REAL-TIME EMOTION RECOGNITION THROUGH FACIAL EXPRESSIONS

ARCHITECTURE DIAGRAM:

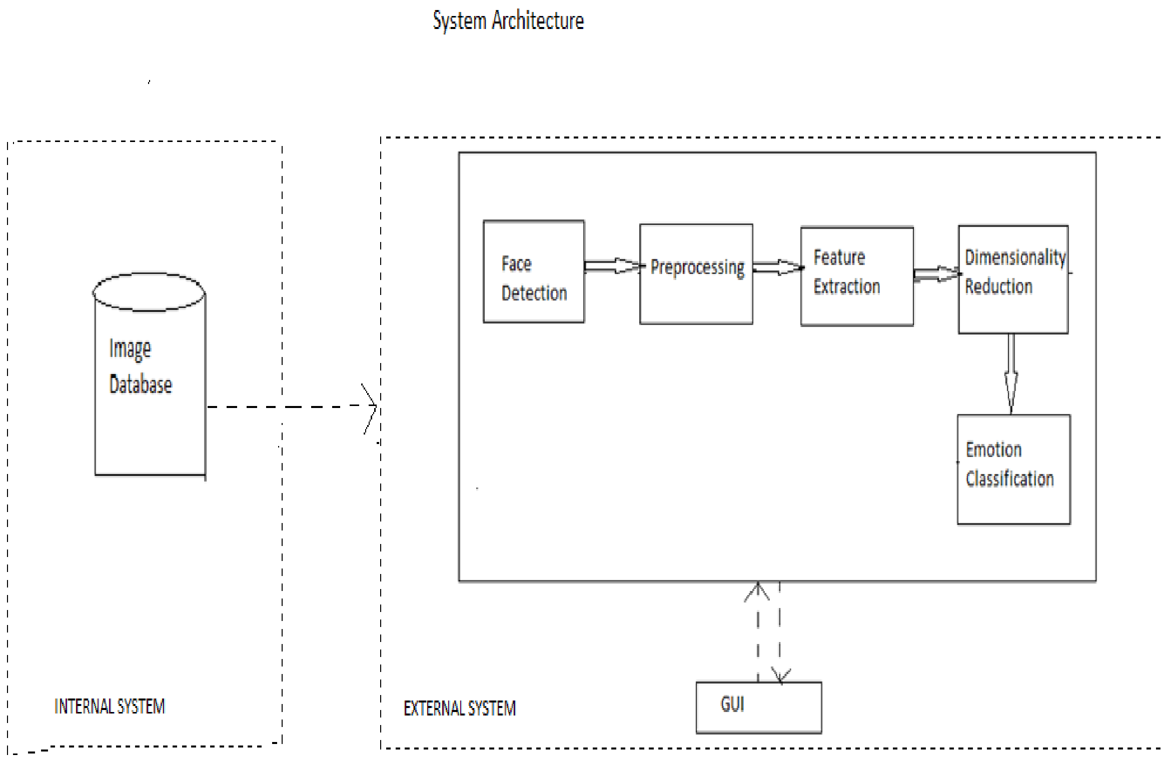


Image database:

Cohn-Kanade database is employed to get photographs of the various expressions posed by ninety-seven individuals. Images taken are around ninety-seven subjects and out of those subjects, the age is ranging between eighteen to thirty years. The database contains solely 35th of the male subject and therefore the remaining 65th are of the female. Out of this 15% is American-African subjects and three are enclosed from Asians. Capturing of the image was done using a camera and the lens kept in front of the subjects. the subjects were asked to perform completely different facial expressions beginning and ending with the neutral faces. The expression given by them covers all the fundamental six emotions. There are around 2000 pictures within which several of them are recurring thus we tend to not use the entire dataset to train the model. However, the dataset is helpful in providing us additional accuracy with the different facial expressions. This knowledge repository is used to train the model which is pictured as an internal system in RERS system architecture. Images of Cohn-Kanade Database.

<u>Face detection:</u>

The first step involves face detection, in which images are captured using a camera or the other digital devices that capture real- time dynamic or static images. And this image is given as an input to the RERS software system. Face Recognition will ensure us whether the face is enclosed within an image. An individual face or multiple faces are detected by open source library OpenCV using python.

<u>Feature extraction:</u>

Initially, the datasets are in the form of images, to extract the features from this dataset several modules are available which will help us to obtain the format required for machine learning. Modules will help us to convert images of arbitrary data into numerical features will be used during machine learning. Eigenface algorithm which plays a vital role to extract the important features called Eigenvectors.

Prior to eigenfaces generation, to identify the eyes and mouth features normalization along with scaling up the pixel resolution is used. Then PCA used to extract the eigenface out of image data in the following approach:

Every image captured is remodelled into a vector of size D(=hw), for given M face images having dimensions of h×w are placed into the set $\{\Gamma_1,\Gamma_2,\cdots,\Gamma_M\}$. The dataset images of faces are suitable for scaling and alignment, and therefore the backgrounds (and presumably on-facial regions such as hair and neck parts) is either eliminated or constant. Each and every faces in a respective image differentiates from the average mean by vector or point, $\Phi_i=\Gamma_i-\Psi$, where the average mean of face is indicated by $\Psi=1/M\sum M_i=1\Gamma_i$. For $A = \{\Phi_1,\Phi_2,\cdots,\Phi_M\}\in R^{D\times M}$, the covariance matrix $C\in R^{D\times D}$ is defined as $C=1/M \sum i=1 \ M \ \Phi_i\Phi_i^{\top}=AA^{\top}$.When $D\gg M$, Eigenvectors of covariance matrix cannot be regimented and it's an unmanageable job for representative images. On the other hand, the eigenvectors of C can be systematically quantified , and one may calculate the eigenvectors of the much smaller given $M\times M$ matrix $A^{\top}A$ initially. The matrices of eigenvalue and eigenvector $A^{\top}A$ are defined as $V=\{v_1,v_2,\cdots v_r\}$. The matrices of Care Λ and $U=AV\Lambda^{-1/2}$, where $U=\{u_i\}$is the collection of eigenfaces.

Eigenvalue calculation:

The linear transformation of a an eigenvector is a non-zero value that varies only by a scalar factor when is applied to a linear algebra domain. In an official way, if linear transformation called T from a vector space *V* over a field *F* into itself and vector v in *V* that is a non- zero vector, then **v** is an eigenvector of *T*. If *T*(**v**) is a scalar multiple of **v**, where λ is a scalar in the field *F*, known as the Eigen value, characteristic root or characteristic value related with the eigenvector v.

In finite-dimensional vector space *V* , the linear transformation *T* can be illustrated as a square matrix *A*, and the vector **v** by a column vector, interpreting the above mapping performed as a scaling of the column vector on the right-hand side and matrix multiplication on the left-hand side in the equation.

Dimensionality reduction:

PCA is concerned with dimensionality reduction. PCA together with linear projection is used to recognize emotions of various faces during a real-time video stream. it'll assist us to reduce the dimension of the different images along with the variations in image data. Principal components are created by the statistical method that uses an orthogonal transformation to convert a group of observations of probably correlative variables. For given p variables within observations, then the aggregate of well-defined principal components is min(n-1,p). Within the given information, the linear transformation is summarized in such a way that the primary principal component has the greatest possible variance which records for the extreme quantity of the variability as possible. In turn, each and every succeeding element has the very best variance potential behind the limitation that it's orthogonal to the preceding components. The following ensured vectors, each being a linear product of the variables and containing n observations is based on an uncorrelated orthogonal set. Relative scaling of the initial variables is sensitive in nature. To learn more about the formulas used in PCA refer the methodology proposed.

PCA involves retention of important vectors where the possible facial expression can be detected. The stage by stage guidelines together with the formulas for the dimensionality reduction by implementing Principal Component Analysis (PCA) which is illustrated below in the following manner:

Step 1: Arrangement and Preparation of Data.

Step 2: Average and Mean calculation

Step 3: Finding the difference of Mean from Original Image.

Step 4: Covariance Matrix computation.

Step 5: Calculationof Eigenvectors and Eigen values for the Covariance Matrix and selection of Principal Components.

Classification:

Classification includes of **Support Vector Machines (SVM)**, which is defined as a formal discriminative classifier determined by a hyper plane separately, otherwise indicated as labeled training data set input (supervised learning). An optimal hyper plane is generated by supervised machine learning algorithm which categorizes new instances. The main intention of this proposed work is to create a self-awareness among individuals and to know the mental behavior of an employee in the corporate world.

SVM, a mathematical function is used to differentiate between multiple objects. These are the classification algorithms used for patterns, during a training phase input data is received to build a decision model accordingly and a function is generated that can be used to find out the future data. This involves process module named as classification, that is formally outlined by separating a hyper plane or its additionally called training the dataset. Optimal hyper plane is produced as an output by the algorithm that categorizes the new examples of datasets. There are 2 approaches, binary classification, and multi-class classification. The system is employed to recognize the facial expressions of people in general through totally different features,that involves the technique like machine learning and neural networks.

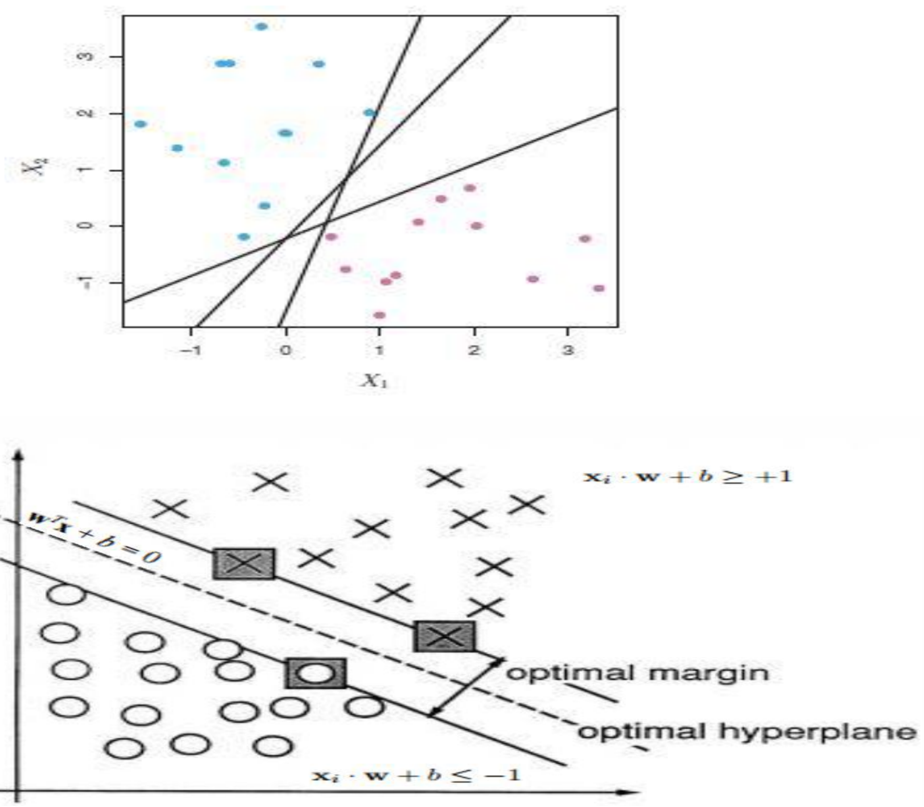


Fig 1. Separating 2D data with maximum-margin 2D data into two classes.

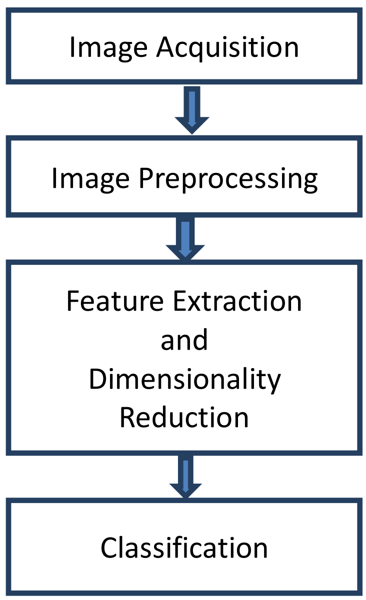
GUI:

Graphical User Interface is used for the interaction with the user. The user may be an instructor of any Educational Institution, owner of an enterprise etc. Input image is either captured by a camera and it is given to the next level to facial expression recognition. Using the software expressions will be classified as six different emotions happy, sad, fear, anger, surprise and disgust. Emotion will be classified using two basic methods such as principal component analysis and support vector machines and later it will be sent to the user to create a self-awareness among individuals and to know the mental behavior of an employee in the corporate world.

PROCESS FLOW DIAGRAM:

Our software RERS deals with recognizing the emotion of an individual and giving them the current psychological state by capturing the static or dynamic image of a human being. certain limitations of the prevailing project have overcome by our proposed emotion recognition project a number of the emotions like being less happy, confusion, lack of interest that wasn't classified before can also be generated by implementing machine learning algorithms .The project work is predicated on extracting a number of the dominant features from the set of and storing them in a database. And we perform a number of mathematical operations in order to train the model. When this brand new captured image or dataset facial image is fed into the RERS software for classification, the dominant features are extracted from detected facial pictures, computes using specific algorithms like PCA, SVM, Eigenfaces and additional packages like Numpy, Scipy, OpenCV for face detection and alternative image processing algorithms that helps in detecting the facial pictures.

Real- time emotion recognition system process consists of following steps:



<u>1) Image Acquisition:</u>

Image acquisition is the first most step to build a real-time emotion recognition system. We are using Cohn-Kanade as our test database initially to train the model, later image acquisition is done by digital cameras in real-time. Cohn-Kanade Facial Expression Database and an extension of it are the datasets used for training and testing of the real-time emotion recognition system. This database is one of the open source set available on the web right now. The dataset consists of images of 210 individuals, exhibiting both posed and spontaneous expressions with time in seconds mentioned at the image background, together with corresponding meta-data(definition of data) which specify the validates the labels data and it varies in quality. The data set consist of both grayscale and color images. The grayscale image is of 8-bit and having size of 640*490 and color image is of 24-bit and having size of 720*480 pixel unit majorly.

2) Image preprocessing:

Image preprocessing the second step that has to be performed right after image acquisition. Usually, when an image is captured it can be disturbed due to factors such as noise and other unwanted defects which will lead to ambiguity, even if the camera position or environment remains unbiased. Therefore, before you proceed to further processing like feature extraction or the emotion classification, the quality of an image needs to be improved through the series of arithmetic and logical operations performed by predefined packages, known as pre-processing.

3) Face detection:

Face detection is the third step. This is an easy task performed using OpenCV with Python. Detecting the face region in an image is an essential part of any facial recognition system or emotion recognition through facial expressions. This process is ideally performed automatically as soon the person faces the cameras and its produces a very low false positive rate during face detection in the video frame or from the dataset. Haar-cascade features, is one such popular classifier for face detection that is being currently opted.

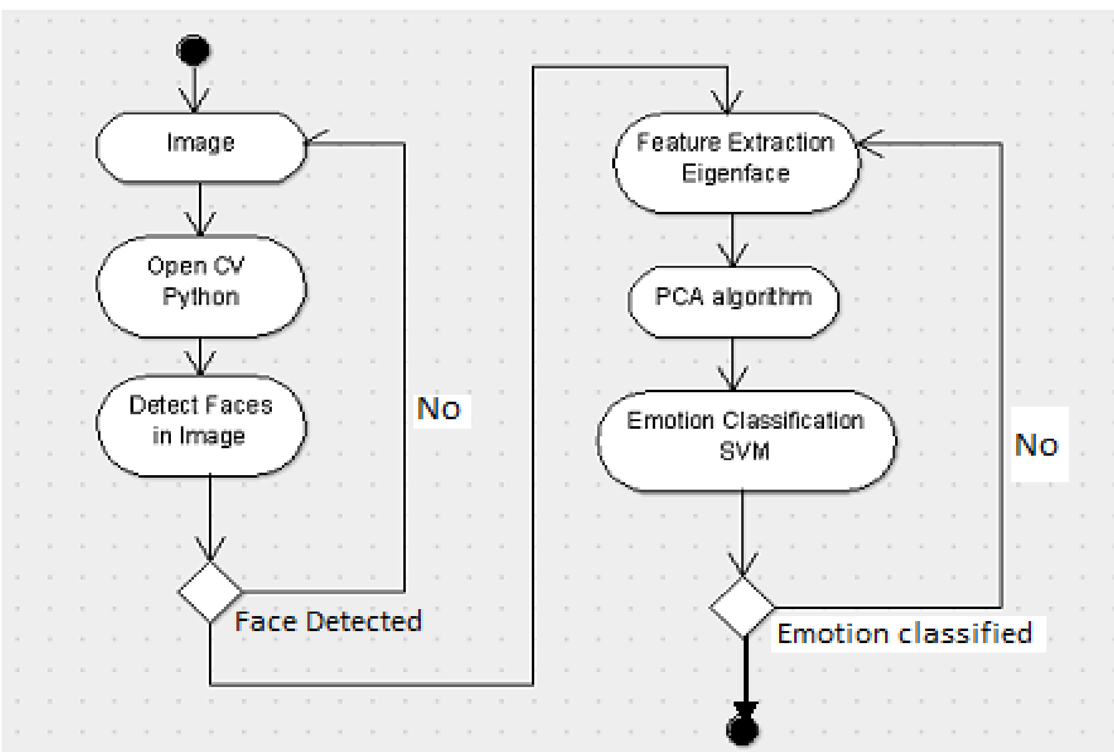
4) Feature extraction and Dimensionality reduction:

Feature Extraction is the fourth step in our proposed system, where the facial expressions of an individual are extracted and this is one of the most important stages for any of the emotion recognition system software. The choice of choosing an algorithm depends not only on factors such as computational properties like time and space complexity of it but also on the type of data like the data definition known as metadata. As a result, the algorithm that we have opted to perform feature extraction is Eigenface calculation, which is widely known for its robustness against illumination modifications and computational efficiency. Further, Principal component analysis plays a major role in dimensionality reduction which retains the efficient eigenvectors for emotion classification by filtering out the unwanted facial features of a person.

5) Emotion classification:

The final step of the system methodology comprises of a machine learning model that is trained to perform emotion classification through facial expressions. Support Vector Machines (SVMs) is very famous and its known as machine learning classifier because if its functionalities. This takes output from the dimensionality reduction module that is the feature vectors as an incoming inputs for classification module and learns different patterns that differentiates one emotion from other. This also falls under the category of supervised algorithm in machine learning domain, which is defined formally by a separating hyper plane and also a differentiating classifier, in other way it can be used to define a trained labelled data. Expressions are classified into six universal emotions such as happiness, sadness, fear, anger, surprise, and disgust. Later on, these emotions are sent to the user, application or an enterprise in the form of feedback through the help of Graphical User Interface.

Activity diagram:



Activity Diagram

Activity diagrams are used to document workflows of a software system, which starts from business level and covers up to operational level. Here we can see different states which represents the operations and the transitions represents the activities that happens when the operations are executed. The main purpose of this diagram is to show that the flow is driven by internal processing vs. external events.

This is an another essential UML illustration which characterizes the dynamic intents of a software system and it is primarily a flowchart display the flow of events from one to another activity accordingly. The activity can be represented as a system operation and the control flow is sketched from one process to another process.