HCI and Eye Tracking : Emotion Recognition Using Hidden Markov Model

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Abstract— Recognition of Emotion can be identified using Eye Tracking methods which may be non-intrusive. SVD and HMM are used for eye tracking to recognize emotions, which classifies six different emotions with less correlation coefficiency and 77% accuracy is achieved. This work also focus on emotion recognition with HMM using the distance calculation method ,measuring sclera and iris distance.A fully automatic eye tracking system is developed for emotion detection with eye tracking. Face Detection, Feature extraction, Distance Calculation and Emotion classification are developed to recognize emotions. Non intrusive device, webcam is used to capture image, image segmentation algorithm is applied for segmenting the eye parts for emotion analysis. HMM is implemented to classify the emotion with distance calculation method. The proposed algorithm identifies six different emotions with high correlation efficiency

Keywords- Human Computer Interaction; Eye Tracking; Emotion Recognitio;, Hidden Markov Model(HMM).

1. INTRODUCTION:

Emotion recognition is an important component for efficient human – computer interaction. It plays a vital role in interactive communication, allowing people to express oneself beyond the verbal domain. Analysis of emotions from human eye expression involves the detection and categorization of various emotions or state of mind. For example, in security and surveillance, they can predict the offender or criminal's behavior by analyzing the images of their faces from theframes of the video sequence.

The analysis of emotions can be applied in a variety of application domains, such as video surveillance and HCI systems. In some cases, the identified emotions are used as input.

In this paper, a facial emotion recognition technique is proposed by the distance calculation method using HMM. Figure 1.Shows the proposed systems' block diagram. Specifically eye tracking is applied for distance calculation in Hidden Markov Model (HMM) as a suitable classifier in emotion recognition.

The rest of the paper origination is as follows; section 2 describes on Related Works, Section 3 focus on the Methodologies applied in this work for emotion recognition and relates this work with other experiments Section 4 highlights the results of this work and final conclusion with future work is described in Section 5.

The Main motivation of this project is to concentrate in Education field to analyzes the learner's emotion, according to which they can be interacted with effective communication

2. RELATED WORK:

In the last two decades, more approaches for human emotion recognition have been proposed. Kumar et al. [1] developed a frequency domain feature of face images for recognition by cross-correlation method with fast Fourier transform. Savvideset al. [2] further extended a correlationfilter and developed a hybrid PCA-correlationfilter called "Core faces," that performed robust illumination-tolerant face recognition. Picard etal. [3] stressed the significance of human emotions on the affective psychological states.

Ekman et al. [4], [5], analyzed six Fundamental facial expressions and encoded them into the so-called facial action coding system (FACS). FACS enumerates action units(AUs) of a face that cause facial movements.Korma et al. [6] used 17 features ,however 5 of them are specific to the scenarios that are calculated based on eye movements over circles formed in images.

This in-depth survey disclosed the fact that many approaches that were developed before applies more than one algorithm and models to identify human emotions [9], G. R´azuri . [10] the decoding of emotional expressions. Finally we use the merged image as an input to a feed-forward neural network trained by back-propagation .

R.Arun and T.Arun [11],[12] the human eyes can be extracted using the well known canny edge operator and classified using a non – linear Support Vector machine (SVM) classifier. Finally, we use standard learning tool, Hidden Markov Model (HMM) for recognizing the emotions from the human eye expressions.. Hence in this paper we proposed an efficient way of emotion recognition using the distance calculation on sclera and iris and HMM is applied for emotion classification.

3. METHODOLOGY

The proposed Method, focus on emotion recognition using HMM with Eye Tracking by the distance calculation method applied for sclera and iris distance measurement. All together 6 academic related emotional groups are recognized namely, Anger, fear, lateral movement of thinking, sleep, confusion, disappointment.

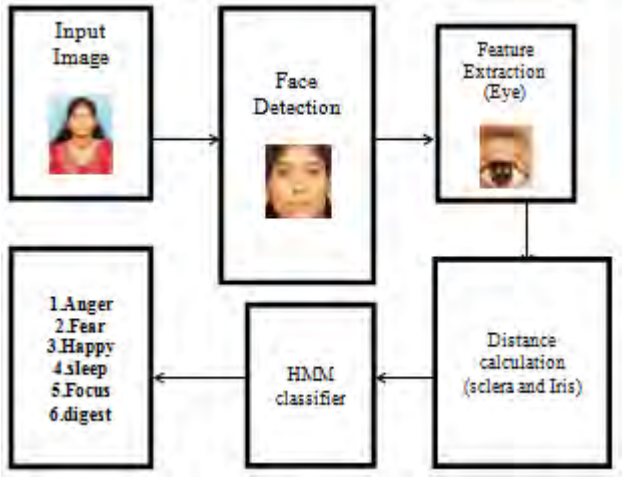

Fig.1.Functional Flow Diagram of the System

3.1. Face Detection

Capture the full image by using webcam installed in a system or using other cameras which is non-intrusive. To capture the full image then Apply the skin color and find the face region connection. Convert the original image to binary image and detect the face.

Fig.2. Face Detection

3. 2.Feature Extraction:

Eyes are the features to be segmented for emotion recognition. In this work face width is considered as w. Scan the width from w/4 to (w-w/4) to find the middle position of the two eyes. With the highest white continuous pixel between the ranges is measured to find the middle position of the two eyes.

Fig.3.Feature Extraction

3.3. Distance Calculation:

The distance is measured between sclera and iris. Fig. 4 describes the distance calculation process, where D1=0.15mm, is the distance between iris and sclera at the left side of the eye & D2=0.15mm, is the distance between iris and sclera at the right side of the eye.

D1 D2

Fig 4: Distance Calculation

3.4. Emotion Recognition by HMM

Emotions are identified with the measurement of iris and sclera distance. Fig.5 gives an idea about six different emotions using the above mentioned process.

Distance Between sclera and iris	Emotion classification
(D1,D2,L1,L2)>0.3mm	Anger
L2=0	Fear
(L1=L2)<0.3mm	Happiness
D1>D2 ,D1<D2	Lateral movement of thinking
(D1,D2,L1,L2)=0	Sleep
D1,D2=0.3mm && L2=0,L1=0.1mm	Disgust

Fig.5.Emotion Recognition

Hidden Markov models have been widely used for many classification and modeling problems. One of the main advantages of HMM is its ability to model non-stationary signals or events. Dynamic programming method allows one to align the signals so as to account for the non-stationary movements. HMM finds an implicit time warp in a probabilistic parametric fashion. It uses the transition probabilities between the hidden states and learns the conditional probabilities of the observations given on the state the model. In the case of emotion expression, the signal is identified as the measurement of the emotion. HMM is given by the following set of

Parameters:

$$\lambda = (A, B, \pi)$$

A is the state transition probability matrix, B is the observed probability distribution, and π is the startingl state distribution. The number of states in HMM is represented as N. In the discrete case, B becomes a matrix of probability entries (Conditional Probability Table), and in the continuous case, B will be given by the parameters of the probability distribution function of the observations, normally chosen to be Gaussian distribution or a mixture of Gaussians.

Since the display of a certain emotion in video is represented by a temporal sequence of facial motions it is natural to model each eye expression using HMM trained for that particular type of emotion. There will be six such HMM, one for each emotion Anger**(1), Fear(2), Happiness(3), Lateral movement of thinking(4), sleep(5), disgust(6)** . There are several choices of model structure available that can be used for different emotions. The two main models are the left-to-right model and the ergotis model.

Otsuka and Ohya [7] ,used left-to –right models with three states to model each type of facial expression.

The advantage of using this model lies in the fact that it seems natural to model a sequential event with a model that also starts from a fixed starting state and always reaches an final state. It also involves fewer parameter, and therefore is easier to train. However, it reduces the degrees of freedom the model has to try to account for the observation sequence. On the other hand, using the ergotis HMM allows more freedom for the model to account for the observation sequences, and in fact, for an infinite amount of training data it can be shown that the ergodic model will reduce to the left-to-right model, if that is certainly the true model.

The observation vector for HMM represents continuous motion of the facial action units. Therefore, B is represented by the probability density functions (pdf) of the observation vector at time, t given the state of the model. The Gaussian distribution is chosen to denote these pdf, i.e.,

$$B = \{ b_i(O_t) \} \sim N (\mu_j , \Sigma_j), 1 \leq j \leq N$$

Where μ_j and Σ_j are the mean vector and full

Covariance matrix, respectively. The factors of the model of emotion expression specifies HMM are learned using the well-known Baum-Welch re-estimation principles. For learning, hand labeled sequences of each of the

facial expressions are used as ground truth orders, and the Baum algorithm is used to derive the maximum likelihood (ML) estimation of the model parameters (λ).Parameter learning is followed by the construction of a ML classifier. Given an observation sequence Ot , where t ε (1,T), the probability of the observation given each of the six models P (Ot| λj) is computed using the forward-backward procedure [8]. The sequence is classified as the emotion corresponding to the model that yielded the extreme probability, i.e.,

$c^* = \text{argmax}[P(O|\lambda_c)]$

$1 \leq c \leq 6$

4. EXPERIMENTAL RESULTS:

The above algorithms are applied on various face images containing the frontal view of the human face and the work is implemented using Java. Fig .6 displays the six different emotions.

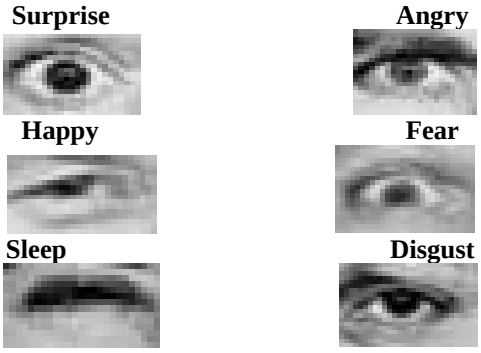

Fig.6. Sample emotions recognized with eyes

5.CONCLUSION:

Human computer interaction has its increasing impact in all applications and computers are a member in our day-to-day life. Non-verbal communication plays a crucial role during interaction of a human being. It can also be used as an input for HCI. Recent researches identified that the understanding and recognition of emotional expressions plays an important role In this work eyes are used as a non-verbal communicator to recognize emotions of users in HCI.

classifier to recognize the human emotions as it achieves good accuracy. Iris and Sclera distance is calculated for both the eyes and HMM is used to identify the emotion based on the probability of observed states. Six basic HMM is the dynamic emotions like **anger, fear, disgust, lateral movement of thinking, happy and sleep** are recognized with high correlation coefficiency. The proposed method can be used for any categories of users and is a non-intrusive method. The proposed method can be used for effective HCI to sustain user's attention towards their work across various areas.

Camera calibration is not made and Head orientation is not allowed. In future head orientation and eye-wear interrupts are to be concentrated to improve the accuracy.

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