAFFE) database [35] contains 213 gray images of seven facial expressions (six basic + neutral) posed by 10 Japanese females. Each image has a resolution of 256*256 pixels. Each object has three or four frontal face images for each expression and their faces are approximately located in the middle of the images. All images have been rated on six emotion adjectives by 60 subjects.
- The Cohn-Kanade AU coded facial expression (CK) database [36] is one of the most comprehensive benchmarks for facial expression tests. The released portion of this database includes 2105 digitized image sequences from 182 subjects ranged in age from 18 to 30 years. 65% are female; 15% are African-American and 3% Asian or Latino.

There is no instance in which 70% or more of the people in one cultural group judged a picture as showing one of these emotions and a similar percentage of the people in another cultural group judged the same expression as showing a different one of these emotions. **(Brown, et al, 1991)**

FLOWCHART OF THE METHOD

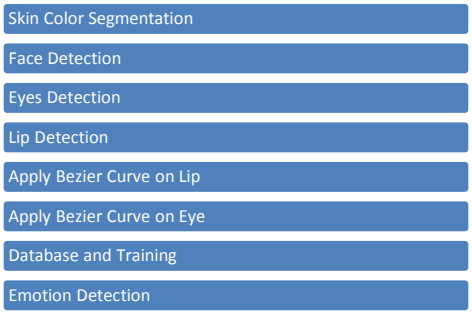


Fig 1

METHODOLOGY OVERVIEW

Building distance features.

(a) One scale is selected from eight-scale Gabor images.

(b) Patches are extracted across all rows and columns in the selected scale image.

(c) One extracted patch say P_a.

(d) Extracted patch set.

(e) Defined matching scale.

(f) Defined matching area.

(g) One matching area.

(h) Distance calculation.

(i) Distance feature set.

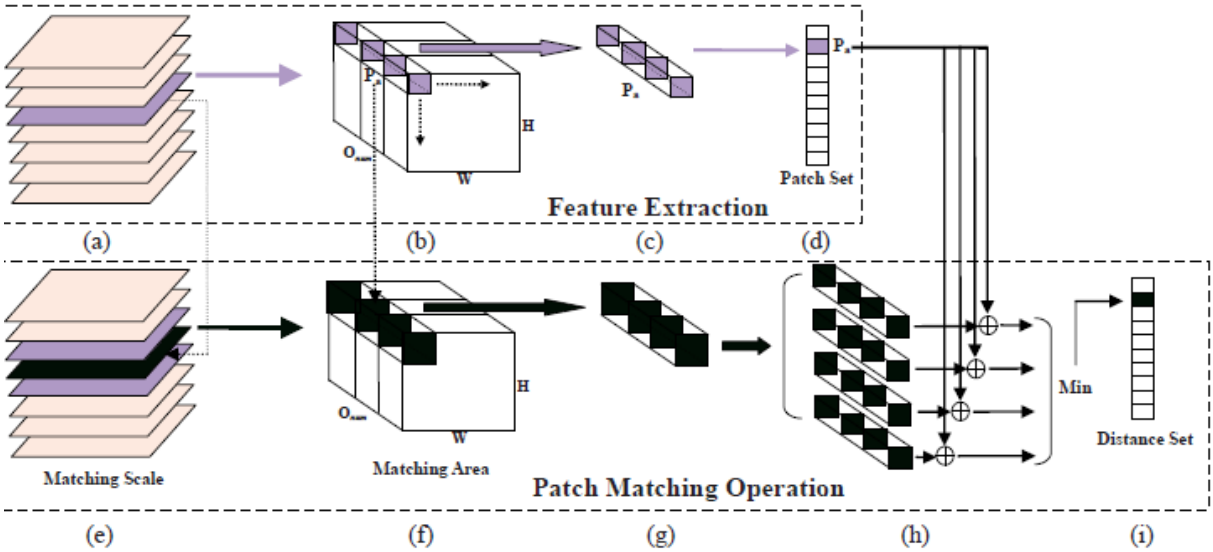


Fig 2 Pseudo code execution

ALGORITHM USED

Pseudo code of building distance features.

(1) Defining moving steps.

(2) Extracting Patches.

(3) Recording matching area.

(4) Recording matching scale.

Input: Image set Si (i=1,…,10); patch size Pj (j=1,…,4); emotion index Ek (k=1,…,6); scale SCm (m=1,…,8); orientation On (n=1,…,4); orientation number Onum; image width W, height H (W=H=48).

Output: Extracted patches, matching area and matching scale.

- **For** each emotion Ek , each scale SCm , each patch size Pj
- Choose one set Si randomly from 10 sets;
- Choose one image of emotion Ek randomly from Si;
- Move_step = Pj/2; (1)

- **For** ih = 1 to (H-Pj+1) by Move_step
- **For** iw = 1 to (W-Pj+ 1) by Move_step
- Extract patches with sizes of Pj*Pj*Onum; (2)
- Record the matching area (Lx,Ly,Rx,Ry): (3)
- Lx = Max(ih-0.5*Pj,1); Rx = Min(ih+1.5*Pj,H);
- Ly = Max(iw-0.5*Pj,1); Ry = Min(iw+1.5*Pj,W).
- Record the matching scale SCm; (4)
- **End**
- **End**

End

Return patches, matching area and matching scale.

Discussion of the Facial expression application available on Google's play store in mobile applications:

There are few applications available on Play Store of Google to recognize the facial expressions. Example of one such application is Face Recognition application which can start experimenting with face recognition right away. It shows you how to perform face recognition with face recognizer in OpenCV using Eigenfaces algorithms.

Another Example is Facial Expressions Training which improves lie detector abilities to help read the faces of human being in the scientific field of psychology.

Thus we find the usefulness of the project undertaken to be able to recognize the facial expressions.

Notable software with face recognition ability includes:

- digiKam (KDE)
- iPhoto (Apple)
- OpenCV (Open Source)[10]
- Photoshop Elements (Adobe Systems)
- Picasa (Google)
- Picture Motion Browser (Sony)
- Windows Live Photo Gallery (Microsoft)
- Lightroom (Adobe)

Fig 3 Skin color segmentation

Fig4 finding connected region

Fig 5 Static to Binary image conversion

Fig 6 Eye / lip detected

Fig 7 Emotional state of a human face

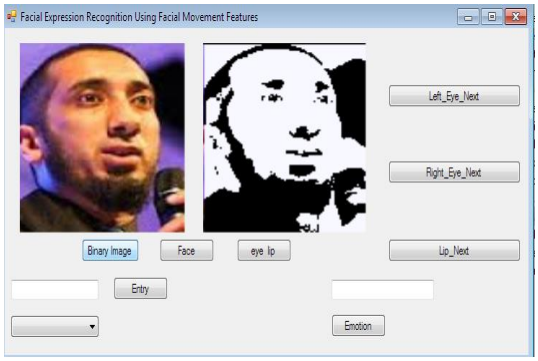
Results of the software tested

STEP 1: Browse the database

STEP 2: Skin color segmentation

STEP 3: Finding Connected Region

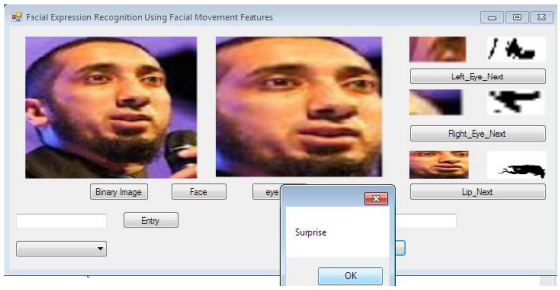
STEP 4: Binary image conversion



STEP 5: Eye and Lip Detection

STEP 6: Applying Bezier curve

STEP 7: Emotion Displayed



SUMMARY

This work accomplishes the issue of facial expression recognition using facial movement features. The effectiveness of the approach is testified by the recognition performance, computational time, and comparison with the state-of-the-art performance. The experimental results also show significant performance improvements due to the consideration of facial movement features, and promising performance under face registration errors. The results tell us that patch-based Gabor features give a better performance over point-based Gabor features in terms of obtaining regional features, keeping the position information, achieving a better recognition performance, and requiring a less number. Different emotions have different 'salient' areas; though, the majority of these areas are distributed around mouth and eyes. In supplement to, these 'salient' areas for each emotion seem to be not influenced by the choice of using point-based or using patch-based features. These 'salient' patches are distributed across all scales with an emphasis on the higher scales. Intended at both the JAFFE and CK databases, DL2 performs the best among four distances. And as for emotion, anger underwrites most to the misrecognition. While the JAFFE database requires larger sizes of patches than the CK database to keep useful information. The proposed approach can be potentially applied into many applications, such as patient state detection, driver fatigue monitoring, and intelligent tutoring system. In our future work, we can extend our approach to a video based FER system by combining patch-based Gabor features with motion information in multi-frames. Recent progress on action recognition [47] and face recognition [48] has laid a foundation for using both appearance and motion features.

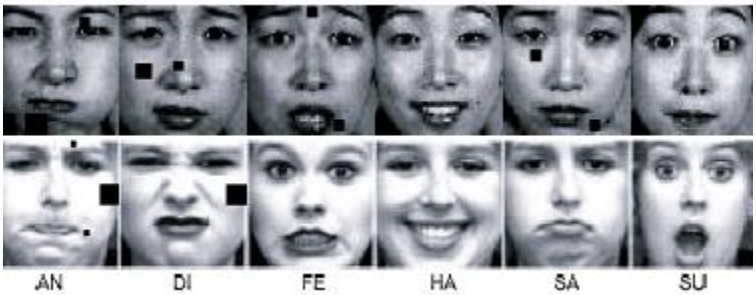


Fig 8 Six Basic Emotions from JAFEE & CK databases

CONCLUSION

Thus, a real-time processing was resulted when our approach dealt with the development of the software tool by time efficient language, C#. Among three stages, computing Gabor images takes the biggest proportion of the overall time, while the classification requires the least amount of time.

The facial expressions are important determinants of human emotion detection. Thus we developed a tool which is capable of determining the human emotion through facial expression. The tool works on dot net platform and uses the supportive algorithm for deploying it on the machine utilizing various machine learning adaptive methods. The thesis is basically focusing on static images which can be stored in the database, and further analysis can be done via the tool. The further research can be done on video based image extraction and the algorithms can be developed using the current algorithm as a source referred as genetic algorithm.

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