Facial Expression Recognition Using Image Processing

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ABSTRACT

Facial Expressions are considered as one of the channels that convey human emotions. The task of emotion recognition often involves the analysis of human expressions in multi-modal forms such as images, text, audio or video. Different emotion types are identified through the integration of features from facial expressions. This information contains particular feature points that are used to analyze expressions or emotions of the person. These feature points are extracted using image processing techniques. The proposed system focuses on categorizing the set of 68 feature points into one of the six universal emotions i.e. Happy, Sad, Anger, Disgust, Surprise and Fear. For collecting these points, a series of images is given as input to the system. Feature points are extracted and corresponding co-ordinates of the points are obtained. Based on the distances co-ordinates from centroid, images are classified into one of the universal emotions. Existing system show recognition accuracy more than 90% when SVM (Support Vector Machine) classifier is used. In proposed system, SVM classifier is used for building the classification model using extracted 68 feature points from 7 Region of Interests (ROI). Proposed system recognizes emotions of the person with high precision.

Keyword: - *facial expression recognition, feature points, image processing, expressions, emotion analysis, Support Vector Machine*

1. INTRODUCTION

Technologies based on human computer interaction are increasing day by day. Facial Expression Recognition (FER) is one such technology. Facial expressions are fastest means of communication while conveying any type of information. They are considered a way using which humans convey emotions. Now-a-days, devices which interact with human, perform coded reaction. But, if machine could get real time information of the human it is interacting with, it would help to improve human machine interaction. FER, if implemented, may lead to a natural Human Machine Interface (HMI).

Also, Knowledge of human emotions helps for implementation of:

- Boosting mood of an employee in industry
- Training AI agents
- Blue eyes technology (Technology which identifies mental state of user)

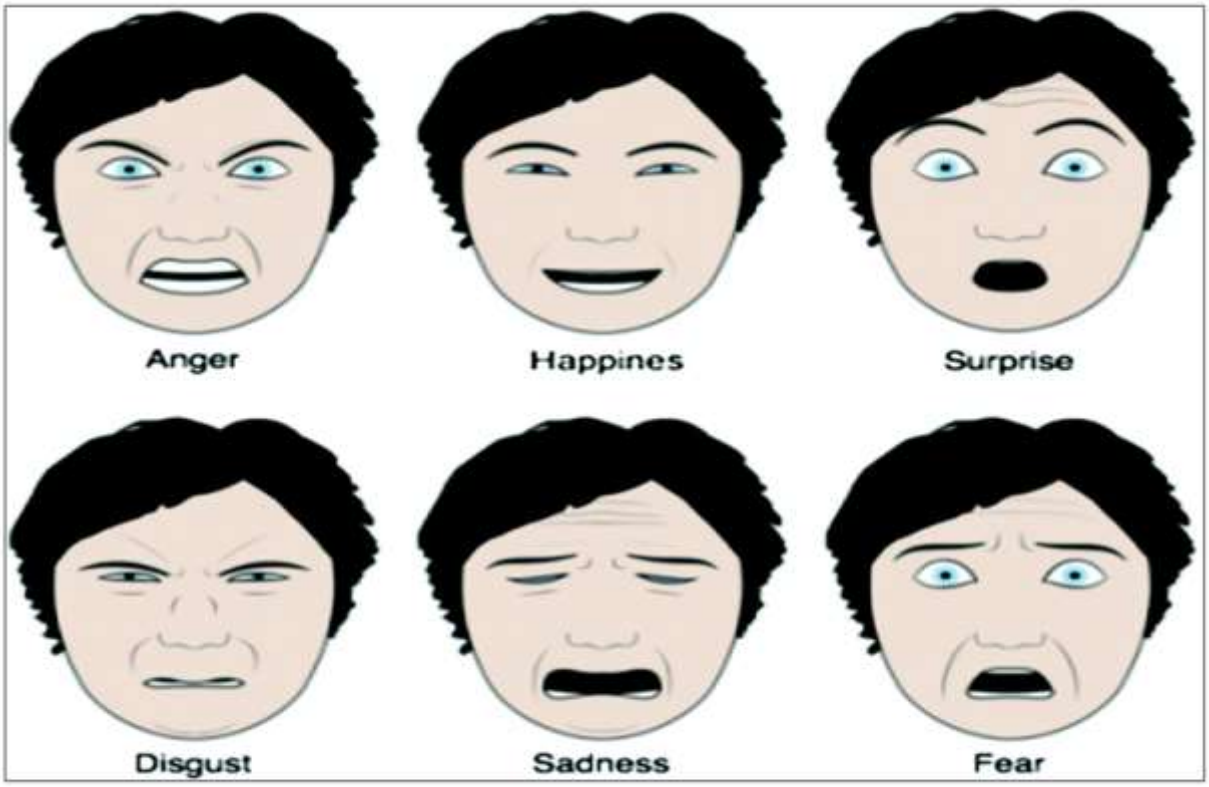

Fig.: Image showing 6 universal emotions.

2. MATERIAL AND METHODS

This system needs a set of images for training and building a classification model. Thus, images in Cohn-Kanade database are used for training.

For detection and identification of face, computer vision libraries are required. OpenCV library provides functions for the same. Using OpenCV, face detection and feature point location is performed. Dlib is used for training and building the classification model.

Study Duration: 12 months.

Sample size calculation: For working of the system, series of images is/are required. At a time, a single image is captured. Series is formed by capturing images after every 30 seconds. A batch of 10 images is considered as one series. Each image from that series is classified and output is that emotion in which maximum images from a batch are classified. Thus, sample size is 10 images i.e. a single batch.

Inclusion conditions:

1. Operating system required is windows 7 or above
2. Python programming language is used
3. . png format of image is required for working of the system

At least 10 GB memory is required for working of the system considering the temporary storage of images captured.

3. PROCEDURE METHODOLOGY

3.1 Training:

Faces are detected from the images in Cohn-Kanade database. Emotions of those faces are known. Feature points of the face refer to 68 points on 7 regions of interest on the face. So, feature points of Cohn-Kanade database are extracted and mapped to particular emotion. Using these values, classification model is prepared.

3.2 Testing:

Series of images is/are captured using a web camera. Face detection is performed on those images and detected face is stored. Feature points are located and extracted. These extracted feature points must be stored in proper data structure for classification. So, before classification, set of 68 (x, y) co-ordinates is converted to an array.

After the array is formed, coordinates of centroid are calculated. Then distance of each feature point from centroid is identified. Those distances are then given as input to classification model. Output of the system is a statement which depicts the emotion of captured images.

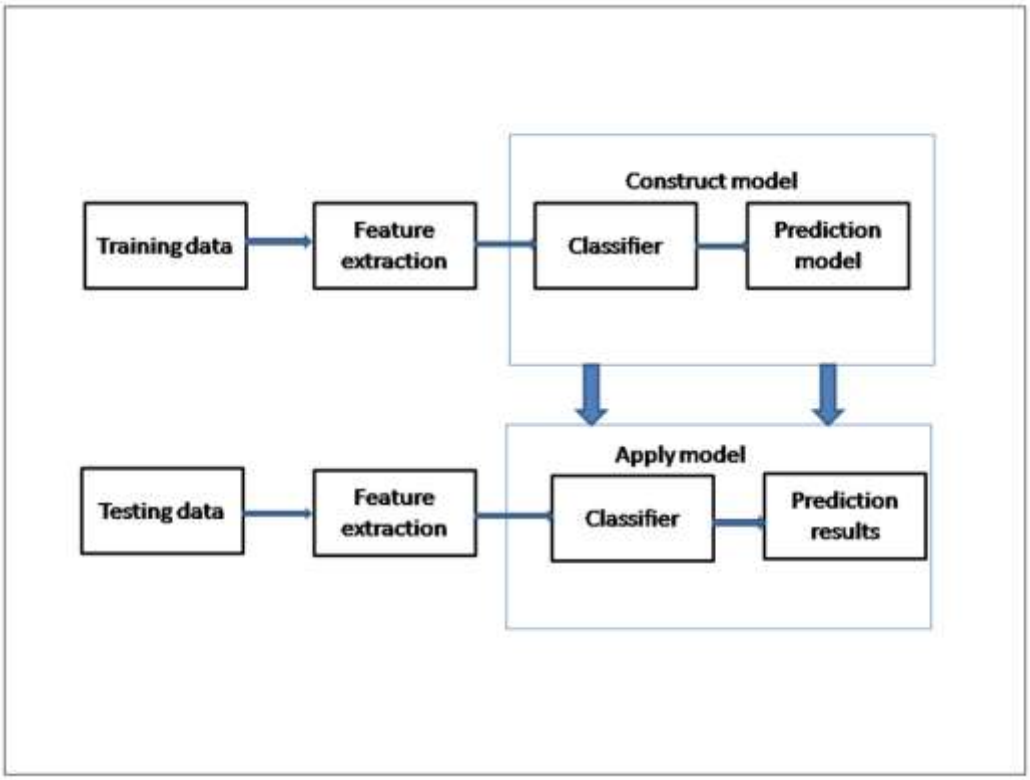

Fig.: Process flow

3.3 Feature points and Region of Interest

1. For tracing particular emotion, feature points of only few regions on face are observed. Those regions are known as Region of Interest (ROI).

2. 7 Regions of Interest are as follows:

- Left Eyebrow

- Right Eyebrow
- Left Eye
- Right Eye
- Nose
- Lips
- Jawline

3. The 68 feature points are divided and mapped onto these 7 regions. Each eyebrow has 5 points, eye has 6, nose has 9, lips have 20 and jaw line has 17 feature points.

ROI	FEATURE POINTS
Left Eyebrow	**23-27**
Right Eyebrow	**18-22**
Left Eye	**28-36**
Right Eye	**37-42**
Nose	**43-48**
Lips	**49-68**
Jawline	**1-17**

Table: Showing mapping of ROI and feature points

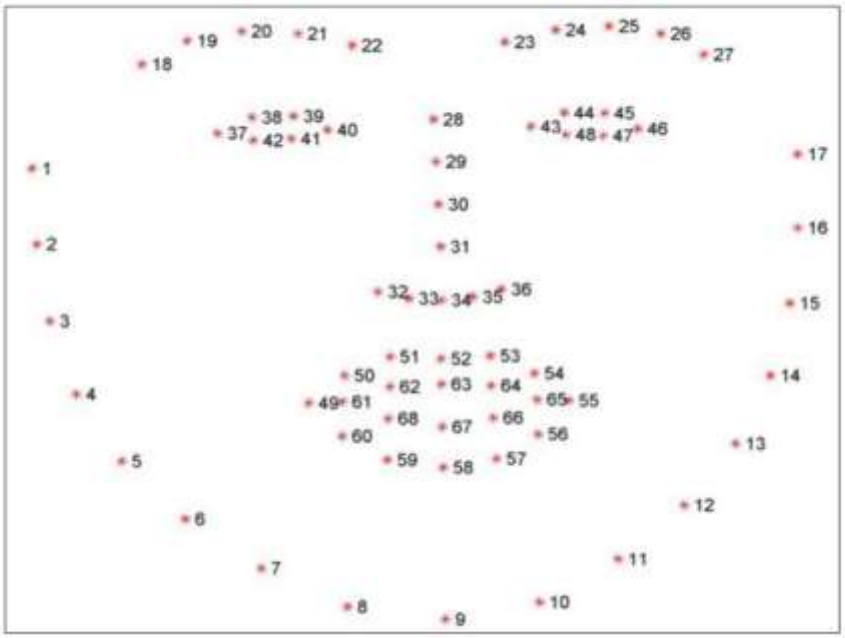

Fig.: Location of feature points on face

4. ANANLYSIS

1454 images from Cohn-Kanade database are used for training the classification model. Faces from those images are extracted and 68 feature points are extracted and used for training.
Extraction results in (x,y) coordinates of feature points. If only the value of coordinates is considered for classification, the accuracy decreases sharply because if the face is tilted then values change abruptly. As this type of change in value do not have a pattern, building a model is difficult. Considering this problem, Euclidean distance of each feature point from a fixed point is calculated. That fixed point is centroid of 68 points. This method solves the problem of changing values.

Phase wise working of the system after training is done:
Phase 1:
Phase 1 of the system is collection of images using web camera.
Phase 2:
In phase 2, face is detected from the batch of images.
Phase 3:
Phase 3 is the step where feature points are extracted from the face detected in phase 2, calculating the centroid and Euclidean distances.
Phase 4:
Phase 4 is classification of images in particular emotion using SVM classifier.
Phase 5:
Proposed system gives the emotion of the face in the images as a result in phases 5.

5. DISCUSSION

Facial expressions are considered as a best way to convey emotions. Human Emotions are nowadays used in multiple applications. Basically, there are six universal emotions such as happy, sad, fear, angry, disgust and surprise. These emotions can be categorised under computer vision domain. Facial Expression Recognition using image processing system proposes a new approach for recognising the facial expressions using OpenCV libraries and Haar Cascade Algorithm for face detection.

Dlib, a C++ toolkit contains Machine learning algorithms is used for training and building the classification model. It uses SVM classifier to classify the images into six universal emotions. Classification is done based on the batch of series of 10 images, so, that the classification accuracy increases. The SVM classifier has the accuracy greater than 90% and hence, expressions can be identified with high precision. 1454 images from the Cohn-Kanade database are used to make a classification model to train the test images which are captured using the Web Camera. The images are compared with the training classification model and the images are classified according to its most similar trait of emotion. The output is displayed on the screen as a dialogue box showing if the person's face shows Sad, Happy, Fear, Surprise, Disgust and Anger as an emotion.

The SVM algorithm efficiently identifies the human emotion along with the use of 7 ROI. The image being converted to feature point and then applied for the final result, shows the correct human emotion irrespective of the fact that image is compressed for application of SVM algorithm. The algorithm being highly precise yields effective recognition of human emotions into the six universal emotions.

There are many projects related to the topic which are implemented using predefined grids and also many mathematical formulas for extracting features. But the proposed system classifies the emotions without complex calculations. About 50 images were tested and classified accurately to their specified classes.

6. CONCLUSION

Facial Expression Recognition provides a way to identify human emotions. Proposed system identified the same with the help of captured series of images. It detects the face from collected images for efficient extraction of feature points. The system effectively classifies the images into one of the 6 universal emotions. Haar Cascade algorithm used for detection of faces works appropriately with around accuracy rate of 90%. SVM classifier used in the system gives the expected output properly.

7. REFERENCES

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