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Facial Emotion Recognition with Facial Analysis

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Abstract
Computer vision techniques are used in many fields such as traffic control, event monitoring, marketing, healthcare field, quality control, military technology, etc. One of the sub-areas of computer vision is facial expression recognition. Facial expressions which can be classified fear, happiness, joy, sadness, aggressiveness are recognizable with computer vision technics. In this study, we developed a system which can perceive four facial expressions are confused, happy, sad and normal. At the first step of the system, human faces are detected and located in an image. In the second step, eyes and mouth are detected in facial areas. Then, Bezier Curves are generated using the mouth and eyes with computer graphics technics. Each curve is compared with previously defined curves in the database and finally system decides emotion of face. Experimental results show that, the system performance is well enough for face emotions recognition and it can be use real-time
Keywords: *Computer Vision, Face Detection, Facial Emotion Recognition, Human-Computer Interaction, OpenCV.*

1. Introduction

With the enhancement of computer hardware and software, Computer vision became very popular research area. And it has been used many areas like traffic control, event monitoring, marketing [1], lie detection (especially in the area of emotion recognition) [2], criminality analysis [3], video games, human-computer interaction [4], security, safety [5], healthcare field, quality control, war technology, etc.

Facial emotion recognition is one of the specific issues of computer vision. Emotions which can be classified like fear, happiness, joy, sadness, aggressiveness are recognizable facial expressions using computer vision. Emotional expressions at face are related to the movements or positions of the muscles under the skin and are a form of nonverbal agreement [6]. According to a study; words are important 7 percent, voice tone 38 percent and the effect of body language is 55 percent in a communication [7]. Analysis of emotions for humans can be used in many areas such as suspect tracking, patient monitoring, human-machine interaction and marketing [6].

The facial emotion detection is a difficult process for machines even facial expressions sometimes can't be understood by people [8]. One of the reasons of this complexity is two different facial expressions can be seen at a face at the same time and another reason is facial expressions differ from person to person [8], [9].

Face detection, face direction recognition, emotion recognition, face recognition, etc. are important for computer vision based system. For instance, security officers monitor videos from security cameras. Security officers are loose attention 45 percent after 12 minutes and after 22 minutes, this rate would be 95 percent [5]. In this respect, development of the abovementioned fields is very important for automatic computer monitoring. Also, computers can help effectively to the users [10] and robots can behave like humans[11].

According to [12] the eyes, nose, hair and ears give a lot of information about behavior. Using this information, we developed a system which can recognize four facial emotions with analysis of eyes and we added lip features in order to ease recognition. The eyes and lips on a face are converted lines with Bezier Curves and in this way a facial silhouette is generated. After this phase, the silhouette is compared with silhouettes which are stored in a database. At the end of the comparison, decision facial emotion is determined by the system.

After this introduction, the rest of paper is organized as can be seen below. The next section includes some works about facial emotion recognition. Section 3

describes our works and methodology. The final section has results and some suggestions.

2. Related Works

Computer vision applications have been studied for years. Facial emotion recognition is one of the sub-branch of computer vision. In this area, there are several applications and approaches. In view of these approaches, a Support Vector Machine (SVM) becomes prominent for classification.

Generally, the studies have a flow. According to the flow, first step is face segmentation and then the frames have a preprocessing process. The next step is feature extraction and then moves on to the classification process. The general flow is given Fig. 1.

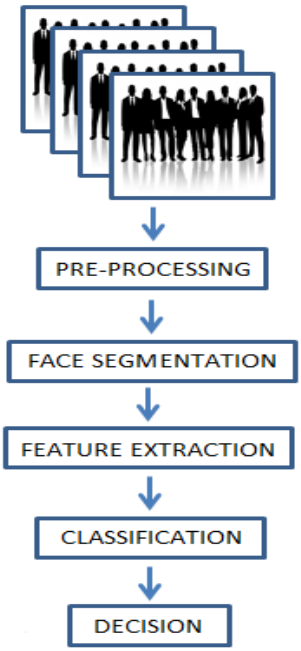

Fig. 1. General recognition flow

Kurt et al., use Artificial Neural Network (ANN) and skin analysis for face detection. Local Binary Pattern (LBP) was used for feature extraction and nearest neighbor approach was used for classification in their study [8]. Smiling, natural and sadness are recognized by their system and their accuracy is %77. In this study, multiple emotions may be rated at the same time, at the same face. Because, a face can reflect smiling and at the same time the owner of the face can be sad at the same time. In [9], OpenCV face detector was used in order to detect face location in each frame. Histograms of oriented was used in order to extraction feature vectors and SVM with Radial Basis Function kernels were used for classification process. Their accuracy is 70 percentages. Anger, fear, joy, relief and sadness are recognized by the system. Dhall et al. used Pyramid of Histogram of Gradients and Local Phase Quantization (LPQ) for feature extraction. Constraint Local Model was used for face detection and for classification, they used SVM and Largest Margin Nearest Neighbours. In the study [2], Anger, fear, joy, relief and sadness could be recognized by their system with high performance. Tariq et al. presented a paper about emotion recognition [11]. Pittpatt Face Detection and Tracking Library were used in order to capture and track the face location. Hierarchical Gaussianization, Scale Invariant Feature Transform (SIFT) and Optic Flow methods were used in feature selection and the classification method was SVM. Result of the study is approximately %80. Conneau and Essid presented a different approach in their paper [13] about feature extraction. For this purpose, electroencephalographic signal was used. SVM is ıts method for decision part as the same of the others. Their accuracy rate is 78 percentages. Yang and Bhanu's paper [14] includes a study about recognition of facial expression using a model with emotion avatar image. After the face detection, SIFT flow algorithm was used in order to register each frame with an avatar face model. For feature extraction, LBP and LPQ methods were used and in classification step, SVM was suggested. Cruz et al. used Boosted Cascade of Haar-like Features in order to detected face location in their study [4]. LPQ was used for feature extraction. SVM and Hidden Markov Model were used for decision step. De et al. recognized 5 emotions which are surprise, sorrow, fear, anger, happiness in their study [6]. Face detection process was actualized with HSV color space and for feature extraction, Principal Component Analysis are used. Euclidean Distance was used to decision. The study's performance is approximately %85.

There are different examples in literature for emotion recognition. For instance, some studies include voice recognition with computer vision to detect the emotions. These studies' name is audio-visual

emotion recognition. [10], [15], [16] are some examples of the works.

3. System Approach

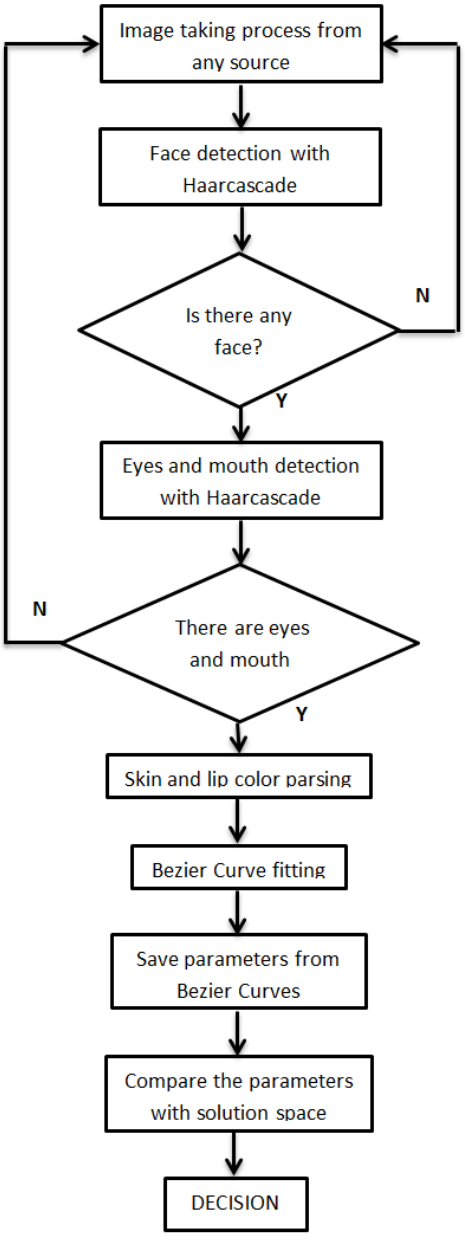

Fig. 2. The flow of the system

Our system consists of several stages. Firstly, an image is taken from a computer or a camera. The next stage is face detection with Haar Cascade Classification. If a face is found in the image, eyes and mouth detection step is started. With eyes and mouth detection, lip location is marked and Bezier Curves is generated according to the marked location by the system. Some parameters are collected from the curves and store a database in order to compare with solution space. After the comparing, system gives decision about the face emotion which can be confused, happy, sad and normal. Flow of the system is shown Fig 2.

C# was used for codding and EmguCV library was used some computer vision process. EmguCV is a wrapper in order to access Open CV's ability on .NET Framework. In this project, face, eyes and mouth detection was performed with the OpenCV via EmguCV. Haar Cascade Classification is in OpenCV.

In face detection step, the image is converted grey scale and face detection is performed by haarcascad_frontalface_default.xml. We used this classifier because of its speed. Face location is cropped and transformed 200*200 pixels. After the detection of eyes and mouth, skin color locations are changed with white color and eyes with mouth locations are changed with black color. After this stage, Bezier Curves is generated from marked area (black color location). An overview for the Bezier Curve of a mouth is represented Fig. 3.

Fig. 3. An example of Bezier Curves of confused state

There are some examples of Bezier Curves for confused, happy, sad and normal situation in solution space. After the generated Bezier Curves process, this new shape is compared with our solution space and system give a decision. A general overview is presented Fig. 4.

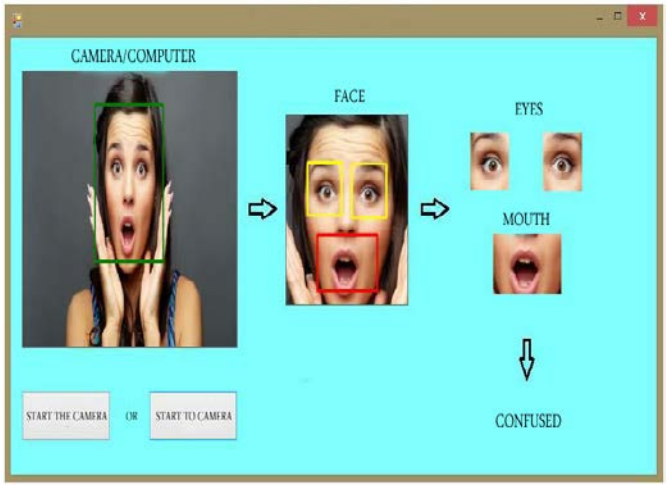

Fig. 4. A general overview of our application

4. Conclusion and Future Works

We present a human facial expression analysis system with a new approach. Our system uses an image which is taken from a camera or previously stored image by a user. The image is processed with Haar Cascade Classification by the system. Then face is detecting. After the face detection process, eyes and mouth are found out and marked. The biggest marked area must be lip location and this location is main point for Bezier Curves transform. Finally, these curves compared with our solution space for decision which can be confused, happy, sad or normal.

First step of our system is a Bezier Curves fitting study. We have achieved successful results in first stage. The system may generate incorrect results with some images which are under different lighting values in this state and another similar negative situation is partially or fully closed face with a hat or a glasses. In such circumstances, different methods may be demonstrated. For example, lighting problem can be solve with image preprocessing techniques.

For increasing the success of the system, an image preprocessing stage can apply for the image in order to overcome the lighting constraints. Increasing features vectors will increase the classification success rate of the system.

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