Emotion Recognition: A Step Ahead of Traditional Approaches

Surbhi Agarwal, Madhulika Bhatia and Madhurima Hooda

Abstract Emotion recognition is an intriguing issue these days. It affects essential applications in numerous regions for example surveillance, defense, financial services etc. Determining a particular expression from face images effectively is a crucial venture. In this paper, we have demonstrated a novel approach to recognize emotions displayed in video sequences. The authors have considered seven basic emotions measuring factors: anger, fear, disgust, happiness, sadness, surprise and neutral. These factors are constantly encountered in our day to day life. The focus of this paper is towards contemplates a combination of extended biogeography based optimization algorithm, support vector machines and local binary patterns to obtain the best possible results.

Keywords Support vector machine · Biometrics · Feature extraction
Viola jones · Linear binary pattern · Extended

1 Introduction

Facial feature recognition has developed as a vital biometric procedure in issues like validation, access to assets, reconnaissance and so forth. The variability that exists regarding light, arrangement, emotion etc. makes this process a little cumbersome [1, 2]. Due to many similarities present on a human face, a good discrimination becomes tedious [3, 4]. Numerous strategies have been proposed and utilized as such. Contours are extracted by using various methodologies such as local feature matching, appearance based, knowledge based, feature based, template matching and holistic matching methods. Template matching methods center their focus on

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intensity of the pixels. In this paper a novel approach by combining many methodologies has been proposed. This aims at utilizing the best traits of every mono approach that has been used in the combination. The prevalent expressive capacity present with human beings is natural. This gives them a standout amongst even the most capable, dynamic and adaptable methods of expressing ourselves. The framework introduced in this paper identifies frontal faces in the video sequences based on the seven basic emotions mentioned above. These emotions are used to express our feelings along with a continuous comprehension of the data that is passed on [5]. We have used support vector machines to classify the expressions in the video sequence belonging to Cohn kannade database [6]. With the use of optimization algorithm the person whose emotions are being judged is also detected.

1.1 Applications of Face Recognition

1.1.1 Law Enforcement and Justice Solutions

To beat world's ever-advancing criminals, today's law enforcement agencies are seeking for innovative technologies, so as to stay a step ahead of them. FRS holds the charge of developing technologies that can make the job of a law enforcement officer easier.

2 Techniques Used in the Framework

2.1 Extended Biogeography Based Optimization Algorithm (Extended BBO)

Extended BBO is an expansion to BBO calculation that was created by Simon [7, 8]. In BBO the immigration rate i.e. the rate at which the island is betrayed and resettlement rate i.e. the rate at which island gets swarmed are considered [7]. In extended BBO as proposed by [8] extra parameters have been presented, for example, suitability index variable (SIV), habitat suitability index and fitness value, distance calculation, extinction rate, dependency factor and relevance factor [8, 9]. The features are attained as per the SIV. Distance calculation compares to the measure of Euclidean separation. Relevance factor kills the hesitant and undesirable features from the face acknowledgment process [8, 9].

2.2 Support Vector Machines (SVM)

Support vector machines are utilized for universally useful pattern acknowledgment [10]. It characterizes the information by utilizing an induced function called hyperplane which meets expectations by making an edge between the distinctive groups. The edge is a set of those pixels which exists between object and background, object and object, region and region [11]. The information to be gathered can be paired or multiclass. The hyperplane not just guides in conveying the danger of misclassification to a base, additionally functions admirably for untrained specimens fitting in with the test set [10]. In this paper SVM has been utilized for binary arrangement.

2.3 Linear Binary Pattern (LBP)

LBP is based on template matching method [12]. Human face dependably comprises of a few features that are more expressive than the others e.g. eyes, lips and so on [13]. Consequently on the off chance that we see the face picture as an arrangement of pixels, then feeling acknowledgment will be more reliant on a few pixels and less subject to others. LBP meets expectations by characterizing a picture regarding pixels. Each time a 3 × 3 area is considered. The center pixel is thought to be the threshold. All the neighboring pixels having a worth more prominent than this limit are numbered as 1 and the pixels having esteem not exactly the edge are numbered as 0. Consequently a string of paired digits gets produced. Utilizing this twofold string a shifting recurrence of 1's and 0's is acquired. Eventually either the centralization of 1's is more than 0's or the other way around. Subsequently a histogram is produced as need be. These histograms help in the partition of diverse features from the face [14, 15]. Further, by normalizing the histograms highlights are removed to fill the need of classification (Fig. 1).

2.4 Viola Jones

This algorithm is utilized to recognize confronts (faces) continuously at a rapid [16]. It incorporates inside itself the advantages of Adaboost and cascade classifiers. The cascade classifier property empowers the segregation between highlights, for

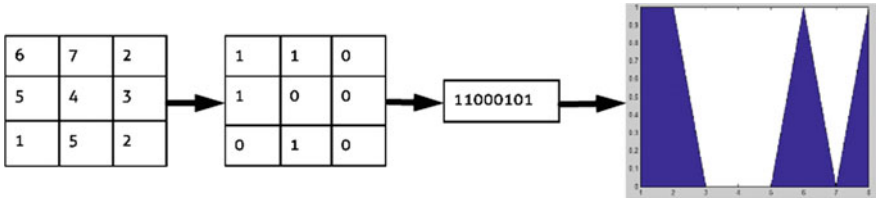

Fig. 1 Example of LBP

example, nose, eyes, lips and so forth. Adaboost scales the execution by having the capacity to characterize the information that has been misclassified by other calculations by investigating the frail base classifiers. E.g. given a chance, say one needs to distinguish a face initially embedded into a background. Viola jones calculation helps in identifying the face by taking out the undesirable data i.e. background. Progressively it comes down to finding the sharp features, for example.

3 Experimental Setup

We isolated the whole process into the accompanying stages that run parallel. Cohn kannade dataset was used for training and testing. Some sample images of the video sequences belonging to cohn kannade dataset are as follows (Fig. 2).

3.1 Phase–I

The pictures of Cohn kannade dataset are passed through Gabor kernels which redress the alignment and enlightenment of the pictures subsequently issuing them a proper orientation. Further, it is passed through principle component analysis for ideal extraction of highlights (features). For a considerably more precise highlight extraction the pictures are passed through extended biogeography based optimization algorithm. At this stride the pictures get prepared and store the outcomes.

Fig. 2 **a** Anger. **b** Disgust. **c** Fear. **d** Happy. **e** Neutral. **f** Sad. **g** Surprise

We can later on pass an untrained picture and the distinguishing proof of its right subject will happen [9, 16, 17].

3.2 Phase–II

The second stage lives up to expectations in parallel with the first stage by applying viola jones calculation on the dataset. Viola jones crops the coveted piece of the picture by taking out the pointless foundation. Linear binary pattern creates the histogram and permits the highlights to be prepared by classifier. Ultimately support vector machine trains the chosen pictures with the edited part by performing a binary classification utilizing its hyper plane. The untrained pictures are tried later on [13].

3.3 Phase–III

Stage III goes about as a connector between the beforehand portrayed countenances. In this stage we can utilize the untrained pictures to focus the exactness of the structure. When the subject under test is dictated by extended BBO, the face is sent to the system trained by SVM. At long last with the assistance of stage II the expression of the face is distinguished. Subsequently stage I decides the subject (out of the 40 subjects) that is being tried by lessening the time. Stage 2 prepares the system for deciding the articulation of that subject. Stage 3 is utilized to check the accuracy (Fig. 3).

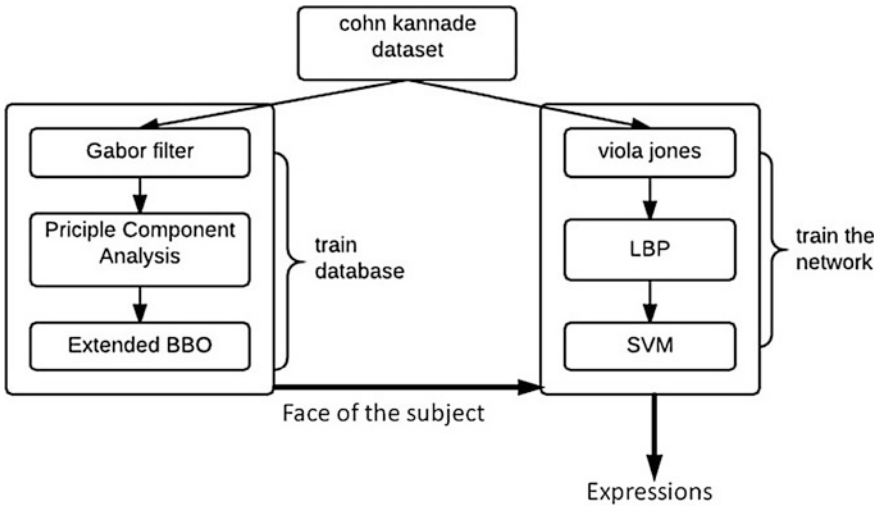

Fig. 3 Block diagram for experimental setup

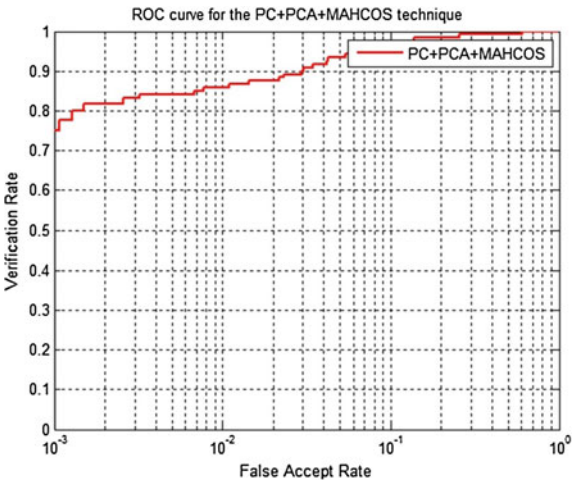

Fig. 4 ROC curve

4 Results and Discussion

The Cohn Kannade database utilized comprises of 40 subjects. Every subject contains numerous pictures displaying different emotions. We have restricted our database to 10 pictures in every subject. Training has been performed on 9 pictures of every subject leaving one untrained picture in every subject. On testing the tenth picture for its declaration the outcomes received are as indicated in the subsequent tables and curves.

4.1 ROC Curve

To show effectiveness of face acknowledgment calculation in view of extended species abundance model of biogeography an ROC bend has been plot in Fig. 4, with confirmation rate at Y pivot and False Rejection Rate at X pivot. Productivity can without much of a stretch be seen at the beginning stage in results, it can be plainly demonstrated that preparation database with Extended BBO outflanks the approaches used without extended BBO. Result acquired from methodology demonstrates high check rate than by only Gabor and PCA calculation (Tables 1, 2 and 3).

Table 1 Techniques used in the framework

Comparison	Support vector machine	Linear binary pattern	Viola jones
Proposed by	Vladimir N. Vapnik, Corrina Cortea in 1993	T. Ojala, M. Pietikäinen, and D. Harwood in 1994	Paul Viola and Michael Jones (2001)
Approach	Supervised learning approach	Texture spectrum model	Integrates Adaboost and cascade classification
Application	Text categorization, bioinformatics, hand written character recognition	Image retrieval, visual inspection, motion analysis, environment modelling	Face detection, object detection
Limitations	Inseparable data cannot be classified by SVM	It does not specify any methodology to improve accuracy by some more percentage under high localization errors	It does not work very accurately for side face detection. Moreover the results get altered in the presence of very high or very low lighting effects
Usefulness	It eradicates the problem of overfitting. It is a non-probabilistic binary classifier that works well for extracting emotions in a face image or text	LBP exhibits a robust nature. It is independent of gray level variations in the image. Results generate are appropriate even in the presence of localization errors but with a margin of improvement	It scales the features by keeping the image size constant as it only crops and enlarges the wanted segment. This algorithm gives a better efficiency in less time for extracting features

Table 2 Confusion matrix

Emotions	Anger	Disgust	Fear	Happiness	Sad	Surprise	Neutral
Anger	*60.2*	4.2	23.4	0	0	5.2	7
Disgust	5.2	*80.19*	2.7	0	0	12	0
Fear	1.2	20.4	*58.3*	0	15.1	5	0
Happiness	0	0	0	*95*	0	5	0
Sad	0	16.2	1.2	0	*68*	14.6	0
Surprise	1.2	2.4	0	2.2	0	*94.2*	0
Neutral	8.2	0	0	0	0	0	*91.8*

Table 3 Average confusion matrix

Emotions	Neutral	Positive	Negative	Surprise
Neutral	*91.8*	0	8.2	0
Positive	0	*95*	0	5
Negative	1.75	0	*89.05*	9.2
Surprise	0	2.2	3.6	*94.2*

5 Conclusion

Separating emotive data by advanced instruments gives the security framework a help. Henceforth we have shown expression recognition using optimization and classification algorithms. The mix of procedures that have been utilized in the paper live up to the expectations precisely on the database used. To affirm its precision on continuous feature successions multiclass support vector machine must be connected on the image set. Stage 1 and stage 2 can work autonomously and produce results for their particular capacities. Subsequent to consolidating the two stages and building a scaffold between them as specified in the stage 3 a more enhanced working with better results is created. In the future work the centre will be fixated on enhancing the computational unpredictability. The accentuation will likewise be laid on a decent joining of voice and motion acknowledgment alongside expression location.

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