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Hybrid Process Using Principal Component Analysis and Knowledge Based System for Facial Emotion Detection

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***Abstract*—** Emotion Recognition is such a challenging yet interesting area of research which has attracted a large number of researchers from so many varying backgrounds [Computer Graphics, Artificial Intelligence, Robotics, psychology and many more].The research consists of a hybrid process which uses Principal Component Analysis [algorithm] and Knowledge Based system to detect a face emotion. The algorithm uses the PCA for transformation of the related variables into Principal Components for the face recognition and extraction of action units (i.e. eyes and lips) and it is used after segmentation and detection of connected regions.

I. INTRODUCTION

Human vision can encounter feeling as connected with mind-set, demeanour, identity and attitude. Computer Vision tries to copy the human vision by recognizing and analyzing the digital image as information. The way that world is three-dimensional while the computer vision is two-dimensional is essentially one of the fundamental issues that muddle Computer Vision. [1]

Regular nearly everybody in this world collaborate with other in some way either specifically (for e.g. up close and personal) or in a roundabout way (for e.g. telephone calls). In some calling professions, collaboration with individuals is the principle deed to perform like call focuses, deal administrators and so on. With awesome progression in innovation as far as various procedures of individuals cooperating with each other it is entirely vital that one ought to know about current feelings of the individual he/she is connecting. With the progression of 3G innovation in mobile communication field one might be skilled to communicate up close and personal with other while talking so on the off chance that one knows about mind-set of other ahead of time that connection will surely bring about social and additionally proficient advantages. One noteworthy approach to distinguish feelings is by analyzing the voice by setting parameters in ranges like tone, pitch, pace, volume and so forth however this is an intricate calculation to work out and takes a considerable measure of figuring time and additionally cost.

II. FACIAL EMOTION RECOGNITION

Facial Emotion Recognition will turn out to be indispensably vital in future multi-social visual correspondence framework, for emotion translation between societies. So far the Facial Emotion Recognition is tended to by numerous computer vision scientists or researchers. Computers rapidly take care of numerical issues and retain a huge purpose of data; however human computer collaboration still needs instinct or lacks of intuition. Since individuals anticipate that humanoid robots will carry on like people, this viewpoint is much more imperative to this interaction scenario. [1] Researchers plan to determine these inadequacies by expanding conventional frameworks with human-like association abilities. Learning about human feeling, conduct and goal is important to build helpful interaction system. Knowing the client's expectation and feeling gives more advantageous interaction mechanism. Computer interaction essentially requires a robust emotion interpretation. Moreover, normal human computer communication requires identifying and detection whether the person is telling the truth or not. Miniaturized scale appearances inside the face raise these subtle differences. In 1965, Darwin started the study of human facial expressions which still attracts many researchers to continue studying and investigating this area of research. In 1971, Ekman and Frisen discover six universal facial expressions that are communicated and translated similarly by people of any cause everywhere throughout the world. They don't rely on upon the social foundation or the nation of beginning. These six feeling classes are: Happiness, Sadness, Surprise, Fear, Anger and Disgust. The general explanation of the issue of machine vision to perceive the facial feeling can be taken after as: A facial image is given, identify or verify the emotion of person in the scene using stored database of facial image properties.

There are number of computer vision specialists managing to deal with the detection of human facial expressions and emotions recognition from the facial image and stress is laid shape some wonderful studies to compress the continuous logical exploration here. Different scientists acquaint multi-modular frameworks to improve the detection rate of human emotions from the facial image. Specialists found that, it is extremely intriguing to consider both facial display and auditory information together, to process, since he trust this sort of multimodal data preparing will turn into a datum of data handling in future interactive media period. They likewise found that people perceive Anger, Happiness, Surprise and Dislike by their visual appearance, contrast with voice only recognition. At the point, when the dubbing is done for the audio track of facial emotion clip, the factors like Anger, Sadness, Surprise or Happiness were video dominant.[2]

However, Dislike feeling gave blended reactions to various speakers. It is likewise a finding that Sadness and Fear feelings were audio dominant.

The investigation and study of Beat et al. demonstrated that the clustering of FACS codes (low level) into different

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meaningful categories of facial expressions through LSA and PLSA without turning to manual semantic rating of facial expression displays that are hard to accomplish and regularly one-sided. Numerous analysts expected that each occurring FACS AU is shown with the same intensity and portrayed that the likelihood of utilizing real time emotion diagnosis frameworks to bolster e-Learning. Gunes and Piccardi presented FABO, a bimodal face and body gesture database suitable for use in automatic Vision-Based analysis of human nonverbal affective behaviour. The FABO database contains approximately 1900 videos of facial expressions recorded by the face and body cameras, simultaneously. This database is the first to date to combine facial and body displays in an organized manner. [3]

III. APPROACHES FOR FACIAL EXPRESSION DETECTION

Numerous strategies for facial emotion detection and recognition have been proposed amid the previous 30 years. Facial Emotion recognition is such a challenging yet intriguing problem that it has pulled in scientists who have diverse foundations: psychology (brain science), robotics, computer areas such as computer vision, computer graphics, etc. The reason behind this may be due to the vast and diverse literature on Emotion Recognition. Often, a single system or framework includes numerous techniques inspired by different standards. The use of a blend of procedures makes it hard to arrange and classify these systems based upon what sorts of strategies they use for feature classification.

To have an unmistakable and abnormal state order, we rather take after a rule recommended by the mental investigation of how people use all encompassing and neighborhood highlights. Late methodologies for Facial Emotion Detection are Template Based Method and Feature Based Method.[3]

Template Based Method

This methodology utilized the normal face for every classification of feeling and characterizes the individual facial expression as indicated by the best match of every layout. This methodology for feeling order from static images has just exceptionally restricted detection and speculation capacities. This poor execution can be ascribed to the smoothing of facial subtle feature created by little misalignments of the facial emotions and the expansive between individual contrasts of facial emotions uncovered in the information set. Despite the fact that the nonlinear extraction of proper key elements from facial emotions by the multi-layered observation can boost grouping execution, the speculation execution more often than not achieves just 60%.[4] This methodology considers every one of the pixels in the facial image for the handling concerning utilizing Template based strategy, Firstly we need to build a database in which we are embeddings the normal countenances of every feeling class. In the wake of making the database, when we need to check the feeling from the concealed facial image then we need to locate the normal face from the inconspicuous image and afterward need to perceive the present feeling in that facial image by coordinating the extricated normal face with the normal countenances put away in the database.[4] If it found any match in the database then gives as yield the feeling classification of that match. Be that as it may, if no match found in the database for the normal face extricated from the inconspicuous image then layout based methodology compute the normal of the estimations of every classification present in the database on the other hand test the normal face with the normal values and attempt to discover the closest conceivable match.

Feature Based Approach

This methodology incorporates distinguishing changes of the parts in different facial locale. The algorithm of these facial areas relies on upon the Facial Action Coding System (FACS). The Facial Action Coding System is a human viewed based structure proposed to recognize changes in facial features. FACS comprises of 44 anatomically based activity units, which independently or in blend can speak to all unmistakable segregate expressions. Highlight focuses are removed from the diverse locales of interests and afterward tried with the estimations of highlight focuses present in the database in various feeling classifications. As indicated by the best match discovered it will give the feeling class as yield. This methodology was quickened the calculation and to characterize the images in view of the development of individual facial locales as opposed to the whole face.

Geometric Based Face Expression Detection

The technique enhances the face identification rate and restrains the inquiry space. Skin Color Modelling (SCM) is one of the best face discovery systems for image and video. Nonetheless, highlight determination is vital for surprisingly better layout coordinating execution as far as identification rate and time.[5] This paper exhibited a productive component extraction and algorithm technique in light of geometric structure of the facial image limit and inside. To display the geometric structure of face, Principle Component Analysis (PCA) and shrewd threshold discovery are utilized. Combination of PCA based geometric demonstrating and SCM strategy gives higher face detection exactness and enhances time multifaceted nature. Both models give separating of image in term of pixel qualities to get the face area that are quick and proficient for vast image databases. Proposed framework utilizes skin shading model to lessen the hunt space. Introduction invariant limit taking into account geometric model and enhances framework further.[5] For solid layout coordinating, feature extraction and determination in view of novel blend of geometric channel with SCM channel is presented. Proposed framework is made out of two noteworthy segments: to start with, skin areas are divided utilizing skin shading model. In the second part, sectioned locales are separated utilizing geometric model of face. They can concentrate on four shading spaces which are typically utilized as a part of the image preparing field: RGB: Colours are exact as far as the three fundamental hues: red (R), green (G), and blue (B). HSV: Colours can be represented exclusively in the terms of tint (H), immersion (S), and power esteem (V). They are the three properties that are obvious

about shading. The transformation amongst HSV and RGB is nonlinear. The real objective in this division procedure is to take away the foundation of the image from skin locales utilizing previously talked about skin shading model. To begin with, information image is changed into chromatic shading space.[5] A gray scale image of skin plausibility is developed utilizing Gaussian model. Skin pixels have some arrangement of stable qualities for every r, g and b part. A normalized image is comprises of has three standards and they are normalized red, normalized green and normalized blue. These normalized parts are removed by Segmentation process and later two images are built. Each of these images is changed into high contrast image by applying disparate limit for normalized information image.

High-Level Language based Face Detection:[6]

Hear numerous open sources or business libraries to unravel the inconvenience of face discovery. There are still hard to utilize on the grounds that they require express learning on subtle elements of algorithmic procedures. They anticipated an abnormal state language model for face recognition with which clients may create frameworks effectively. Important conditions are for the most part considered to group the enormous inconvenience of face discovery. [6] The conditions perceived here are then spoken to as expressions as far as a language display with the goal that engineers may utilize them to express different issues. Once the conditions have created by clients, the proposed related mediator translates the conditions to discover and characterize the best calculations to take care of the spoke to issue with comparing conditions. The motivation behind this strategy is to think of a high level language model for face detection with which clients will extend frameworks effortlessly and even without particular learning of face identification speculations and calculations. By doing this, the issue of selecting calculations and choosing convoluted parameters for calculations are secluded from improvement of face-recognition applications.[6] Developers simply need to characterize the issue and express it with the language model proposed and a translator will choose calculations suitable for the related sub-space of the issue. They first consider the imperative conditions to order the tremendous issue of face identification. The conditions distinguished here are then communicated as far as a language demonstrates with the goal that designers have been utilized them to express different prerequisites of a given issue. Once the conditions are communicated by designers, the mediator assumes an essential part to decipher the conditions to discover and sort out the ideal calculations to take care of the spoke to issue. The model is a part of the Open Vision Language (OpenVL), a vision language that permits software engineers to portray their vision issue as far as what it is they need to do, rather than how they need it done. A proof-of-idea is actualized and some case issues are tried and analyzed.[6] They introduce two diverse identification issues to accept and show the convenience of our evidence of idea language model proposed in this paper. Three diverse face detection calculations have been actualized for the determination of appropriate calculations in this paper: AdaBoost based calculation, Neural Network based calculation, and Color based calculation. The primary case is to recognize an upright, frontal and huge face for face ID. Face discovery is frequently utilized as a pre-handling for distinguishing people by giving the definite future change, the procedure require more face recognition calculations will be broke down and included for more commonsense and better convenience of the language model. Some keen methodologies for selecting calculations are important to be considered for more ideal determination process [6].

Haar Like Feature Based Face Expression Detection[7]

Initially, this examination characterized another feature for course identifier. That element was called Separate Haar Feature. Second, they characterized another algorithm calculation in course identification to build up the recognition rate. There are taking after three key conditions. The first is "Separate Haar Feature", which includes couldn't care less range between the rectangles of Haar Feature. The second includes the calculation for selecting the best width for don't care range. At last, proposed another algorithmic system which settles on the choice by not just a phase result in cascade detection procedure to build up the identification rate. In this course calculation, when a image was rejected by any stage, it is not ascertained in the left stages.[7] This course calculation can dispose of the foundation images quickly, yet once a wrong recognition happens in one phase, this wrong discovery will happens in the identification. At that point we proposed to utilize the consequences of the front stages to amplify the present stage threshold. This course calculation is useful for disposing of the foundation images quickly; however it likewise disposes of the face images when a wrong discovery happens in any stage. They need to utilize more data to do the choice. They proposed to spare the worth separation between stage quality and edge of the front stages which is recognized and acknowledged in and utilizing this message together with the edge and esteem in the present stage to do the choice. They have two recommendations to enhance the detector.[7] In the primary proposition, enhance the component extraction part to remove capable feature esteem. Also, second, enhance the cascade algorithm calculation by including more messages from front stages results to do the stage algorithm. For this situation, the mass cameras are introduced before an entryway and the individual to be perceived is required to remain at an exact position so the substance of the individual ought to be gained effectively. Thus, the face in the image taken is very much situated and the size is sufficiently enormous for detection as well as for acknowledgment. The second case recreates face recognition utilized for an observation framework. Identifying faces and breaking down the movement is one of the essential capacities for keen observation. In this issue, facial emotions are generally a long way from the camera and the posture and edge of the face can't be ensured to be at a specific extent. In that sense, the face detection ought to manage little faces with discretionary posture and set up pivot. Essential conditions for

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the face recognition issue that can be distinguished effortlessly by clients are researched and the engineering for the language model in light of these conditions was created. The issue of selecting calculations and choosing entangled parameters for calculations are confined from improvement with the proposed language model.

IV. PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (**PCA**) - As the name suggests, the analysis of the Principal Components is done. Consequently, the analysis is done by making the utilization of orthogonal transformation which works in an approach to convert into set of related variables brought through set of uncorrelated direct values fetched through a set of observations. These set of uncorrelated linear values can be named as Principal Components which considers either equivalent or not exactly the quantity of unique qualities. As the primary Principal Component has the biggest conceivable difference for that set of direct values (i.e. it represents a great part of the conceivable variability in the information) and the same change happens for each of the succeeding segment under the imperative which says that it will the orthogonal for the each former segment and thusly, change happens.

The set of uncorrelated orthogonal variables are the resulting vectors. The principal components are orthogonal because they are the Eigen vectors of the covariance matrix, which is symmetric. PCA deals with the relative scaling of the set of original variables. This method is used as a classification approach in case of face detection, emotion detection, faces recognition etc. algorithms.

This analysis tool can be used as an exploratory data analysis tool and can be further used to develop predictive models. The process involves the decomposition of a matrix i.e. data covariance or correlation matrix after implementing the normalization or mean centering for each of the matrix attribute.

The factor scores i.e. component scores are usually used to discuss the results [i.e. the transformed variable values] obtained by PCA. Another important factor which is used to discuss the results of PCA is loadings [i.e. the weight multiplier with is used with each original value for standardization purpose in order to get the component score].

PCA contributing to the true eigenvector-based multivariate analyses is considered as the simplest analysis. The operations involved in the PCA can be realized as the best way to explain the data variances. PCA can provide or supply a lower dimension image, a projection or a shadow if a dataset consists of multivariate variables is analyzed in a high-dimensional data space and when it is visualized from its most informative viewpoint. The concept mentioned is implemented to reduce the dimensionality of the transformed data with the use of first few principal components.

Factor analysis is the main function provided by PCA which is specifically used to solve the eigenvectors of a slightly different matrix and is used to incorporate the assumptions which are domain specific about the underlying given structure.

The set of eigen vectors are processed to become unit vectors. Interpretation of the unit eigenvectors [which is orthogonal mutually] as a data fitted ellipsoid axis once the orthogonalization is done. By the calculation of dividing the eigen values to that of eigenvector by the sum of all eigen values, the proportion of eigenvector variance can be represented.

V. PROBLEM FORMULATION

Artificial recognition of facial expression has pulled in a ton of consideration in the most recent couple of years and diverse facial expression detection techniques have been created. The present study utilizes a feature point tracking strategy independently connected to the five facial image locales (eyebrows, eyes and mouth) to catch essential feelings. The utilized information set contains an aggregate 60 facial pictures from subject's distinctive sexes and nationality not wearing glasses and/or facial hair.

The principle impediment of the current object recognition strategy is that exclusive the main closest neighbor of every test image feature is considered in the ensuing stages. This confinement makes the current strategy quick, yet in the meantime makes it not able to detect objects with dreary surfaces.

Different methodologies with direct coordinating conquer this by permitting each feature to vote in favor of all plausible object theories given the feature position and orientation. Assessing this sort of strategies, or changing the current to acknowledge a few theories for every test image feature, would be a fascinating line of continuation of this work.

VI. RESEARCH GAPS

Discovery rate of recognizable proof of face and AU structure human facial image are less.

Potential business estimation of detection of facial elements in fields like Lie Detection, reconnaissance, criminal examinations, security and legal applications needs more research. Facial Emotion Detection can be used for mechanized investigation of human face acknowledgment.

To expand the effectiveness of recognition of face and activity units with the assistance of upgraded PCA and Skin Color Segmentation approach.

To make human computer communication more valuable by making human computer interface more exact furthermore to find the route in which we can instruct robots to perceive human, with the assistance of scientific conditions which can without much of a stretch comprehended by robots.

VII. PROPOSED APPROACH

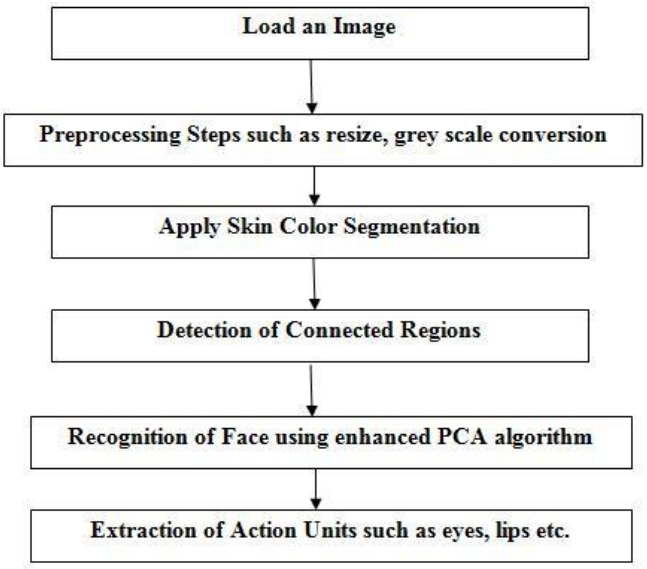

Fig 1: Flow Chart

The Skin Color Segmentation will be applied on the given facial image to detect the connected regions [To get facial pixels]. To recognize the face from the facial image with the help of enhanced PCA algorithm. To extract of Action Units from the facial image as eyes, lips etc. with the help of knowledge based system. Recognition of emotion categories using the properties of the extracted ROI's.

VIII. SIMULATION RESULTS

In this research an algorithm is developed for face reorganization, feature extraction and emotion classification using Skin Color Segmentation, Knowledge Based Approach and PCA respectively.

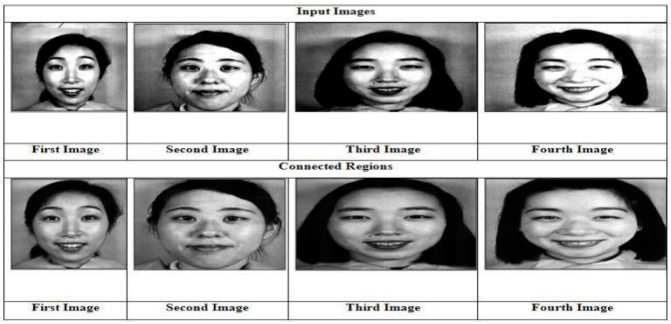

Fig 2: Connected Regions for different facial images having category Smile

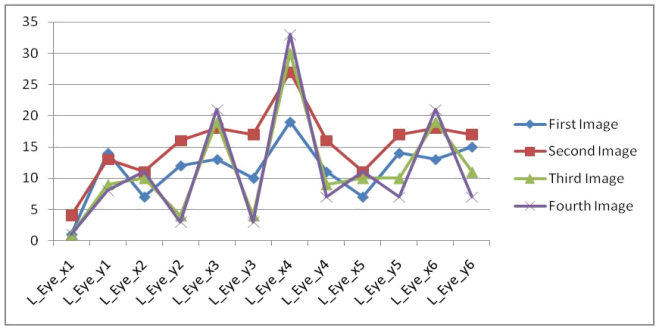

Fig 3: Comparison of Feature points found on Left Eye region by different facial images having category Smile

From fig 3 has shown that the feature points found by proposed technique i.e. using PCA.

Categories	Input Images	Hit count	Miss Count	Accuracy percentage (%)
Smile	89	84	5	94.39
Sad	88	82	6	93.18
Surprise	76	69	7	90.79
Normal	79	76	3	96.20

Table 1: Result Comparison

Table 1 is the comparative study for the results generated by proposed research for various input images. From this table the accuracy calculated by the proposed work is approx 94%.

IX. CONCLUSION

Facial Emotion Detection will turn out to be essentially critical in future multi-social visual correspondence framework, for feeling interpretation between societies. So far the detection of facial feelings is tended to by numerous computer vision specialists. In this exploration the facial feelings were recognized utilizing PCA strategy. From the outcomes area it is demonstrated that the proposed technique is giving high precision on various feelings of face.

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