Facial Expression Recognition using Hidden Markov Model

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Abstract: in this research we gave proposed a facial expression recognition system with logical partition. Since generating an effective way for feature extraction in FER is vital step in this domain. We have partition the image into three parts and then extracted the feature helps us to get good accuracy. We have adopted two different approaches, first is local binary pattern and landmark based. To evaluate the efficiency of our proposed system we have tested it with CK+ and computer created dataset, FergDB. Our proposed work shows 50% accuracy in CK+ and 48.2% in FergDB dataset.

Index Terms **– FER, HMM, local binary pattern, landmark, logical partition**

I. INTRODUCTION

Increased concern in the security and safety led to increase use of CCTV system to monitor the behavior of the individual and their expression help us to understand the cognitive intention of particular person. Vigilance by the human observer is declined now days. As there is the development of automated system. This system is useful for detecting not only the expression but emotion. Developing such system would reduce the crime and reflect the mental state of person that allows us to predict the future behavior. Research shows that the facial expression contributed to about 55% effect of overall emotion expression during interaction [1].

The idea is to develop the algorithm for recognizing the facial expression and recognition. In this research paper, we are proposing a facial expression recognition using hidden markov model (HMM). There exit a number of FER approaches in past few year as this is the most selected research area. These approaches are broadly divided into two categories based on how information is extracted from the facial image. The first category is based on texture modality where pixel information is taken into consideration. Texture related features are derived from the pixel values, which enable us to capture the minute detail and information. Another category is land mark based where key points are extracted corresponding to the movement in facial expression[2]. We are employing both modalities to create the system. Both these modalities are showing different behavior with different datasets. We are employing logical partitioning to the images to extract relevant section of face which is useful in providing us the good features. Hidden Markov model (HMM is considered one of the most promising models for face and recognition. HMM has the ability to deal with time sequential data and to provide us parsimonious nature as well as learning capability made it an appropriate selection for classifying unknown feature vector sequences. To understand the effectiveness of our approach, experiments are conducted on CK+ [3] as well as FergDB datasets. The result show that the logical partition work well for extracting the feature and help us to enhance the efficiency of our proposed algorithm.

The rest of the paper is organized as follows: section II explains the overview of the proposed system. Section III explains the methodology of the system in which we have explained the proposed algorithm. Section IV gives the brief about the hidden markov classifier. Section V gives the experimental results.

II. PROPOSED FLOW

In fig 1, the image or video are the input. They are loaded first and the basic step is image preprocessing followed by Logical partitioning where the image is partitioned from each partition relevant feature are derived and then appropriate feature are selected after that feature are fed into the HMM classifier. Classification result will be then displayed in terms of accuracies. We are classifying three different emotions named detrimental emotion which is expressed by the fear and anger expression, unfavorable emotion is expressed by the sad and disgust expression and the delightful emotion are classified by the joy and surprise expression. For the feature extraction techniques are using local binary pattern is used as texture modalities and for landmark modalities we are extracting 68 key points of face.

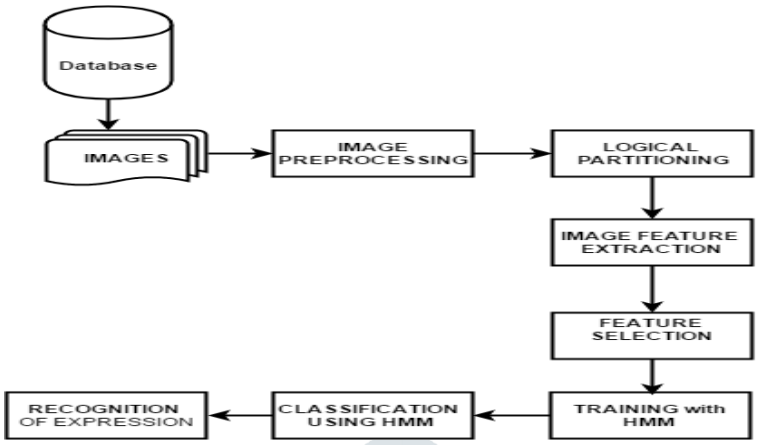

Fig. 1: flowchart of proposed FER

III. METHODOLOGY

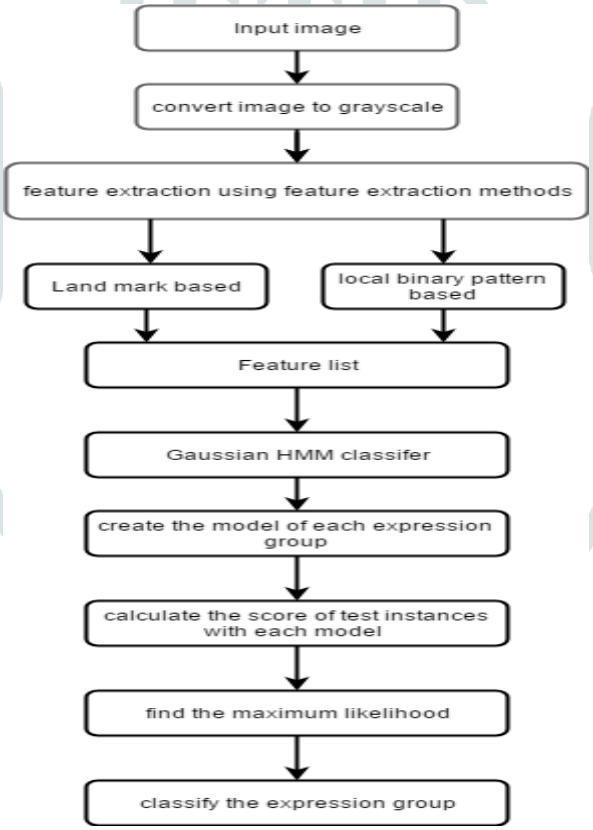

Fig 2: Algorithm for facial expression recognition process.

1. FEATURE EXTRACTION:

In this section we have described the algorithm flow of our proposed FER system. Feature extraction process consists of three step pre-processing for illuminate and moving invariance, we have applied histogram equalization to compensate the illumination of image. Local binary pattern is popular among different popular techniques like Gabor etc to represent the texture information. It is initially designed for texture classification but now days it is most popular technique used for face recognition. the most important characteristics is simplicity and robustness to illumination problem. In [4] the combination of Gabor and LBP is used.

But because of high dimensionality we have derived the histogram of each LBP rather than using the any other optimization method.

In original Ojala et. al. [5] Has proposed this texture descriptor. It performs by thresolding the value of neighbour pixel against the central pixel interpreting the result as a binary number. The original LBP uses the (8, 1) circular neighbourhood and follows uniform pattern.

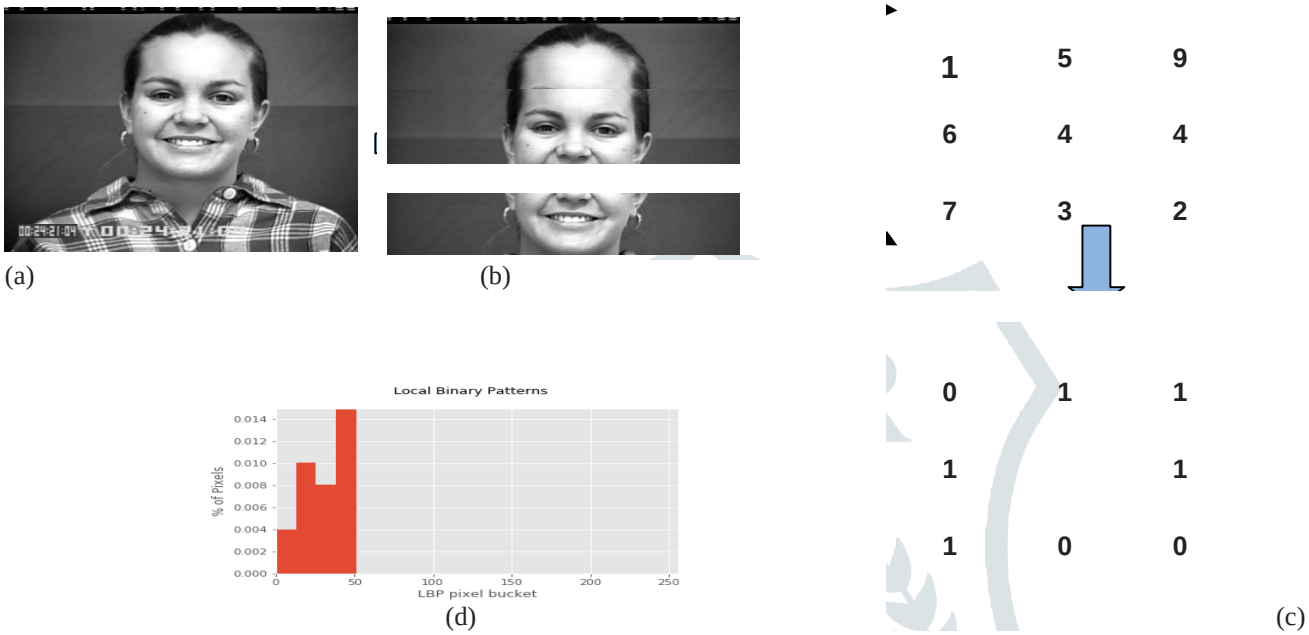

Fig 3: (b) represents the logical partition, (c) LBP operator, (d) histogram of LBP

We have partition the image into three sections to get the relevant feature from head section, eyes section and mouth section. By understanding the inter relationship between these logical segments we can determine the expression of the subject. The image in this research has the size of 460*540 and thus from each partition we are getting the 1094 histograms. Another method of feature extraction is landmark based where we are first detecting the face using HAAR cascade.Facial landmarks are a set of salient points, usually located on the corners, tips or mid points of the facial components. Reliable facial landmarks and their associated detection can be widely used for representing the important visual features for face registration and expression recognition. 68 key points are located and their differences with the mean distance are calculated. Landmark points are best way to acquire the feature in this algorithm first we have retrieved the images from the directory. Landmark points are called “anchor points” or key points. We have used HAAR cascade file to detect the face and then DLib predictor is used to find 68 key points their x and y coordinate is stored and there distances is calculated. Point 29 is midpoint face and we have found the angle of the tilted face with respected to it. The appended feature is then supplied to the HMM classifier.

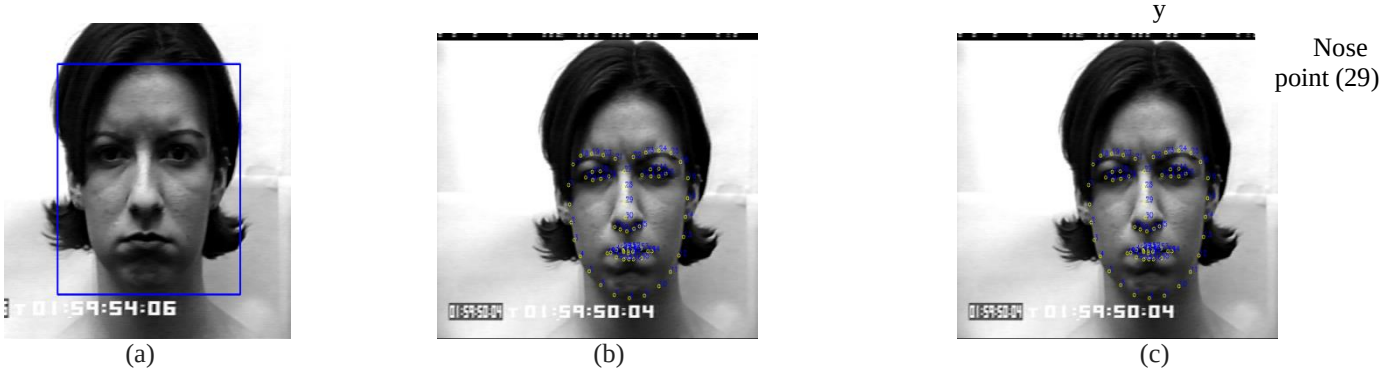

Fig 4: (a) represents the face detection, (b) Landmark point extraction (c) head movement calculation

To deal with the head movement we have calculated the angle between the vertical axis, y and line that passes to the points of the nose which is 29. We are getting total 201 features for a particular image.

2. CLASSIFICATION

The HMM is a sequence model. A sequence model or sequence classifier is a model whose job is to assign a label or class to each unit in a sequence, thus mapping a sequence of observations to a sequence of labels [6]. An HMM is a probabilistic sequence model: given a sequence of units (words, letters, morphemes, sentences, whatever), they compute a probability distribution over possible sequences of labels and choose the best label sequence. Its states are not visible, but visible on the output of states. When all the probability distribution of the output of each state is known, the next state can be predicted through the current state, or through an associated output sequence to predict the state sequence. Therefore, HMM is widely used in the timing pattern recognition [7].

The process of facial expression recognition based on HMM is as follows:

(1) For each facial expression, each feature point, a HMM is initialized. The number of observable symbols of HMM is set to the number of different feature values in the feature set, and the number of hidden states is set To 3. The state transition matrix, the observable symbol probability matrix and the initial state probability distribution are randomly generated.

(2) Take a sample from the training set, using forward algorithm to estimate optimal path of transition among the state and update the corresponding parameters of the models, which are initialized for this sample's facial expression with different feature points.

(3) Take the feature vectors of the feature points in test set as input of the corresponding model of various facial expressions, and calculate its occurrence probability with the forward algorithm.

(4) Calculate the average of all probability calculated by all feature points models with the same expression. Then the test sample is classified as the expression which gets the highest average probability.

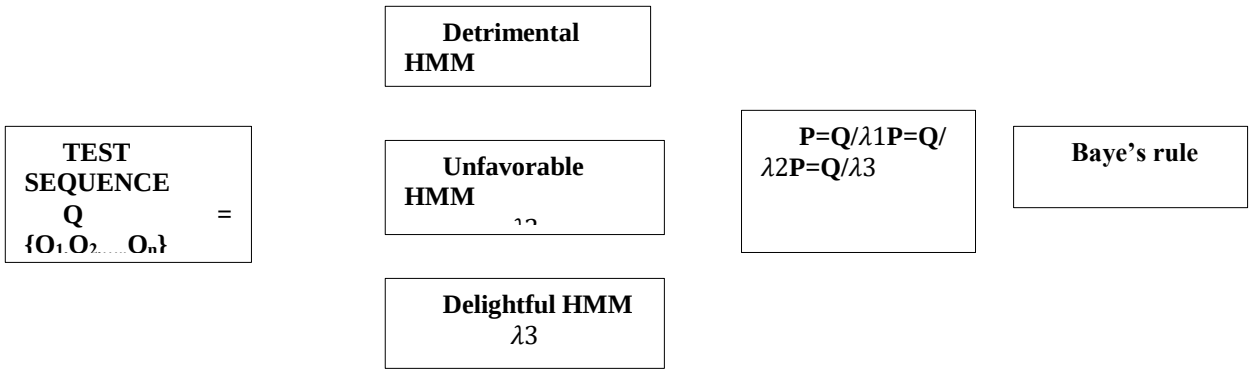

Fig 6: evaluation phase for HMMs

IV. EXPRIMRNT RESULTS

In the experiments, three moods with their expression are classified. We have used two dataset for finding the accuracy. The two datasets are CK+ (Cohn- Kanade +) and FergDB. CK+ dataset consist of near 10000 images out of that we have used 480 images for training and tested our algorithm using 36 images. FergDB dataset consist of animated facial images and 600 images are used to train our model and 20 images for each expression group are used testing the accuracy.

Table 1: experiment result for CK+ dataset (in percentage)

	Emotions group	Methods		
		Local binary pattern	Landmark based	LBP with logical partition
CK+	Detrimental emotion	42.33	46.33	51.33
	Unfavorable emotion	42	41	50
	Delightful emotion	46	45.66	50.66
	Overall accuracy	43.33	43.66	50

Table 2: experiment result for FERG DB (in percentage)

	Emotions group	Methods		
		Local binary pattern	Landmark based	LBP with logical partition
Ferg DB	Detrimental emotion	50.56	64.33	48.33
	Unfavorable emotion	49	68.66	47.22
	Delightful emotion	50.33	72	49
	Overall accuracy	50.033	68.33	48.23

When we compare the table1 and table 2 we can analyze that the two dataset are showing different behaviours with different methods. From table 1 we can conclude that proposed method i.e. Logical partitioning with LBP worked well. But at the same time accuracy decreases for computer created dataset (ferg db) and landmark is showing prominent result.

V. CONCLUSION AND FUTURE WORK

In this paper, we have proposed the facial expression recognition as FER is the most important research topic nowadays because of its application in all domains. Application like surveillance, pain detection, online tutoring system etc. There are various feature extraction techniques like local binary pattern, Gabor, principal component analyses etc but we are adopting two different method local binary pattern and landmark based. We are applying the techniques after logically partitioning the image. This partition helps us to extract the relevant feature from the image. as we can see that segmenting the image has given the good accuracy than applying the LBP on image. Though accuracy is comparatively less but further research is going on.

VI. REFERENCES

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