FaceApp

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Dedication

First of all, we dedicate our project to

Allah Almighty and to whom the world

owes its existence Muhammad (Peace

Be upon Him)

This humble effort is

dedicated to our

beloved parents who

brought us to the level

of excellence where

we are studying today

looking for most

Promising and

gleaming future ahead

for which they

scarified most of the

Time of their life

&

To our respected and

genius teachers who guided

us throughout academic

career!

And all those people

Who have remembered us in their prayers!

A lot of thanks for all my teachers!

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In the last but not the least, special gratitude with the deepest sense of respects to our parents whose love and affections kept us steep fast and enabled us to attain targets and goals of academic life. The authors are extremely indebted to their brothers and sisters whose constant encouragement provides us with the impetus that was necessary for attaining academic initiatives.

Executive Summary

Purpose of study is to develop an efficient method to recognize facial expressions more efficiently especially for different cultures. Human interact verbally and non-verbally, but facial expressions play key role in determining the verbal communication also. This lot of information through nonverbal communication is not considered in previous human-computer-interaction. A system is needed, which can detect and understand the intents and emotions as stated by social and cultural pointers. It is a need to develop such a system that deals with correctly identifying emotions and expressions so that further actions can be taken accordingly. Facial expression classification is also atypical task because it will lead to accurate training of classifier. There are various methods to detect extract and classify expressions, but the database used with them is not enough to train the data with different culture expressions. There is need to develop such database that will cope with such variations. FER is not as simple because different cultures may have different meaning of some facial expression. They may respond differently on same input and may have different expressions for happiness, surprise or anger. We will use neural networks to train our data and develop multicultural database to deal with such variations.

Keywords: *FER, multicultural database, neural networks, nonverbal communication, facial expression classification*

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CHAPTER 1

INTRODUCTION

1.1 Background

Facial expressions have been known as the "general language of feeling," yet people from different societies look glad, angry or sad facial expressions in new manners, as shown by modern research supplied by the “American Psychological Association”. A psychological portrayal of a facial appearance is the picture we find in our 'inner being' the point at which we consider what a dreadful or glad face resembles. Interaction is basic need to people. Numerous logical researches indicated that the greater part of the human correspondence is through nonverbal communication.

The examination found that the Chinese depends on the eyes more to speak to outward appearances, while Western people depended on the eyebrows and mouth. Those social qualifications could prompt missed prompts or confused signals about feelings during culturally diverse interchanges, the investigation detailed. Emotion recognition from confronting images has attracted wide tending in a broad chain of Human Computer Interaction (HCI) uses such as robotics, educational fields, biometric systems and health informatics. Giving computers the content to understand human users' states is key for spontaneous human-computer interaction within these applications [23].

Articulation acknowledgment is an errand that people perform every day and easily, however it isn't yet effortlessly performed by PCs, regardless of late techniques have given correctness bigger than 95% in certain conditions. The calculation of facial terms is not simple task for machine learning techniques, as persons can show the manner, they portray different expressions. Still image frames of the only individual can vary for one facial expression in sense of light, background and posture.

There are many hindrances in determining (FER) because of variety of facial expression among different cultures and deviation even for same individual. Still, we human may get to errors [2]. Then again, FER by computers is exceptionally important in several applications, for instance, human being conduct understanding and human-PC between face [3]. Facial appearances are of two kinds; unconstrained and presented. The present examination demonstrated that these two kinds of articulations are distinctive in numerous viewpoints.

The components for example, lighting, present, head position, social varieties and so on make unconstrained articulations increasingly troublesome and testing to perceive. The target of the investigation is to build up a framework that is sufficiently strong to such varieties [2]. Among the biometric systems, Face Recognition system is the one which can bring spontaneous things which means that it can operate without any contact with the subject. Despite its speediness and acceptance amongst people, it has still disadvantaged in accuracy if related with other types of physiological forms. In this research, three pre-processing techniques will be applied to the face recognition system in order to get better accuracy. Moreover, these three techniques will be applied separately and combined with different feature extraction parameters [39]. There are many explanations for current improved concern in facial recognition, mostly people are concerned with security, the requirement for identification in the current situation in digital world, facial expression examination and modelling methods in data organization in software and computer entertaining. Facial recognition, including main components such as detection of face, tracing, arrangement and extraction of features, and tackling issues of erection of a face recognition system [38]. Face detection of face is major to all facial analysis techniques, including face position, alignment, illumination factors, and gender recognition, glass no glass. Focus of detection techniques are detecting facial or non-facial regions. It may be easy task for human to detect faces but it may be difficult for computers to identify 100% accurately with all limitation of light, background, poses, positions, age factor, wrinkles etc[24]. Presented or impulsive expressions: Face expressions can be extensively separated into 2 classifications, presented appearance dataset and natural face appearance datasets. The posed outward appearances are frequently gotten by training on-screen characters to play out a particular facial appearance, and spontaneous outward appearance is regularly caught while having the subject watch a video. SVM helps in classification of facial expressions. It uses geometric and algebraic operations for extraction of high dimension feature to isolate input data images into a high dimension featured space using selected non-linear kernel function, and learning algorithm shaped for its help. A specific radial-basis function useful as kernel in this paper. Facial hairs, glasses or any disability may affect the correct facial expression recognition, to cope with these will be a challenge for future work. Geometrical based extraction of feature consider nose ,mouth, eyebrows and other face constituents and in case of look based feature extraction exact area of face is required. The

main segment in facial expression recognition is face detection, which is used to identify either there are any faces in the image or not and, if there exists, return the position and the size of each face .While face identification is a minor for human eye detection, it is a challenge for computers because of deviations in scale, position, alignment, posture, facial appearance, illumination, and many exterior features (like glasses, face hair, makeup.)[21]. Now study has recognized by various safety providers such as palm biometric, finger print services and different bio-metrics. The face biometrics are much safe because of its different features which provides benefits over other biometric applications that is fingerprint and palm identification [31]. The face expressions are firm signals of larger communication. Oral connectedness implementation act between frail and animals via eye contact, motion, facial expressions, embody communication, and paralanguage. Eye occurrence is the big point of communication which provides the motley of ideas. Eye happening controls the effort, discussions and creates a statement with others. Tackling expressions let the grin, sad, feel, revolt, surprise, and awe. A grinning on anthropoid surface show the pleasure and shows eye with a fusiform work. Sad demo is the somesthesia of looseness which may normally said as travel tilted eyebrows and grimace. The angriness on hominid play is a final to forbidding and uncomfortable conditions. The manifestation of choler is verbalized with enfolded eyebrows, slim and extended eye-lids. The sicken expressions are uttered with deplume medico eyebrows and crinkled smell [24].

Figure 1:"Diffferent facial expressions for FER system"

1.2 Problem statement

Facial expression recognition are very easy for humans but in case of computers it's a difficult task to develop a reliable and accurate system is much difficult and challenging .But one advantage is that people have different faces that is unique so it's an advantage to determine each person identity. Although people can likewise appear to be identical, however no two individuals are the equivalent. Then again, from the point of view of facial appearance acknowledgment, calculations should be powerful and complex enough to comprehend the face data. Some face surface properties are known (they have two eyes, a nose, a mouth, and so forth.), the structure and surface of a specific face should be learned. Facial appearances are mostly not clear and separated. Facial appearance acknowledgment, which incorporates facial picture examination, is talked about in unstructured or uncontrolled condition (realistic world). In a perfect world, we might want to gather unconstrained information in genuine conditions. Shockingly, most openly accessible information doesn't consider in such a reasonable setting, however, shows face pictures taken in research facilities and workplaces where lighting is controlled, and individuals are continually looking legitimately into the camera (Zeng et al. 2009). Albeit, a few endeavors have been made to build naturalistic databases yet they despite everything have numerous impediments alongside publicly availability issues.

The usage of cross-cultural databases of facial appearance is difficult and complex task, because in every culture there are different meaning of facial expressions that are difficult to recognize. Construction of cross-cultural database is an important task, as there is no such database that is capable of dealing with such variations. We will try to construct a database that can cope with such problems.

1.3 Objectives

- To improve the knowledge of computer vision and artificial intelligence techniques.
- To develop such a multicultural data base that will help to train neural network.
- To cope with variations created through multi-cultural expressions.
- To develop a computationally efficient ensemble model that will give better results.

- To develop an ensemble learning algorithm for FER that give high accuracy.

- To weigh up the performance of proposed system for cross-database assessment and posed versus spontaneous expressions.

1.4 Significance of the study

- Human facial appearance estimation is difficult job and it plays key role in people relations, extraction of these emotions has high significance in human and computer communication.
- Help to identify cross cultural facial expression recognition.
- Thus, helps to automate facial expressions depicted in videos, images etc.
    - Using facial expression recognition business can evaluate images of people from different
    - Cultural background.
- Monitoring videos in real time that will increase performance, thus saving cost and making life much better and easier.

1.5 Research question and hypothesis

- What are the differences in different techniques of facial expression detection and classification?
- Which techniques perform better in specific scenario?

- How to develop such system that will deal with such facial expression variations.

- How to develop a multicultural database that yields best possible outcomes

H1: A multicultural database can be developed.

H0: A multicultural database cannot be developed.

1.6 Structure of the Dissertation

Chapter 2 surveys going before business related to bibliometric, examination of logical exploration developments. Chapter 3 characterizes assortment of information and

approach. Chapter 4 shows results and 7onversation. At last, chapter 5 shows ends and gives a few proposals for further work.

1.8 Limitations and scope

There is no standardized database available for facial expression classification that is a true Fuzzy representative of all such variations, and it is still an open problem. The research will provide accurate recognition of facial expressions using classifiers and multicultural database. This research includes only frontal faces with no illumination variation and occlusion on face.

CHAPTER 2

LITERATURE REVIEW

Convolution neural network along with special preprocessing technique is used, using public databases (BU-3DFE, CK and JAFFE). A study shows that there are no such databases that can cover facial expressions with deep architecture [1].proposed an incremental model that has capability to adjust for different environment. A dynamically weighted majority voting (DWMV) suggested for generalization for ensemble systems for real life scenarios. Generative Adversarial Network, Convolution neural network, Deep Auto encoder (DAE), Recurrent Neural Network (RNN), Deep belief network, are used for feature learning. For classification CNN is used that regulate the error by adding a loss layer to end of network [4].A pattern averaging technique used for dimension reduction that improves system speed. PAT take average of matrix and give result by reducing matrix dimensions, after that classifier is applied. SVM classifier is efficient than previous classifiers and have an accuracy of approx. 90.17% on JAFFE, 93.34% on Cohn Kanade and 96.16% on MMI datasets. Two types of features that are geometry based and Gabor wavelet extracted from face images and an architecture developed reveals that Gabor wavelet transformation is more efficient than geometric based positions [3].Paper uses Eigen vector along with Euclidean distance technique for facial expression recognition. Neural networks then classify and train data. only 30 images used for 6 expressions Anger, sad, disgust, surprise, happy .MLP shows better results compared to decision tree and SVM.it uses back propagation to train the network [6].There are several techniques used for preprocessing the images but ROI is found to be more useful .Its accuracy is 99%.Databse used for recognition is mostly JAFFE and CK for comparison of performance. For feature extraction GF is suitable as it simpler and less complex than other. For classification SVM is found best by comparison as it has highest accuracy [2]. Posed facial appearance images, technique of grid tracking and distortion for maximum geometric deformation of facial area and use Support Vector Machine to classify and have best results and has good performance recognition that is up to 99.7% and probably the best on Cohn Kanade database. Practicality, real time and accuracy are the different dimensions used for comparison [8]. Area of interest eyes nose lips extracted through template matching technique and distance of eyes and mouth measured to detect whether face is smiling or not. PCA algorithm is used to match sub regions against sub patterns. Classification is done using k-nearest neighbor [9]. We learn how machine learning methods, e. g convolution neural networks, can progress the Facial expression recognition correctness in biometric applications. In our analysis, we have tried

to locate a productive arrangement equipped for improving the acknowledgment precision. It is found that this type of answer can be found using (CNNs). Having described our procedure, it is found that the suggested method increases the results to 91. 2% on the FER 2013 information that include original face images associated to seven face appearances classes [10]. Analyzing the confusion matrices, CAM effects and classification accuracy based on three databases (RAF database, FER +and ExpW data), we can number out over-all approaches for different expressive expressions. Area around mouth shows more information of facial feelings, particularly for the happiness disgust and normal. The surprise emotion is more readable through eyes [11].Survey on different techniques for facial expression detection, extraction and classifier is made to detect the accuracy and performance with number of emotions [12].Model parameter initialization CNN with activation function, initialization of model parameters cope with problem of over fitting in neural networks and overcome problem of bad recognition due to improper parameter initialization. CNN used for collection of images and LSTM for training. It associates BU-3DFE, CK, FER2013, JAFFE and Oulu-CASIA facial expression databases [13]. Relative study of diverse techniques for extraction and detection Gabor function with Support vector machine classification has accuracy of 99% and classify facial expressions like sad, anger, fear, happy and neutral [14]. Huge amount of memory and processing are obligatory to process image. More appropriate substitute of this problem is the geometric features. The facial landmark detection deployed for feature extraction and “CNN” for Classification purpose [15]. “Western” and “Eastern” face emotions. Built on trial outcomes, it is decided that alike mental findings, the planned “FER system” offers in set advantages, whereas “WSN” facial expression recognition are easiest to classify than “ASN”. Additionally, measureable and non-measurable study shows, fear and hate are cultural specific, whereas other expressions are known by diverse environment. “LFC” and “Facial Fourier Descriptors” used for feature extraction and SVM for categorizing [17]. Preprocessing is done to sense the exact region of interest so that extraction of face completed easily. Using dataset then use CNN for training of that dataset. Train network with epoch’s size and size of batch is 100. Accuracy rate of 70% percent was attained. After that when we improved the epochs to 200 accuracy increased to 72% and with epoch size of 300 accuracy rate is 78% [18]. Firstly proposed model concerns with extraction of local aligned facial patches. The face landmarks are used to confine and to represent main areas of face (eyebrow, mouth nose,

eyes and jawline). Landmark detector for facial expression of Kazemi et al., 2014. In this technique, a fully differential technique based on a cascade of decision boosted forests to lapse the location of landmarks from a sparse set of pixel strengths is performed. Aliment is performed with respect to position of eyes. Specific features are learnt at every patch using different sub-networks and the concatenate layer sum up all sub-networks together [19]. Generally work done in order of articulations pick classes of seven articulations that is similarly simple to work with, however can just recognize a confined number of outward appearances, and can't determine the degree of articulation. Strategies are a lot of reasonable while considering the issues existing in true circumstances, similar to pose changes, brightening with losing precision [8].Survey on different FER procedures are examined. The assessment of different FER techniques depends on the absolute of articulations unsurprising and calculation's multifaceted nature. Return on initial capital investment method gives precision of 99%.Gabor Filter gives great exactness between 82.5 t0 99% yet SVM classifier gives the most noteworthy precision pace of 99%.JAFEE and CK information base is by all accounts more proficient data sets in performance [20]. The paper clarifies various strategies that are examined and thought about. From hypothetical investigation and correlation and zeroing in on the principle restrictions, hear like element extraction face identification approach is end up being excellent methodology for face location. Highlight based, mathematical base and haar like highlights are analyzed. Highlight base have low execution time and are more exact, mathematical based are anything but difficult to actualize while haar based have more improved element extraction part [21]. Viola-Jones, neural networks SVM and “Successive Mean Quantization Transform (SMQT) Features” and “Sparse Network of Winnows (SNOW) Classifier Method” are analyzed dependent on exactness and review boundaries. It is discovered that viola jones end up being best face identifier among other thought about .The best is of viola jones for face detection[22].Discussing Speediness and consistency for face detection from an image and calculates total of white and black rectangles and the calculate ratio and only use the best features unlike previous algorithms. Such features are well in recognizing black and tilted faces [23].Features in image may be damaged due to light intensity, noisiness and obstruction. Boundaries of features can be decorated or shadows of image may cause strong edges while shadows which may cause many algorithms inadequate in case of feature based approach, but it’s easy to implement. Using Geometric based approach, it’s

difficult to implement and dimensions are usually reduced to save computation [24]. A new approach to facial expressions recognition is discussed called DSST, which is primarily based on shear let transforms and normalized mutual information feature selection. Firstly all the images are preprocessed and then apply “Discrete Separable Shear let Transform”, all transformation coefficients are obtained. Thirdly an improved standardized data include choice is applied to discover best highlights. At that point highlights are diminished utilizing Linear Discriminant Analysis and finally SVM is utilized to order includes for acknowledgment. Exactness pace of the examined calculation is 96.63%, [25]. The talked about strategy applies Contrast Limited Adaptive Histogram Equalization and Fast Fourier Transform methods to reward the awful light impacts. At that point combined paired example code is created for every pixel. Two pieces for every areas and produce 16 cycle code for every pixel, it consolidates nearby highlights to improve viability of face acknowledgment. MBPC descriptor capture varieties along adequate edges and recognizable framework round eyes foreheads, mouth, eyes, swellings and wrinkle lines of the face. The results of gave strategy are broke down different choices of Local Binary Pattern and LGC based procedures for both drafted and comprehensive pictures. For experimentation Static Face Expression in Wild dataset is picked. MBPC plainly give preferred execution over different strategies with 67.2% and 96.5% exactness for division based and comprehensive methodology separately. Comprehensive strategy has much preferred outcomes over division based method [26]. Another procedure utilizing Histogram of Oriented Gradient highlights are removed both for the challenging picture and for the preparation pictures and arranged utilizing Support Vector Machine. This procedure is dissected with Eigen face acknowledgment strategy and thought about .The examined method and Principal Component Analysis are tried on eight datasets. At the point when the consequences of proposed procedure are contrasted and Eigen face acknowledgment then it is discovered to be empowering. An upgrade of 8.75% in facial acknowledgment contrasting and Principal Component Analysis calculation. ORL information base is utilized for preparing reason. Three assessment boundaries to be specific CMC, EPC and ROC are thought of. The boundaries shows that the proposed calculation beats PCA calculation [27].The nearby slope ternary example is proposed in this paper and effective increment in identifying light varieties variety and clamor. Pre-handling is improved in this method and Scharr angle administrator is utilized .Dimensionality decrease is finished utilizing head part

examination. This strategy minded CK+ information base and JAFEE and end up being more exact and productive than past ones [28]. Rippled transform is utilized for include extraction as it is acceptable in edge identification and surfaces portrayal. At that point LDA and PCA are utilized to extricate highlights for more precision and conservativeness. Outspread Basis Function alongside Least square variation SVM is utilized .JAFEE and CK+ are utilized as datasets [29].Analyzing the basic strategies of steady learning on fluctuated, static and non-static datasets. It gives a brisk review with respect to the principle credits of the distinctive arrangement of considered methods. SVMs give commonly greatest precision at cost of the most intricate one. LASVM diminishes the preparation time and perform for bigger informational collections contrasting and ISVM.ORF execution is more regrettable however its preparation and execution time is significantly less. ILVQ nearly offers a decent option contrasted with SVM's. SGD and NB are acceptable decisions for enormous scope learning. NB and tree based techniques are anything but difficult to apply. SVM and ILVQ request delicate settings [30]. The practical effects of three techniques on different datasets are better but best accuracy of 98%is attained using Viola jones. Viola-Jones with FEI Dataset is accurate when experimental results are detected among all three databases. For the front face recognition Viola-Jones techniques is much accurate among all techniques and attained improved results on three databases [31]. Similar examination of two element extraction techniques for face acknowledgment LDA and PCA on various boundaries outward appearance, light varieties and individual wearing non glass or glass for front face pictures. Utilizing Yale information base LDA performs effectively, Recognition pace of 74.47 % is accomplished with preparing set of 68 pictures and 123 pictures are perceived out of 165 pictures. Facial Recognition recurrence can be improved that incorporates the full front faces utilizing LDA and PCA. Face acknowledgment ratio can be enhanced with mixture preprocessing strategy for PCA and LDA. PCA and LDA joined with different strategies LBP, DCT, DWT and so forth can expand the face acknowledgment rate [32].Histogram-put together nearby descriptors utilized with respect to Facial Expression Recognition (FER) for fixed pictures and gives capable audit and investigation. To start with, we portray the principle steps in encrypting parallel examples in a neighborhood fix, that are compulsory in each histogram-based nearby descriptor. All out, 27 nearby descriptors applied on 4 information bases, utilizing similar situations. Quality of the specific nearby descriptors is checked under various circumstances, for example, changing picture goals and number of

sub-regions, and classifiers. As indicated by the complete investigation it shows that the top neighborhood descriptors for Facial Expression Recognition, by checking the full length, computational expense, and the classification exactness all at same time, is LPQ[33].A new face trimming procedure is utilized alongside CNN to eliminate pointless locales. To normalize the facial picture, histogram balance, Z-score standardization, and down-inspecting were useful. To improve dataset size during the instructional meeting, even flipping and irregular turn were performed. Extended preparing dataset were utilized to prepare the CNN, and the best Convolution Neural Network model was spared. While testing stage, standardized testing pictures (without development) were sent to the CNN model from preparation stage for estimate. Basically, forehead of picture is edited to improve productivity sing open cv.CK+ and JAFEE information bases are utilized. On JAFEE information base outcomes are 98.12% [34].A new descriptor called Local gradient Neighborhood was proposed, it comprises of two main things feature extraction and recognition using mapped interval. The goal is to have a high recognition but low expense. The relation of gray levels of the neigh- boring pixels is considered in Local Gradient Code (LGC).The center pixels and neigh- boring pixels relation is checked in LBP. The paper proposed method that combines LBP and LGC qualities to form a Local Gradient Neighborhood .It unites the relation of gray levels of the neigh- boring pixels and center pixels with neighboring pixels .Using SVM and KNN as classifiers. Results shows that SVM outperforms KNN. Proposed method with KNN achieves accuracy of 72.38% with JAFEE dataset [35].The technique combines boost decision tree with NN. Decision trees are trained to extract local binary features. With limited resources this model helps boost up speed and accuracy rate and make it best for limited resources environments. Using Shallow neural networks joint classification contributes to correct classification of difficult expressions [36].The faster R-Convolution Neural Network is used. Features are automatically separated by network using training dataset unlike the traditional feature extraction techniques. Experiments using such technique gives better rate of accuracy. Chinese Linguistic Data Consortium (CLDC) is use, comprising of cross cultural expressive aural and videotape dataset. Value of map is 0.82.Using trainable convolution network implicit features are extracted. Maximum pooling for facial dimension reduction and Classifiers like Softmax and regression layers are used [37].Classical facial expression algorithms are inadequate as they fail to represent faces when there is high variation in light. Artificial Neural Networks are

good in recognizing faces with little occlusion but its disadvantage is that it requires large number of training dataset images. Different biometric applications support Gabor Wavelet, the disadvantage is high dimensionality in features. Approach is unsuitable for real time applications. Face descriptor based approaches are discriminative and vigorous for light variations and deviations in expressions. They deal with compact, easy extraction and are extremely high discriminative descriptor. The disadvantage of 3 D based face recognition is that it is computationally expensive and not suitable for real time situations [38].The accuracy of recognition is enhanced by preprocessing techniques but time is still a big challenge. An Enhanced Face Recognition System is proposed that uses LBPH technique.in experiments LBPH techniques are changing with preprocessing techniques to achieve high rate of accuracy for different databases.98.5% rate is achieved but time is still a hurdle as it keep on increasing with increase in images in database [39]. The analysis is basically built on gesture, activity and facial expression recognition as they are vital for expression recognition. These 3 fields are then divided into standing computing methods. Haar features is a good substitute for expression recognition. In facial expression recognition, LBP is most standard choice. The explicit benefits of the analysis are: it offers a good analysis of computational methods for gesture, activity and facial expression recognition .This also comprises both kinds of approaches which comprise particular human and also several human actions. It gives a transitory report of standard databases deployed for activity, gestures and face expression estimation [40].

Ref #	Pre-processing +detection	Feature Extraction	Classifier	Database
[3]	Viola Jones	Pattern Averaging	SVM	JAFEE (90.17%) CK (93.34%), MMI (96%)
[1]	Viola Jones	SURF	Incremental based classifier	
[15]	Viola Jones	Facial Landmarks	CNN	JAFFE, MUG, CK, MMI (84%, 89.19%85.42%84.33%)
[16]	Viola John's Template Matching	Edge Detection	-	CK+ and JAFEE
[17]	Viola Jones	Local Fourier Coefficients and Facial Fourier Descriptors	SVM	MUL,ANDI,ASN,WSN
[4]	Viola Jones	Pattern Averaging	SVM	Cohn Kanade, MMI and JAFFE (96.16%)
[18]	Detection(HOG+SVM),Histogram Equalization, duplication of data using various filters, image resizing	Convex hull	CNN	-
[9]	Eigen Faces	Facial Fourier Descriptors and Local Fourier Coefficients	SVM	-
[11]	_	Dlib(Hog +linear classifier)	-	FER+ database, RAF-DB dataset and the ExpW dataset
[6]	Eigen Vector	Euclidean distance	MLP, SVM and J48 decision tree.	SVM 50% and J48 decision tree rate is 70%.
[41]	_	HOG+LBP	_	Yale , Wild (LFW) and AR
[7]	ROI segmentation	Gabor Filter	SVM	JAFEE,CK
[28]	GLTP	Scharr gradient operator, principal component analysis (PCA)	SVM	CK+JAFEE
[29]	Viola Jones	ripplet transform	LS-SVM+RBF	CK+JAFFE

		type II (PCA)+(LDA)		
[35]	-	LGN	SVM+KNN	JAFEE
[36]	-	ensembles of decision trees creating sparse binary feature vectors (LBF) and a shallow neural network	CNN	CK+, MMI, JAFFE, and SFEW

Table 1:"Comparision of state of the art methods"

Chapter 3

Data Collection and Methodology

In this chapter proposed method is described. Fig 5 Shows the basic steps involve in Facial expression recognition are preprocessing, feature learning /extraction and classification.

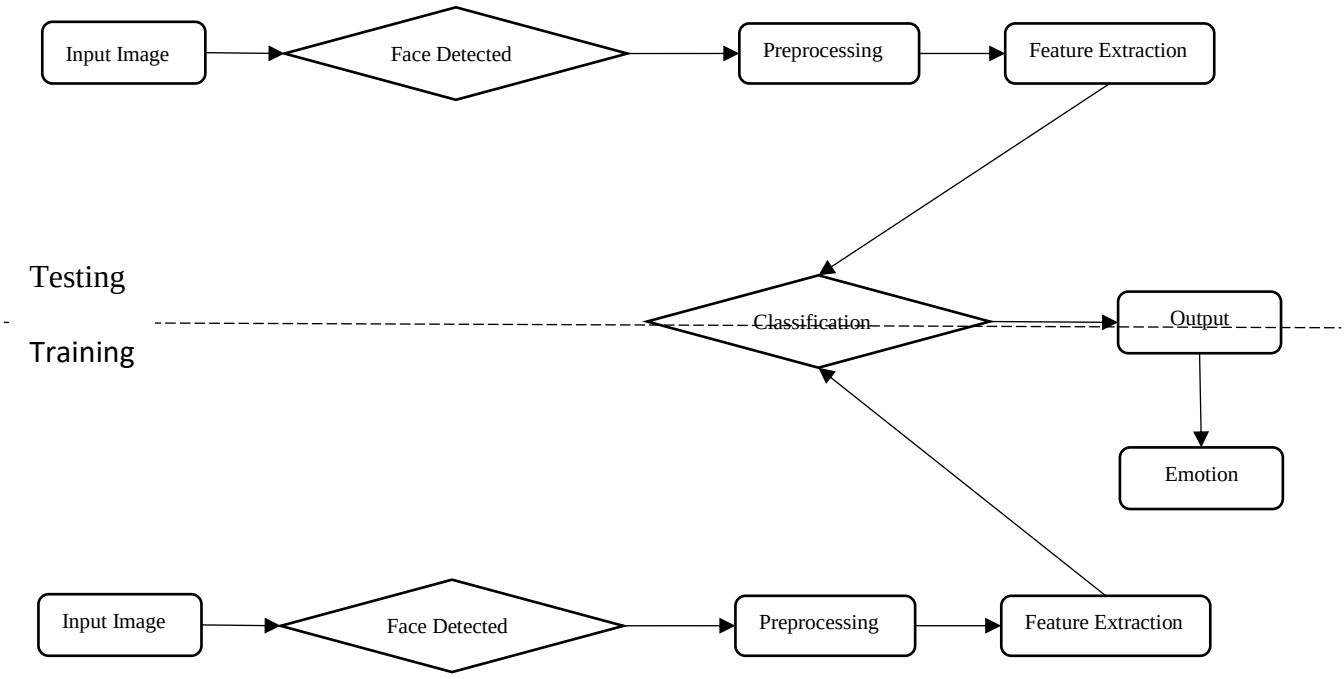


Figure 2: "Basic Flow diagram of FER technique"

3.1 Pre-processing:

It is necessary before training neural network that irrelevant data such as light, head postures etc. It's necessary to normalize the information conveyed by the facial expression. Pre-processing involves various steps i.e., adjustment of light, contrast, removal of noise, clarity in image, scaling, cropping etc.

3.2 Face detection:

Face recognition is trivial task. Some previous work done like viola john's 2001 and Rowley 1998.But for changing environment and complex condition its bit difficult. Detection techniques may be knowledge based, templates based, appearance based, and feature

based. Knowledge based technique involves knowledge of human being and face detected according to knowledge about appearance.in Template based technique some templates in database are matched to detect. Appearance based technique involve training of network to match for desired one. For face detection we used Viola Jones face detection algorithm.

3.2.1 "Viola Jones" face detection technique:

This face detection method is only structure that is built on entity detection which offers degree of best accuracy in real time and is presented in year 2001 by "Paul Viola & Michael Jones". Viola Jones face detection algorithm was implemented in 'Matlab' using vision method called Cascade Object Detector. The Viola – Jones algorithm consists of three procedures for detection of facial regions:

1. Haar like features estimated using internal image for the feature extraction is "rectangular" type.

2. "Ada boost "is machine learning algorithm used for face area detection. Word "boosted" defines classifiers which are multifaceted in nature on every stage, that are composed of simple classifiers consuming any 4 boosting techniques.

3." Cascade-classifier" employed for combining most of features proficiently. Word "cascade" in classifier defines numerous filters on subsequent classifier.

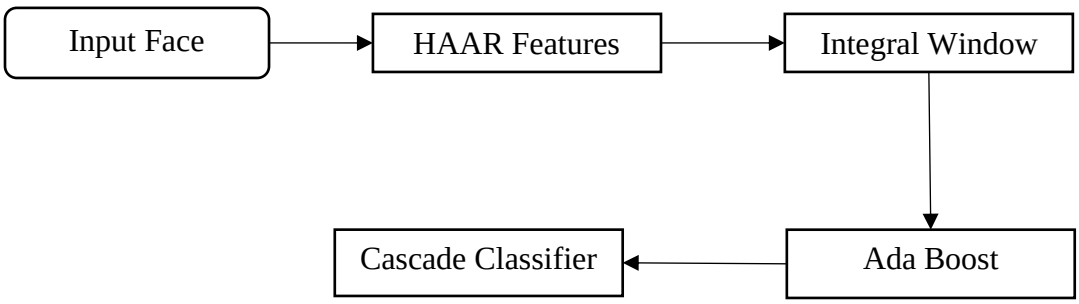


Figure 3:"Basic Flow Diagram of Viola Jones Algorithm"

A. "Viola Jones" Upper Body Detection:

Chest area portions can be distinguished utilizing viola jones technique for still pictures based on object detection structure that contains the model for recognition of close and front chest area region. Viola jones model has been utilized to distinguish part of chest area of human and furthermore gives face object identification. Chest area identifying part of the model distinguishes chest area locale that comprises of head just as shoulder region in blend with face. Every one of these specifics of head and shoulder territory has been modified utilizing Haar highlights and item location. Consequently object in head and face zone utilizes extra kinds of highlights, viola jones model is more incredible against posture and changes in picture, for instance turning head or flickering eyes with edge. Identifying chest area territory utilizing arrangement model there are 3 things:

1. Produce a detector object and its characteristics.
2. Sample image that is given as an input is read and it identifies upper body area.
3. Shows the detected/identified higher body area in bounded box.

B. "Viola-Jones" Face objects Identification algorithm

At first face identification in pictures was a confounding undertaking. Since lighting varieties, act and various components it has numerous varieties. Despite the fact that later it was executed in ongoing specialized items e.g., camera to recognize a facial entity anyplace on the off chance that exchange camera with a district of box. The face objects recognition calculation here made out of varieties like helping, act and rotational faces on it. It can be recognized by receiving various window classifiers using Viola Jones calculation.

C. Eye Identification Algorithm

Area of eye is more obscure comparative with different pieces of face, along these lines discovering districts of eye is fixated on division of a little zone of the picture that is indicated as hazier region. Focus part of eye locale is more obscure comparative with another region fixated on this technique the region of eyebrow has been eliminated. Certain eye territory is finished by methods for histogram investigation strategy, locale of eye shows two pinnacle focuses while the zone of eyebrows speaks to just one pinnacle. The two primary pivot has the course of action of which is the last limitation here, subsequently the two eye locales identifies with same line.

D. Iris & Pupil Identification

Iris in the eye is valuable in biometric acknowledgment since it has numerous properties for acknowledgment .Pupil is focus part of eye and more obscure zone pixels in our eye is hovered by iris. Light enters through understudy and afterward it goes through focal point, and in the end it is engaged to retina. There might be some data lose close by student as edges of understudy isn't generally a roundabout region and there can be a little mix-up in the discovery of this limit. In the event that the head/eye is additionally turned, at that point there happens some trouble in division of iris region.

E. "Viola-Jones" Nose Identification Algorithm

Nose has various attributes to identify it without any problem:

a) Dark White Dark Pixels:

At the point when a picture taken as an info and it is converged with such dim white and dull pixel focuses then the area of nostrils is perceived. This identification depends on 2 zones of gaps on the button, that means dim pixels and emphasis region of nose marks white pixels.

b) Relationship and comparable locale on both the sides:

Nostrils has district of dark territories on right and left areas of nose that is fundamentally the similar. Such qualities reflected as a similitude record on each margins of area.

F. Mouth Identification Viola Jones algorithm

A weak classifiers can arrange mouth identification calculation in which recognizable proof and extraction of highlights from mouth territory depends on a standard choice stump which devours the highlights of "Haar" to encrypt the subtleties of area of mouth. Trial outcomes indicates that the zone of mouth can be seen dependent on the spot of nose, lips and eyes which we can recognize by utilization of these calculations. Such application might be utilized in an extensive scope of highlights and is operational, for the convoluted foundation dependent on mouth discover

1. Haar Features:

The whole picture is deteriorated in littler windows or rectangular shape areas of size M x M. For every window exclusively includes are registered. Generally, 3 kinds of highlights are locked in for face recognizable proof that are, two rectangular highlights, three rectangular highlights and four rectangular highlights. Two square shape highlights are the contrast between the entireties of pixel focuses inside the two-rectangular districts. These square shapes are neighboring and have comparative size, shape and are adjoining to one another on a level plane or vertically. Three rectangular element figure entirety of pixel focuses inside 2 external rectangular districts and is deducted from the whole of pixels in the middle square shape. In conclusion a four rectangular component computes distinction between inclining sets of the square shape, as appeared in Fig. 3. Additionally called as "powerless classifiers". The three square shape include appeared on the face in Fig. 4

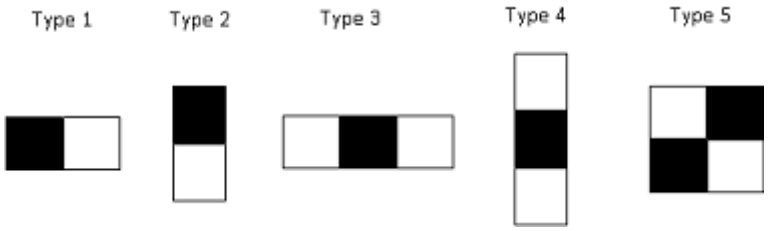


Figure 4: "Haar feature of detected faces"

2. Integral image formation

Features of Haar type are determined effectively utilizing an in the middle of portrayal for picture - indispensable picture.

The essential picture at area 1 in Fig. 5 is the total of pixels in area An; at area 2 it is aggregate of pixels in locale A+B; at area 3, it is whole of the pixels in district C+A; and at area 4, it is total of the pixels in the area A+B+C+D.

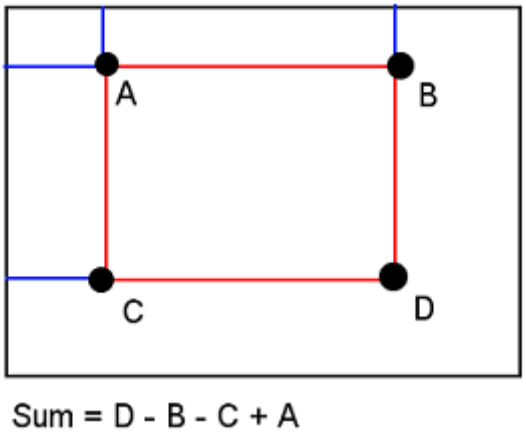


Figure 5: "Integral window"

C. Features Classification using "Adaboost" algorithm:

Number of Haar features determined for each window is excessively enormous enough (approx.: 180,000). Generally these highlights are rehashed. To lessen excess, ada-boost calculation is utilized. Ada-boost calculation is getting the hang of collection work that is utilized to kill rehashed features and change huge arrangement of features in a packed one. This is really a classifier that is made by weighted blend out of the weak classifiers. Each element of window is frail classifier. Ada-boost calculation might be seen as a component choice calculation since it chooses best highlights from every single accessible element. Chosen features are which are more important for face portrayal. This calculation diminishes a huge number of highlights to two or three hundred highlights.

D. Cascading

Choosing the best of the features in every window, presently choose the windows that contain faces. By normal, just 0.01% of the windows in picture are affirmative that is they have faces. Discovering positive windows at first recognized appearances to disregard many fell stages. Each stage diminishes the quantity of bogus positives that is areas that are wrongly distinguished as appearances.

High number of stages in falling shows that higher will be the exactness however the calculation time additionally increments so there is a conflict in both.

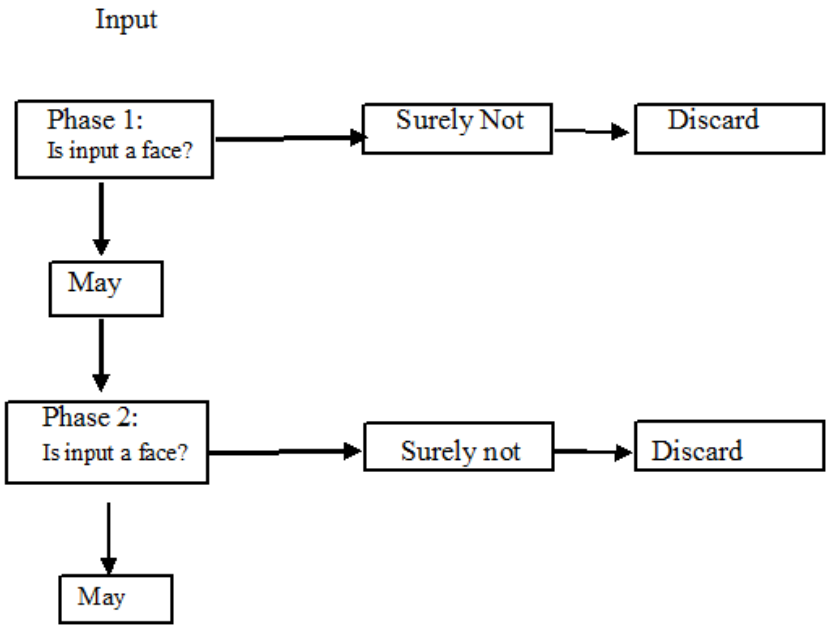


Figure 6: "Detecting face windows"

Now in FER is extraction of feature. Here positive or interested features are extracted for further pre-processing. It is the most important part of FER technique. Feature extraction is a procedure by which dimensions are reduced by an original set of collected raw material is condensed to some further adaptable sets for further processing .Characteristic of such large data sets is that a large quantity of variables that need much computing resources for processing. Feature extraction is used to pool up variables into features, efficiently decrease quantity of records that must be handled, though precisely and entirely relating real data set

3.4 Classification:

Last phase of Facial expression acknowledgment is characterization, here various classifiers arrange the articulations like outrage, glad, nauseate, miserable, shock, and unbiased .Classification is a significant advance as right grouping by classifier will prompt great preparing of information that outcomes in high exactness.

Backing vector machines are connected arrangement of regulated learning strategies utilized for grouping and relapse methods. SVM's are identified with a group of general straight classifiers. Then again, Support Vector Machine is a relapse and arrangement

method. Backing Vector machines can be all around characterized as strategy that utilization speculation unique plane of a straight capacities in higher dimensional component space, it is prepared utilizing taking in calculation from enhancement hypothesis 'that utilizations learning predisposition resultant of factual learning hypothesis. SVM is celebrated when utilizing pixel maps as an information, it produces higher exactness contrasted with refined neural organizations with extended highlights close by composing acknowledgment. Utilized in different applications, similar to hand composing request, face acknowledgment, etc, especially in design grouping and relapse focused applications. The nuts and bolts of Support Vector Machines have been set up by Vapnik , and device of relapse expectation which uses AI hypothesis to build forecast exactness however consequently staying away from over fit to information. Backing Vector machines might be characterized as frameworks that utilizes speculative space of direct capacities in high dimensional element space, preparing finished with learning calculation utilizing advancement hypothesis that execute taking in predisposition coming about because of measurable learning hypothesis.

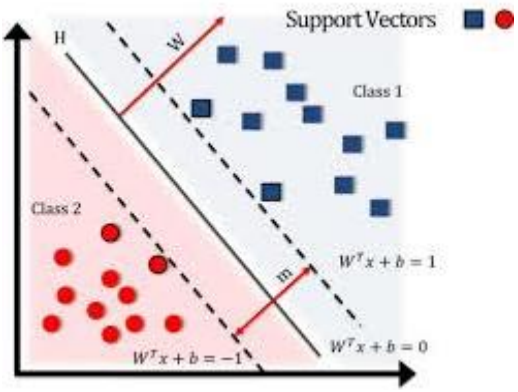


Figure 7: “Classification using SVM”

Machine learning procedures accept I /p information through a training stage, create a model of I /p and o /p, hypothesis function which may be deployed to forecast future data. Assume a set of labelled training examples

$S = ((x_1, y_1 , …., (x_l , y_l)), y_i \in \{-1, 1\}$

The learning systems normally try to catch a decision function like

H (x) = sgn w · x) + b)

This produces a label that *belongs to {*−1*,* 1*}* for a beforehand unobserved example x.

SVM's basically built on things grown from arithmetic learning theory, founded by Vapnik, despite of similarities with natural learning systems. Such outcomes shows that interpretation accomplishment of a learned function on coming hidden facts based on difficulty of class of functions it is chosen from despite of the complexity of the function itself. Restricting this class difficulty, theoretic assures on simplification performance can be done.

Chapter 4

Implementation and Proposed methodology

In this chapter, we suggested a novel feature extraction procedure in which we will combine some features of different face extraction techniques. Feature based techniques are considered vigorous concerning deviations in head angle/orientation, posture, and position of face within image. Though they are more costly computationally in comparison to general methods. Even with the difference against cost and efficiency, both techniques occasionally present challenges in characteristically recognizing a subject's face based on single feature. So, two or additional face features might be combined to capably define facial images. Therefore, this work suggests the idea of combining geometrical, statistical and texture based facial extraction techniques .Therefore combining the best features from the three different techniques .This will give better results and accuracy and is then classifier for six basic expressions using SVM classifier. Firstly input video is converted into frames to get the input images. These images are then passed "VideoReader" class is used to set the initial time of video, then use read () function to extract frame from video at correctly that time. Then I'm write () function is used to save it to disk.

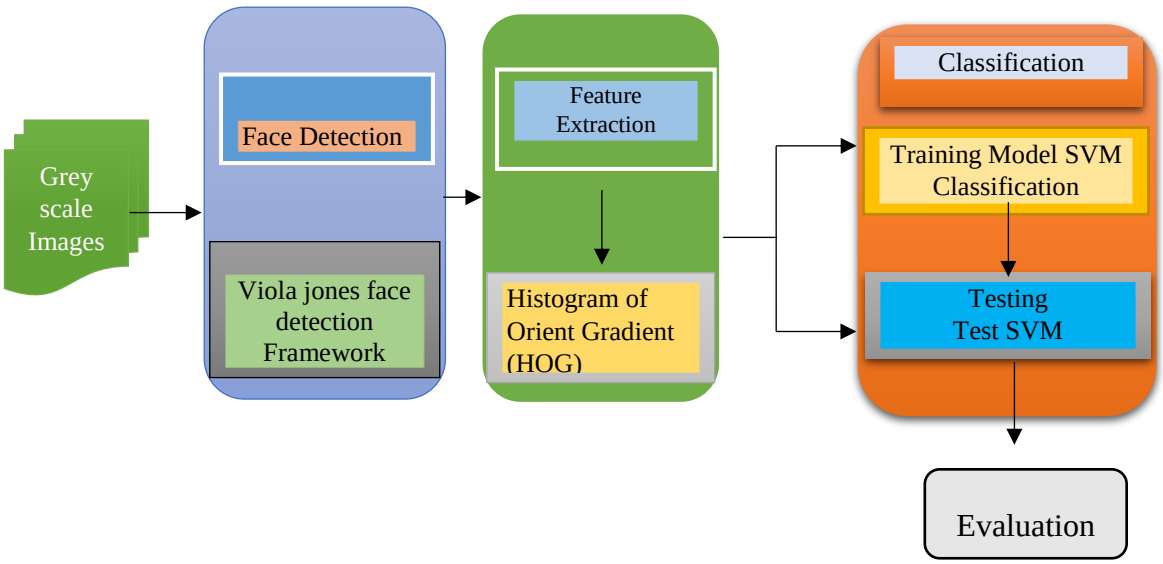


Figure 8:"Classification using SVM"

4.1 Face Detection:

4.1.1 Face Detection procedure

Built on Vigorous Real time Object Detection Structure presented by Paul Viola & Michael Jones, following are three steps to achieve Face identification using a frame:

1) Integral Image representation which speeds up computation of features.
2) Small number of important features by means of Ada-Boost build the classifier.
3) A cascade structure combined by several more complicated classifiers make detector to focus only on the promising areas so that object might be positioned in much shorter time.

The basic steps of viola jones algorithm are shown in Fig 9,

Algorithm: Viola-Jones Face Detection Algorithm

```
Input: original test image
Output: image with face indicators as rectangles
for i ← 1 to num of scales in pyramid of images do
    Downsample image to create image_i
    Compute integral image, image_ii
    for j ← 1 to num of shift steps of sub-window do
        for k ← 1 to num of stages in cascade classifier do
            for l ← 1 to num of filters of stage k do
                Filter detection sub-window
                Accumulate filter outputs
            end for
            if accumulation fails per-stage threshold then
                Reject sub-window as face
                Break this k for loop
            end if
        end for
        if sub-window passed all per-stage checks then
            Accept this sub-window as a face
        end if
    end for
end for
```

Figure 9:"Viola Jones Face detection Algorithm"

A. Implementation using “Viola Jones algorithm” :

   Implementation of viola jones uses integral system object “vision.CascadeObjectDetector” is used in recognition of human face and eyes.

During research it was detected that the attainment proportion of “Viola Jones algorithm” is good.

The failure to detect with 100 %accuracy is basically due to

x Bad illumination.

x Partial obstruction of face.

x Higher false rate of detection .

Mostly, the procedure is not able to identify a person’s face having glasses on their eyes particularly if having a shade of light on glasses or with bad illumination.

4.2. Feature extraction:

4.2.1 Histogram of Orient Gradient (HOG):

The most important stage in FER is feature extraction. The competence of FER depends on the techniques used in this stage. Here we used HOG algorithm for feature extraction that was suggested by Dalal and Higgs [27]. Fig. 10. Extracted HOG features from a grayscale input image.

Figure 10: “Feature extraction using histogram of orient gradient”

The HOG descriptor basically relies on the shape and look of indigenous object inside an image can be considered by the provision of gradients concentration or edge directions. HOG is the mixture of gradient direction histograms. To improve the accurateness, local histograms are proficient to be construct-normalized that is completed choosing broader section of image that’s called block and computing its strength, after that the generated value is deployed to standardize all cells inside the block. Fig.10. shows the visualization of

Extract histogram of oriented gradients (HOG). Features on face Construct-normalization produces better invariant to shadowing and illumination. HOG is an enhanced descriptor than parallel ones because of its being operated on indigenous cells and it is stationary for photometric and geometric alteration inspire of being object orientation. Total quantity of extracted HOG features is 8100, it is huge, and thus dimension reduction is crucial.

.

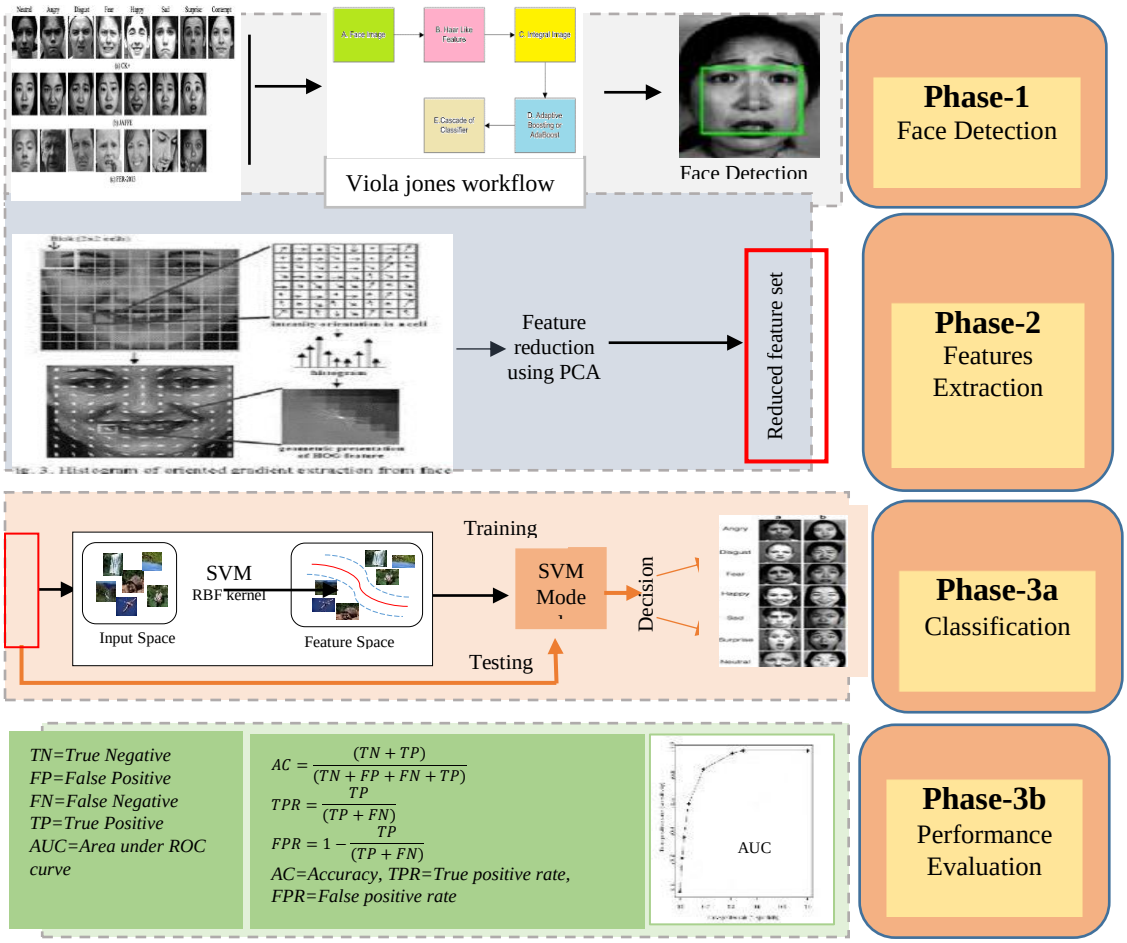


Figure 11: "Work Flow of Proposed technique using SVM"

4.3. Classification:

4.3.1 Classification using Support Vector Machine:

Seven class SVM classification applied in MATLAB. Training is done using image sequences from the database. We used 3 data bases CK+, JAFFE, and KDEF. SVM gives good accuracy with JAFFE dataset but with CK+ its best and almost all images are correctly classified. Confusion matrix is' n × n' matrix containing info about real class labels in columns and

classification based labels of data in rows. The crosswise records in confusion matrix are amounts of facial expressions that are categorized appropriately, while the entries other than crosswise indicates not correctly classified entries.

4.4. Training Phase

Training is done using 70 % images from 3 datasets CK+, JAFFE, and KDEF. Every dataset has seven type of basic emotions.

4.5. Testing Phase

In testing phase, remaining 30% images from all 3 datasets of JAFFE, CK+, and KDEF were used to classify the input image for seven of the basic emotions

4.6. Implementation and Evaluation

This part describes the conditions which we used to conduct experimentation, it produces an overview of the assessment datasets which are: Evaluation Database JAFEE, CK + and KDEF. Each of data sets contain seven basic emotions of happy, fear, disgust, sadness, surprise, angry and contempt. We develop the framework using MATLAB R2019a software design tools on a PC with Windows 10 and the subsequent features: ϖ Processor: Intel(R) Core (TM) i7-7500U CPU @ 2.70GHz 2.90 GHz ϖ Installed Memory (RAM): 8.00 GB ϖ System Type: 64-bit operating system, x64-based processor.

4.6.1. Implementation and Evaluation

For classification, non-linear SVM classifier is used. To find the best parameter values of the SVM kernel we use a grid-search method. To evaluate the performance of the classifier, we use 10-fold cross validation. Performance is measured in expressions of average and standard deviation of accuracy, True Positive Rate (TPR), True Negative Rate (TNR) and (AUC) of (ROC), these measurements are the most used in image forgery detection and we considered them to make our work comparable with other existing methods. Accuracy is percentage of correctly classified samples to the total number of classified.

$$\text{□□□} = \frac{100(\text{□□} + \text{□□})}{\text{□□} + \text{□□} + \text{□□} + \text{□□}}$$

True positive rate measures the percent ratio of correctly classified samples and is calculated using:

$$\text{FPR} = \frac{\text{FP}}{\text{FP} + \text{TN}}$$

The false positive rate evaluates the percent ratio of correctly classified of authentic images using and is calculated using equation.

$$\text{FPR} = \frac{\text{FP}}{\text{FP}+\text{TN}} \quad ,$$

Where TP, FN, FP, and TN are, individually, the numbers of true positive, false negatives, false positives, and true negatives.

4.7. Datasets

4.7.1 JAFFE

At Kyushu University, students of Psychological department composed this dataset. This information dataset comprises of the 7 essential articulations which were presented by 10 Japanese female models. 213 images are total in this dataset, angry images are 30, disgust 29 images, fear images are 32 , happy images are 31, contain 30 neutral, 31 sad images, and 30 are of surprise. Separately every model gave roughly three pictures to every apparent expression. To each picture was spared in grayscale with a goal of 256 × 256.

Figure 12: "JAFFE dataset sample images for 7 basic emotions"

4.7.2 CK+

This dataset contains eight articulations which incorporates seven essential articulations in addition to one scorn that were posed by in excess of 200 individuals running from 18 to 50 years old. It by and large comprised of European-American and African-American people. The pictures were taken in time spans here the underlying edge was nonpartisan, that was at that time progressed into the articulation that was wanted toward the end outline (the

pinnacle outline). Such pictures were spared, few in grayscale and few in shading, in 640 × 490 or 640 × 480 pixels. The dataset contains neutral 123 images and images with certain expression are 327. The expressive images pictures consist of angry images 45, contempt 18 pictures , images that are disgust are 59, 25 images are fear, 69 images of happy, 28 images with sad expressions, and surprise 83 images . The contempt expression images are excluded in this work.

Figure 13: "ck+ dataset sample images for 7 basic emotions"

4.7.3 KDEF:

The Karolinska Directed Emotional Faces (KDEF) is a set of 4900 images of human facial expressions. There are total 70 individuals displaying seven dissimilar emotions. Each expression is viewed from 5 different angles but only frontal images of 70 individuals were included in dataset. So total images are 980.

Subjects

Population: 70 amateur actors, 35 women and 35 men.

Collection criteria's: Persons between 20 and 30 years selected. No beards, mustaches, earrings or eyeglasses, and preferably no makeup on face.

Figure 14: "KDEF sample images for 7 basic emotions"

Chapter 5

Results and Discussion

5.1 Datasets used:

In this chapter experiment results for our proposed technique using 3 datasets are shown. Firstly, JAFFE is used for experimentation. This information dataset comprises of the 7 essential articulations which were presented by 10 Japanese female models. 213 images are total in this dataset, angry images are 30, disgust 29 images, fear images are 32 , happy images are 31, contain 30 neutral, 31 sad images, and 30 are of surprise. Separately every model gave roughly three pictures to every apparent expression. To each picture was spared in grayscale with a goal of 256 × 256.

This dataset contains eight articulations which incorporates seven essential articulations in addition to one scorn that were posed by in excess of 200 individuals running from 18 to 50 years old. It by and large comprised of European-American and African American people. The pictures were taken in time spans here the underlying edge was nonpartisan, that was at that time progressed into the articulation that was wanted toward the end outline (the pinnacle outline). Such pictures were spared, few in grayscale and few in shading, in 640 × 490 or 640 × 480 pixels. The dataset contains neutral 123 images and images with certain expression are 327. The expressive images pictures consist of angry images 45, contempt 18 pictures , images that are disgust are 59, 25 images are fear, 69 images of happy, 28 images with sad expressions, and surprise 83 images . The contempt expression images are excluded in this work.

Third dataset use is KDEF, The Karolinska Directed Emotional Faces (KDEF) is a set of 4900 images of human facial expressions. There are total 70 individuals displaying seven dissimilar emotions. Each expression is viewed from 5 different angles but only frontal images of 70 individuals were included in dataset. So total images are 980.

5.2 Results of Data sets:

5.2.1 JAFFE

Experiments done using JAFFE dataset produces good results having accuracy of 95.30%. Evaluating different parameters like AUC, accuracy of 7 classes individually and TPR, FPR, TNR and TFR shows very good results. All classes identification rate is above 95%. Results for JAFFE dataset for all seven classes are shown in table.

SVM ACC using JAFFE dataset=95.30%										
Labels	**Precision**	**NPV**	**FPR**	**FNR**	**FDR**	**Spec%**	**Sen%**	**f1 score**	**MCC**	**ACC**
Anger	0.97	1.00	0.01	0.00	0.03	0.99	1.00	0.98	0.98	1.00
Contempt	0.91	1.00	0.02	0.00	0.09	0.98	1.00	0.95	0.95	0.99
Disgust	0.96	0.99	0.01	0.07	0.04	0.99	0.93	0.95	0.94	0.99
Fear	0.97	1.00	0.01	0.00	0.03	0.99	1.00	0.98	0.98	1.00
Happy	0.94	0.99	0.01	0.03	0.06	0.99	0.97	0.95	0.94	0.99
Sadness	0.94	0.99	0.01	0.03	0.06	0.99	0.97	0.95	0.94	0.99
Surprise	0.96	0.99	0.01	0.13	0.04	0.99	0.87	0.91	0.90	0.98

Table 2:"Evaluation parameters for JAFFE dataset"

5.2.2 CK +

Experiments done using CK+ dataset produces very good results having accuracy of 99.70%. That is considered almost 100%.Evaluating different parameters like AUC, accuracy of 7 classes individually and TPR, FPR, TNR and TFR shows excellent results .All classes identification rate is above 97%.Results for cK+ dataset for all seven classes are shown in table

SVM ACC using CK+ dataset=99.70%										
Labels	**Precision**	**NPV**	**FPR**	**FNR**	**FDR**	**Spec%**	**Sen%**	**f1 score**	**MCC**	**ACC**
Anger	1.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
Contempt	1.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
Disgust	1.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
Fear	1.00	1.00	0.00	0.03	0.00	1.00	0.97	0.99	0.99	1.00
Happy	1.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
Sadness	1.00	1.00	0.00	0.00	0.00	1.00	0.99	0.99	0.99	1.00
Surprise	0.99	1.00	0.00	0.00	0.01	1.00	1.00	1.00	0.99	1.00

Table 3:"Evaluation parameters for CK+ dataset"

5.2.2 KDEF

Experiments done using KDEF dataset produces very good results having accuracy of 99.70%. That is considered almost 100%.Evaluating different parameters like AUC, accuracy of 7 classes individually and TPR, FPR, TNR and TFR shows excellent results .All classes identification rate is above 97%.Results for KDEF dataset for all seven classes are shown in table

SVM ACC using KDEF dataset=92.30%										
Label	**Precision**	**NPV**	**FPR**	**FNR**	**FDR**	**Spec%**	**Sens%**	**f1 score**	**MCC**	**ACC**
Anger	0.97	0.99	0.00	0.09	0.03	1.00	0.91	0.94	0.93	0.98
Contempt	0.94	0.99	0.01	0.06	0.06	0.99	0.94	0.94	0.93	0.98
Disgust	0.79	0.98	0.04	0.14	0.21	0.96	0.86	0.82	0.80	0.95
Fear	0.99	0.99	0.00	0.04	0.01	1.00	0.96	0.97	0.97	0.99
Happy	0.92	0.98	0.01	0.14	0.08	0.99	0.86	0.89	0.88	0.97
Sadness	0.90	0.99	0.02	0.07	0.10	0.98	0.93	0.92	0.90	0.98
Surprise	0.93	1.00	0.01	0.02	0.07	0.99	0.98	0.95	0.94	0.99

Table 4:"Evaluation parameters for KDEF dataset"

5.2.3 Combined

SVM ACC using Combined dataset=90.04%										
Label	**Precision**	**NPV**	**FPR**	**FNR**	**FDR**	**Spec%**	**Sens%**	**f1 score**	**MCC**	**ACC**
Anger	0.96	0.98	0.01	0.10	0.04	0.99	0.90	0.93	0.92	0.98
Contempt	0.94	0.99	0.01	0.11	0.06	0.99	0.89	0.91	0.91	0.98
Disgust	0.82	0.97	0.04	0.15	0.18	0.96	0.85	0.84	0.80	0.94
Fear	0.98	0.99	0.00	0.10	0.02	1.00	0.90	0.94	0.93	0.99
Happy	0.86	0.98	0.02	0.11	0.14	0.98	0.89	0.88	0.86	0.97
Sadness	0.89	0.98	0.01	0.13	0.11	0.99	0.87	0.88	0.86	0.97
Surprise	0.89	0.99	0.03	0.03	0.11	0.97	0.97	0.93	0.91	0.97

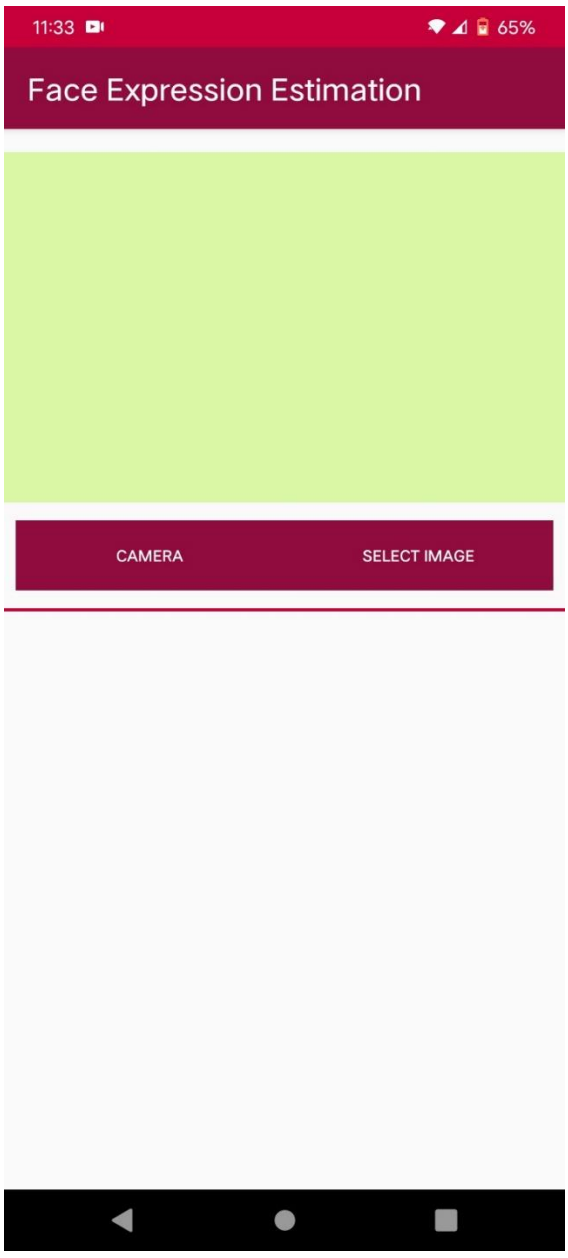
Table 5:"Evaluation parameters for all combined datasets"

CHAPTER 7

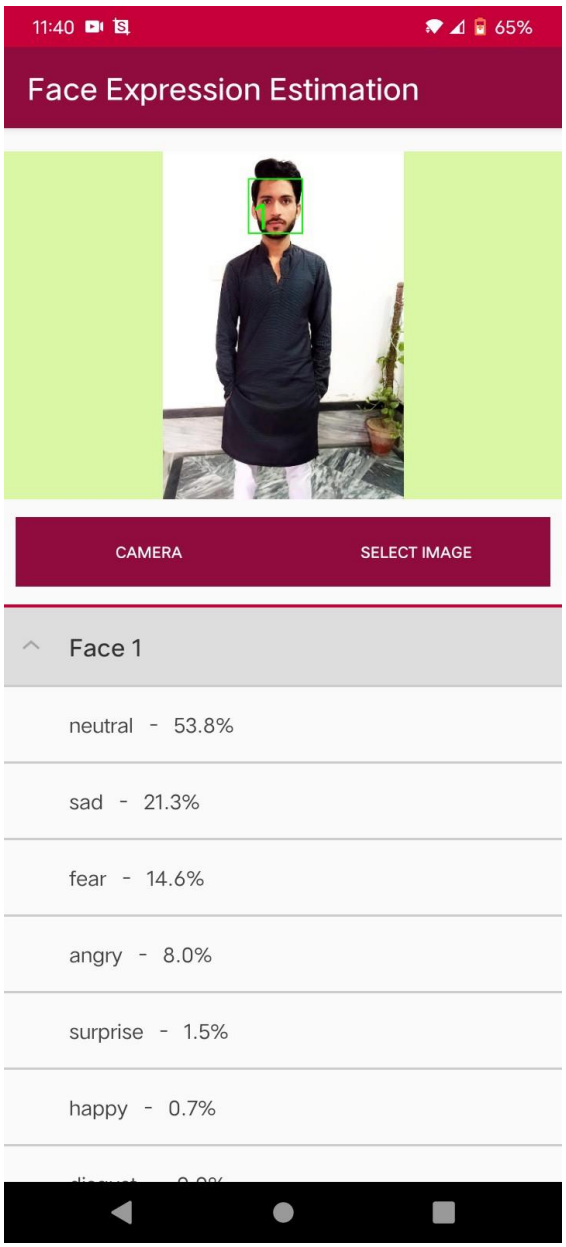
CONCLUSION & FUTURE WORK

In this report, machine learning algorithms are used to increase the overall efficiency of face detection and recognition system. To check the accuracy of the technique we used traditional databases like JAFFE, CK+, and KDEF and then combine all these datasets to check the overall cross-cultural accuracy of proposed technique. Firstly, viola jones is used for face detection, this algorithm is efficient for up frontal faces and gives high accuracy. Then the feature of detected face is extracted using Histogram of Gradient (HOG) descriptor. These features are reduced using PCA and then passed to SVM classifier for evaluation. This method gives high accuracy of 99.7% using CK+, using JAFFE accuracy calculated is 95.30%, KDEF 92.30% accurate classes were classified and combining CK+ and JAFFE features gives 98.5% accuracy while if all three datasets are combined for cross cultural emotions that accuracy is approximately 90%.This shows that our proposed technique gives good results if used for cross cultural data bases. In future, all this work can be experimented with different techniques and for other than frontal faces.

Appendix 1:



Appendix 2:


11:40
65%
Face Expression Estimation
CAMERA
SELECT IMAGE
Face 1
neutral - 53.8%
sad - 21.3%
fear - 14.6%
angry - 8.0%
surprise - 1.5%
happy - 0.7%

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