A REVIEW ON EMOTION RECOGNITION USING HYBRID CLASSIFIER

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ABSTRACT

In Human Computer Interaction (HCI), Expression Recognition or Emotional State Recognition using Holistic and Feature information is the vital step. Earlier work had been done by the researchers gives less attention on the critical issue of hybrid classifier. Enormous interest in automatic Processing of digital images and videos due to wide availability of power and low cost desktop Embedded Computing and the ever-increasing contents in the collection of image data in various fields of neuro-science, security and other fields have brought the necessity of designing the above system. The approach towards the work is carried by detecting the eyes & lips along with classification of different facial expressions into one of the 4 basic human emotions, viz. angry, happy, sad, and surprise with hybrid classifier to get improved results.

Index terms- Facial Action detection system, Emotion recognition system, hybrid classifier.

I. INTRODUCTION

Face detection has number of applications like authentication, human/computer interface and surveillance. It has become as an active research area in the field of pattern recognition and computer vision. The face can express faster than the people verbalize or even realize their feelings. Human face tells about the human being and so many communications and prediction can be done through the face. Facial Expression provides very strong cue in measuring levels of interest of a person while interacting with a machine. Facial expression is one of the most powerful, natural, and immediate means for human beings to communicate their emotions and intention. Facial emotion constitutes 55 percent of the effect of a communicated message and is hence a major modality in human communication. Automatic Facial Expression Recognition in human-computer environment is essential and challenging. Face plays an essential role in interpersonal communication. Automating facial expression analysis could bring facial expressions into man-machine interaction [8].

A. FACE DETECTION

Face biometric alone has many potential applications viz. forensics, security applications, and other commercial applications. Most of the busy areas, banks, hospitals and all other public areas are heavily monitored by the surveillance cameras in order to protect law and order thereby providing security to the general public. Any stringent actions took place are recorded by the cameras and mostly faces are the means to identify the culprits. Early methods [7] focused only on the detection and localization of human faces facing towards camera. Many Researchers explored ideas on iris, fingerprint, voice, palm etc other than face but the former ones are error-prone and expensive. Face detection can also be considered as a specific case of object detection [7]. Broadly, the face recognition systems are classified into two categories: verification and validation. Face verification is a 1:1 match that compares a query face against template face images. Face validation is a 1:n approach that compares a query face with all images in the database.
Firstly, Collection of database plays a vital role in the field of image processing. The work [7] focused on the complex issues of the problem i.e., to identify the human face in multiple views with different poses, illumination variations and with different rotations. The researchers were focused on appearance-based approaches and knowledge based methods. In [7], an automatic face detection method is proposed on skin based segmentation of RGB images generating templates. The input image is given to the system, it will extract the facial feature of the image with the help of skin color segmentation. The color space transformation is used in skin color segmentation which is widely used. The Aim of Color space transformation is to increase the separability between skin and non-skin classes [6]. Threshold value is given to reject the non-skin pixel from the face. Early face detection method has a method based on knowledge and a method based on characterization and template matching. Their main drawback is that they have more sensitive, lower accurate and higher rate of false alarms of the noise, transformation of light, face size transformation [12]. The [13] Face Detection method based on integration of Principal Component Analysis and Linear Discriminant Analysis. This Fuzzy based Recognition system aims to reduce the dimension of the image. It also helps to determine the Magnitude of Eucledian Distance for fine and successful Facial Recognition. It is based on skin Color Segmentation and then Face Localization and Normalization. PCA is used to find out Eigen values, Eigen Vectors and Eigen space of human facial features.

A method based on Linear Discriminant Analysis using Wavelet Transform Approach for Face Recognition System had used. It enhances Performance such as Accuracy and time Complexity over Classical LDA. LDA is well known scheme for Feature
Extraction and Dimension Reduction. It provides improved Performance over PCA. Here ORL face database is used and Graphical Comparison is shown between different Algorithm which provides improved Recognition Rate.[14]

<table>
<thead>
<tr>
<th>K</th>
<th>PCA</th>
<th>LDA</th>
<th>Wavelet LDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>78</td>
<td>79</td>
<td>83</td>
</tr>
<tr>
<td>6</td>
<td>84</td>
<td>85</td>
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<td>87</td>
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<td>91</td>
<td>94</td>
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<td>9</td>
<td>96</td>
<td>97</td>
<td>95</td>
</tr>
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</table>

Table1. Comparison Between LDA and PCA algorithm[14].

B. FACIAL ACTION UNITS
The performance of face recognition system depends heavily on the particular choice of facial features. The process of feature extraction should involve the derivation of salient features with reducing the redundant information of data and providing enhanced discriminatory power. Principal Component Analysis (PCA) is an effective method of linear dimensionality reduction used in face recognition system. PCA has many drawbacks. One is that its linearity can limit its relevance to the highly nonlinear systems frequently encountered in face recognition applications. LDA based method is proposed to maximize the between class scatter and minimize the within-class scatter[1].

Contraction of the facial muscles produces changes in the direction and magnitude of the motion on the skin. Surface and in the appearance of permanent and transient facial features. Examples of permanent features are the lips, eyes and any furrows that have become permanent with age. Transient features include facial lines and furrows that are not present at rest but appear with facial expressions. Even in a frontal face, the appearance and location of the facial features can change dramatically. For example, the eyes look qualitatively different when open and closed. Different components require different extraction and detection methods. Multistate models of facial components have been introduced to detect and track both transient and permanent features in an image sequence.

Lip and eye feature tracking is not reliable because of the aperture problem and when features undergo a large amount of change in appearance, such as open to tightly closed mouth or eyes [11]. While they used three separate feature extraction modules, they were not integrated for the purpose of AU recognition. By integrating their outputs, it is likely that even higher accuracy could be achieved [11]. Computer facial expression analysis systems need to analyze the facial actions regardless of context, culture, gender, and so on.

<table>
<thead>
<tr>
<th>Test databases</th>
<th>Train database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohn-Kanade</td>
<td>EKman-Hager</td>
</tr>
<tr>
<td>Recognition rate</td>
<td>Recognition rate</td>
</tr>
<tr>
<td>Upper face</td>
<td>Upper face</td>
</tr>
<tr>
<td>93.2%</td>
<td>96.4%</td>
</tr>
<tr>
<td>Lower face</td>
<td>Lower face</td>
</tr>
<tr>
<td>96.7%</td>
<td>93.4%</td>
</tr>
</tbody>
</table>

Table2. Generalizability to independent Databases [11].

The method is based on identification of human face in multiple views with different poses, illumination variations and with different rotations using Hybrid approach. Here Feed Forward Neural Network Trained by Back Propagation Algorithm is used along with Gradient Descent method for updation of weights. Fuzzy set theory is used to define the pixel value which is uncertain. For that Triangular membership function is used. Then fusion of both method is done to increase the Accuracy of Result up to 94%. But here Bio-ID data set is used due to large variety of illumination, Background size and Face size. Face identification is done here for Safety and Security Purpose.[7]
C. EMOTION RECOGNITION

Facial expressions are the facial changes in response to a person’s internal emotional states, intentions, or social communications. For emotion analysis, higher level knowledge is required. Computer facial expression analysis systems need to analyze the facial actions regardless of context, culture, gender, and so on. The accomplishments in the related areas such as face detection, face tracking, and recognition make the automatic facial expression analysis possible. Automatic facial expression analysis can be applied in many areas such as emotion and paralinguistic communication, clinical psychology, psychiatry, neurology, pain assessment, lie detection, intelligent environments, and multimodal human computer interface (HCI). Facial expression analysis includes both measurement of facial motion and recognition of expression. The facial expressions were decomposed to smallest visually discriminable facial movements called as action units where each facial (Au’s) is related to one or more facial muscles [2].

The researchers in paper [2] shows the Gabor filter based features in combination with GA and SVM is used for dynamic analysis of six facial expressions from video sequences. GA is used to overcome the problem of high dimensional feature vectors and computation cost. A local Gabor filter bank with selected frequencies and orientations is produced by GA. The detection rate of six basic emotions has been reached to 92.97% for Cohn-Kanade (CK+) database.

\[
\begin{array}{ccccccc}
\text{Predict} & \text{Surprise} & \text{Happiness} & \text{Sadness} & \text{Fear} & \text{Anger} & \text{Disgust} \\
\hline
\text{Surprise} & 93.55 & 3.22 & 0 & 1.61 & 1.61 & 0 \\
\text{Happiness} & 1.75 & 96.49 & 0 & 1.75 & 0 & 0 \\
\text{Sadness} & 0 & 0 & 68 & 8 & 8 & 8 \\
\text{Fear} & 1.49 & 0 & 1.49 & 95.52 & 0 & 1.49 \\
\text{Anger} & 18.52 & 3.70 & 3.70 & 3.70 & 66.66 & 3.70 \\
\text{Disgust} & 1.20 & 0 & 1.20 & 0 & 1.20 & 96.38 \\
\end{array}
\]

Table 4. Matrix for six basic emotions [2]

The work develop a facial expression recognition system, based on the facial features extracted from facial characteristic points in frontal image sequences. Selected facial feature points were automatically tracked using a cross-correlation based optical flow, and extracted feature vectors were used to classify expressions, using RBF neural networks and Fuzzy Inference System (FIS). Then recognition results from two classifiers were compared with each other. It is Observed that Success Rates was about 91.6% for RBF and 89.1% for FIS classifiers.[3]
The Researcher proposed neuro-fuzzy based automatic facial expression recognition system to recognize the human facial expressions like happy, fear, sad, angry, disgust and surprise. Initially facial image is segmented into three regions from which the uniform Local Binary Pattern (LBP) texture features distributions are extracted and represented as a histogram descriptor. The facial expressions are recognized using Multiple Adaptive Neuro Fuzzy Inference System (MANFIS).

The proposed system designed and tested with JAFFE face database. The proposed model reports 94.29% of classification accuracy. [10]

A novel human emotion detection using a well-known local binary pattern (LBP) and a newly developed feature matrix is used. A unique feature matrix is then combined to apply to Adaptive Neuro Fuzzy Inference System to generate five facial expression models, namely, happy, sad, angry, disgust and surprise. A number of experiments are carried out on facial expression determination with different LBP techniques by varying the number of points and radius of neighbourhood to JAFFE face database. The proposed system achieves very high accuracy with LBP which has outperformed most of the existing methods. [15]
The benefits of both fuzzy logic and artificial neural networks, we will use the hybrid approach, which combines fuzzy logic and artificial neural networks in a single model [9]. Closed-loop control in medicine emerged as a serious contender for many forms of control in late 1970s. It was pioneered by Sheppard, when they demonstrated through clinical experiments that this form of control is safe, effective and in many cases better than manual control. Closed-loop control methods can be divided into two groups: adaptive and non-adaptive. In a following section, more details are given of the different types of closed-loop Controllers [9]. Genetic Algorithm (GA) is a bio-inspired search heuristic which can generate useful solutions to an optimization problem. For feature selection purpose, the algorithm requires a fitness function to provide a measure to evaluate each individual population. GA’s operates iteratively on a population of structures, each of which represents a candidate solution to the problem, encoded as a string of symbols (chromosome). A randomly generated set of such strings forms the initial population from which the (GAs) starts its search. Three basic genetic operators guide this search: selection, crossover and mutation [4]The propose system uses neural network along with genetic algorithm for detecting the state of emotion in Neuron-Genetic System [5].

Table 8; The Accuracies for the different Feature Extraction Process using ANFIS Model.[15]

<table>
<thead>
<tr>
<th>Feature Extraction Process</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBP</td>
<td>90%</td>
</tr>
<tr>
<td>LBP_{(8,1)}</td>
<td>87%</td>
</tr>
<tr>
<td>LBP_{(12,1.5)}</td>
<td>90%</td>
</tr>
<tr>
<td>LBP_{(16,2)}</td>
<td>95%</td>
</tr>
<tr>
<td>LBP with face divided into 3 parts</td>
<td>85%</td>
</tr>
</tbody>
</table>

Table 9 : Developed Feature Matrix for JAFFE Database[15].

<table>
<thead>
<tr>
<th>Expressions Images</th>
<th>Happy</th>
<th>Sad</th>
<th>Surprise</th>
<th>Anger</th>
<th>Disgust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Happy</td>
<td>4</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Sad</td>
<td>0.25</td>
<td>4</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Surprise</td>
<td>0.25</td>
<td>0.25</td>
<td>4</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Anger</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>4</td>
<td>0.25</td>
</tr>
<tr>
<td>Disgust</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>4</td>
</tr>
</tbody>
</table>

In order to utilize the benefits of both fuzzy logic and artificial neural networks, we will use the hybrid approach, which combines fuzzy logic and artificial neural networks in a single model [9].
The features of each eye and mouth movement to express different emotion is very difficult to judge. As the emotion is recognized with the different combination of facial feature, so there is possibility that one of the feature which is to be used in anger can also be used in surprise. Due to the presence of common facial feature in different emotion, the recognition of correct emotion is uncertain. To give the best possible result an attempt is taken to use the combination of classifier.

General approach to automatic facial expression analysis consists of steps: face acquisition, facial data extraction and representation, and facial expression recognition [3]. The skin color based algorithm is used to detect the face of the driver. Once the face area is found, the eyes and mouth can be found by Thresholding & segmentation process. After extraction of facial feature selection and feature extraction stage followed with the fusion strategy– hybrid classifier is used for detection/recognition/classification [3].

I. DISCUSSION

In the proposed architecture after giving an image as a input, the skin color segmentation is applied which will detect the human face. Further it is seen that the feature of eyes and lips are extracted which will corresponds to facial emotion recognition. Then these, features are passed to the emotion recognition system for more accurate classification and detection of exact state of emotions of a person namely happy, sad anger and surprise.

The proposed approach consists of three parts: A human skin segmentation to identify probable regions in human face, adaptive shape analysis to separate isolated human faces from initial segmentation process and a view-based face detection to further identify the location of each human face. The researchers [11] shows that a feature based method performs well as with the comparison did by template-based method for more complex data. It may be premature to conclude that one or the other approach is superior.

A. MORPHOLOGICAL PROCESSING

The color segmented image is converted into a gray scale image because morphological operations work on intensity images. Intensity thresholding is performed to break up dark regions into many smaller regions so that they can be cleaned up by morphological opening. The threshold is set low enough so that it doesn’t chip away parts of a face but only create holes in it. Morphological opening is performed to remove very small objects from the image while preserving the shape and size of larger objects in the image.

The definition of a morphological opening of an image is an erosion followed by a dilation, using the same structuring element for both operations. Hole filling is done to keep the faces as single connected regions in anticipation of a second much larger morphological opening. Otherwise, the mask image will contain many cavities and holes in the faces.

The work[12] describes standard of JPEG, RGB image is converted to a luminance color space; it is often called YCbCr color space. It is derived from the YUV color space. Y stands for brightness. Cb and Cr are obtained by chancing U and V. Cb stands for red component, and Cr stands for blue component. Cb and Cr are often called color. In the coding program, the sampling rate of Y, Cb and Cr is 4:2:2, because people eyes has more sensitive for signal variation than for brightness signal. We found that Y has little effect on the distribution of the sample in the YCbCr colorspace. But sample data’s are concentrated in one area of Cb-Cr.

YCbCr color space has the following advantages [12]: Its principle is similar to the process of human visual Perception. Space format of YCbCr color room is widely used in the television display area. It is also used in video compression coding, such as MPEG, JPEG. Its space format separates brightness component from the color components. Its space format’s calculation process and representation of spatial coordinates are easier than others. Clustering characteristics of skin color is better in YCbCr color room. YCbCr color space and RGB color space can transform from each other.

II. CONCLUSION

This research work presents a comprehensive study and analysis of system to find the Emotion Recognition. Hybrid classifier often involve the method of specifying a set of simple rules and a method of iteratively applying those rules. The hybrid classifier approach for the proposed system is found hopefully to be more efficient than the existing digital image
processing techniques, since it presents a multiple classifier system for efficient facial feature extraction to increase recognition accuracy.

III. REFERENCES

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