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Real Time Face Detection using Improvised Machine Learning Algorithm

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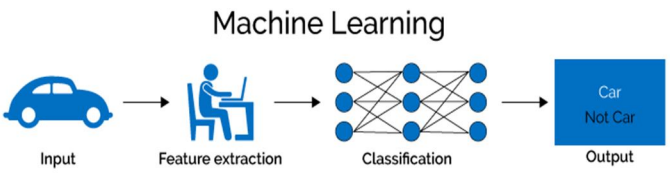
Abstract: ***Face recognition has become an important field in computer-based application development in the last few years. This is because of the wide range of areas in which it is used. In addition, because of the wide variations of faces, face recognition from database images to real-time images/capture images are a challenging problem in front of the face recognition system. Image processing, pattern recognition, and computer vision are relevant technologies which are used in the face recognition field. The innovation of new approaches for the face recognition technology is a continuous subject for building much stronger face recognition algorithms. In this work, to identify a face, we are using Machine learning algorithms and python as the programming language. We are using Open-CV, the most popular library for computer vision, provides bindings for Python. Open-CV uses machine learning algorithms to search for faces within a picture. In this system we already store some images of the person in our database along with his details. By using this system, the surveillance camera system present at some public Space which automatically matches the input faces with that persons database and gives Notification if the results are matched.***
Keywords: Input Image/Live Video Input, Dataset of Images, Face Detection, Image Pre-processing, Features Extraction, PCA, Database of Authenticated Users, SVM Algorithm,

I. INTRODUCTION

Over the most recent couple of years, face recognition system has been considered as the most imperative applications compared to other biometric-based systems. The face recognition process can be stated as follows: Given a database consisting of many face pictures of known people, one inputs a face picture or a live video stream, and the process aims to verify or determine the identity of the person in the input image or video.

Face recognition system using image processing and various detection algorithms have been of interest to many young as well as senior researchers. The development in this area has been quite speedy due to the popularity as well as need behind such systems in modern day organizations. With the fast growing continuous improvements in machine learning algorithms the attention towards developing the system that would be able to detect as well as recognize a person's face has been ever increasing. Face detection deals with the marking of an area of the image that may contain the human face and face recognition deals with the decidability of which person that face belongs to. Such kinds of systems have been largely used for the purpose of marking attendance in multiple educational and institutional organizations. Image processing is an integral part of Facial recognition systems. It basically deals with filtering, resizing, reshaping and enhancement of images which are further sent for detection to the actual system. Image enhancement methods to undo the effect of degradations of the image are a more sophisticated class of image processing. Interestingly this is another field in the growing research area.

Machine learning - : Machine learning is a concept that a computer program can learn and adapt to new data without any human interference. Machine learning is a field of artificial intelligence (AI) that keeps a computer's built-in algorithms current regardless of changes in the worldwide economy. So for the face recognition system we are using SVM (Support Vector Machine) Algorithm.



In Machine Learning we are basically taking 3 steps-

1) *Detect:* Find the faces in the pictures.
2) *Landmark:* Find and extract the facial features of the image.
3) Compare: Identify and compare both the images (real time image with the database image).

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II. LITERATURE WORK

Following are the research papers we studied for the face recognition and the face detection system.

A. Deep Neural Network for Human Face Recognition

1) Dr. Priya Guptaa, Nidhi Saxena, Meetika Sharma, Jagriti Tripathia

2) This paper gives information of Face recognition (FR), the process of identifying people through facial images, by using Convolution Neural Networks (CovNets), which is a type of deep networks has been proved to be successful for FR.

3) 2018 (IEEE Journal)

B. Real-Time Implementation Of Face Recognition System

1) Neel Ramakant Borkar and Sonia Kuwelkar

2) This paper proposes a hybrid face recognition algorithm by combining two face recognition techniques by integrating (PCA) principle Component Analysis and (LDA)

3) 2017 (IEEE Journal)

C. Research on 3D Face Recognition Algorithm

1) Yu Song, Wenhong Wang and Yanyan Chen

2) 3D face recognition methods are able to overcome the problems of illumination, expression or pose variations in 2D face recognition.

3) 2009 (IEEE Journal)

D. Implementation of Face Recognition Algorithm for Biometric Based Time Attendance System.

1) Maulahikmah Galinium, Adrian Rhesa Septian Siswanto and Anto Satriyo Nugroho

2) Face Recognition begins with extracting the coordinate of features such as width of mouth; eyes, pupil, and compare with the measurements stored in the database and return the (facial metrics). To get the best facial recognition algorithm (Eigenface and Fisherface) provided by the Open CV by comparing the ROC curve.

3) 2012 (PTIK_BPPT Paper)

III. PROPOSED WORK

We are developing the Face recognition (AI) app using Machine learning and Python which uses Open-CV library to provide the high quality images for facial recognition and increase the security.

The System should be strong enough to be able to replace traditional image processing system. It should also be able to verify the image which is present in our database with the real time image of the person.

We are developing a system which can detect and recognize the face. Initially we divide the system into two main parts:

1) Face Detection

2) Face Recognition

In Face Detection we are detecting the face of a user excluding all remaining parts in the image or in live video. This face detection is done by using three methods and they are as follows:

a) Image Processing – Coding

b) Image Enhancement and Restoration

c) Principle Component Analysis (PCA)

In face Recognition we are going to recognize the person's image by comparing it with the detected image of the same person. In this we are going to compare the image which is already stored in the database with the real time detected image of a person. This face detection is done by two methods:

i) Segmentation

ii) Open CV

The main motto of our system is to develop face recognition System which uses machine learning as a key ingredient to Recognize and map a person's facial features from a video or Photo and then tries to match the information on databases to Verify someone's identity.

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A. Face Detection

Face detection is done by image processing and pattern Processing. So for the image processing we have to mainly focus on image coding (reduced the bandwidth transmission of an Image) and image enhancement (improving the appearance of An image).

1) *Image Processing – Coding:* It is one of the basic approaches to apply an invertible transform to the given image. It approximate the image transform and then construct the approximate image by inverting the transform. This transform can be designed so that it can be approximate more economically than the original image. So that errors in this approximation become less noticeable when an image is reconstructed from its transform. There are many other approaches to image coding one of that is to take the differences between successive image samples; since These differences contain very non-uniform probability density, These image differences can be either spatial (intraframe) or Temporal (interframe).The expected accuracy of an image coding system can be predict theoretically, if we assume a model for the class of images where they are being encoded and a specific error criteria is present. Images are usually consisting of distinct parts, so that a homogeneous random field model is inappropriate. Work is needed on image coding techniques which segment the image into significant parts before attempting to approximate it; at the same time, increased understanding of human visual capabilities is needed.

a) *Image Enhancement and Restoration:* In image enhancement there are mainly 2D digital filters are used. And it contains point wise modification of the Grayscale images. A good class of image enhancement is designed to remove the effects of degradation on the image. These degradations are additive combinations of blurring and noise operations. Where blurring takes the form of a weighted sum/integral operation applied to the ideal image, and the noise is uncorrelated data with the ideal image. In case of image coding, these approaches are usually based on the homogeneous random field models for the images and on least squares error criteria.Here image models are based on segmentation of the image and their success criteria is more closely related to the human perceptual abilities which are highly desirable.

b) *PCA (Principle Component Analysis):* This method is used for dimension reduction and feature extractions of an image. This strategy helped to reduce dimensionality of the original data of an image by extracting the main components of multidimensional data. PCA is often used to reduce the dimensionality of large data sets, by transforming a large set of variables into a smaller one which still contains most of the information in the large set. It is normally used to produce a set of Eigenface. Similarly, you can think of Eigenface as a set of standard face elements that you can calculate by statistically analyzing a large number of face images.

B. Face Recognition

The aim of image recognition is the classification or Structural description of images. Image classification involves feature detection and image measurement. Image description consists of image segmentation and relational structure extraction. Detecting the presence of a specified pattern (such as an edge, a line, a particular shape, etc.) in an image requires matching image with a "template," or standardized version of the pattern. Template matching is implemented as a linear operation in which the degree of match at any point is measured by a linear combination of image in gray levels with a neighborhood point. However, the result of such a linear operation is generally ambiguous. Such ambiguities can be eliminated by breaking the template into parts and requiring that part with specified match so that the conditions can be satisfied for each part, or for the most of the Parts. This approach has been used to detect curves of images.

The use of this template parts can also helps to overcome the sensitivity of template matching to geometrical distortion. Rather than matching the entire template with the image, one can match the parts, and then look for combinations of positions. Optimal combinations can be determined by mathematical programming techniques or by simultaneous iterated reinforcement of the partial matches which are totally based on the presence of the other needed matches.

1) Segmentation: Images are composed of regions which contain Different ranges of gray levels, or of the values of some other local properties. Such image can be segmented by examining its gray level. For segmentation there are Parallel methods of region extraction based on thresholding. They are potentially less flexible than sequential methods, which can learn about the geometrical, textural, and gray level properties of the region being extracted from the image. and then they can compare them with any available information about the types of regions or objects that are supposed to be present in the image. Such information can be used to control merging and splitting processes which can be used to create an acceptable partition of the image into regions. An important case of sequential region growing is tracking, which extracts regions (or region boundaries) in the form of thin curves. This technique can be used as a type of piecewise template matching, where the pieces are short line or curve segments, and a curve is any combination of these which smoothly continues one another; thus, here again, curves can be extracted by mathematical programming or iterated reinforcement techniques.

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a) *Open CV (Computer Vision Library):* OpenCV is a Computer vision library of programming functions mainly used at real-time computer vision. OpenCV was built to provide a common infrastructure for computer vision applications and to speed up the use of machine perception in the commercial products. OpenCV is the huge open-source library for the computer vision, machine learning, and image processing. And nowadays it plays a major role in real-time operation which is very important for face recognition systems. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human. So we are using Open-CV library for computer vision, which provides bindings for Python. Open-CV uses machine learning algorithms to search for faces within a picture.

IV. ALGORITHM

There are many Face Recognition algorithms are present. These algorithms mainly focus on the detection of frontal human faces. By using these algorithms we can perform image detection and recognition in which the image of the person is matched bit by bit.
Face recognition algorithms mainly contains two types such as:

1) Geometry based Algorithms
2) Template based Algorithms.

This Template-based Algorithm contain many face recognition algorithms like SVM [Support Vector Machines], PCA [Principal Component Analysis], LDA [Linear Discriminant Analysis], Kernel methods/Trace Transforms.
The geometric feature based Algorithms analyses local facial features and their geometric relationship. It is also known as a feature-based Algorithm
Other than these there are many more face Recognition algorithms are present such as:

a) Eigenface Algorithm
b) Local Binary Patterns Histograms (LBPH)
c) Fisherface Algorithm
d) Linear Discriminant Analysis (LDA)
e) Scale Invariant Feature Transform (SIFT)
f) Speed Up Robust Features (SURF)
g) Independent component Analysis (ICA)
h) Elastic Bunch Graph Matching (EBGM)
i) Kernel Algorithm
j) Trace Transform
k) Active Appearance Model (AAM)
l) Support Vector Machine (SVM)
m) Hidden Markov Model (HMM)
n) 3-D Face Recognition
o) Bayesian Framework

From above all these algorithm we are using SVM Algorithm for Face Recognition System because it gives better performance and high accuracy than the remaining algorithms. SVM uses the radial basis function kernels which are more likely use to perform better as they can handle non-linearity in the data. As compare to other algorithms, SVM captures better inherent characteristics of the face.

A. *Support Vector Machine (SVM)*

SVM stands for Support Vector Machine (SVM). It is one of the most popular and important techniques in the classification field. The SVM classifier has the advantage over the traditional neural network because it can achieve better generalization performance as compared to ANN whereas; Multi Class SVM has better accuracy as compared to other technologies.
SVM works relatively well when there is a clear margin of separation between classes. It is more effective in high dimensional spaces and in cases where the number of dimensions is greater than the number of samples. SVM is based on the concept of decision planes which defines decision boundaries. A decision plane is one which separates a set of objects which have different class members.
SVM is relatively memory efficient because it uses subset of training points (Support Vectors) as decisive factors for classification and it can handle many features at a time.

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"Support Vector Machine" (SVM) is a supervised machine_learning_algorithm which can be used for either classification or regression challenges. However, it is mostly used in classification problems. In the SVM algorithm, we plot each data item as a point in N-dimensional space (where N is the number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiates the two classes very well as we can see in the below diagram.

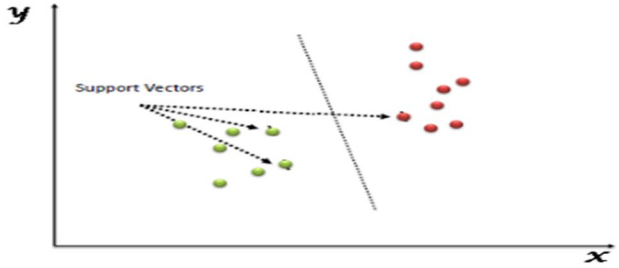

Fig: SVM Support Vectors

As we see in above figure Support Vectors are simply the co-ordinates of individual observation.
The SVM classifier is a frontier which best segregates the two classes which are hyper-plane and hyper line. As we see below:

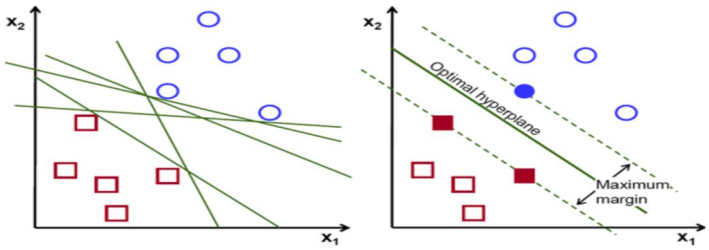

Fig: SVM Feature Selection and Hyper-plane.

However, SVM cannot be used when the feature vectors which define samples have missing entries. A classification algorithm which is successfully used in this framework is the all-known Support Vector Machines (SVM), which can be applied to the original appearance space or a subspace which is obtained after applying a feature extraction method. The advantage of SVM classifier over traditional neural network is that SVMs can achieve better generalization performance.

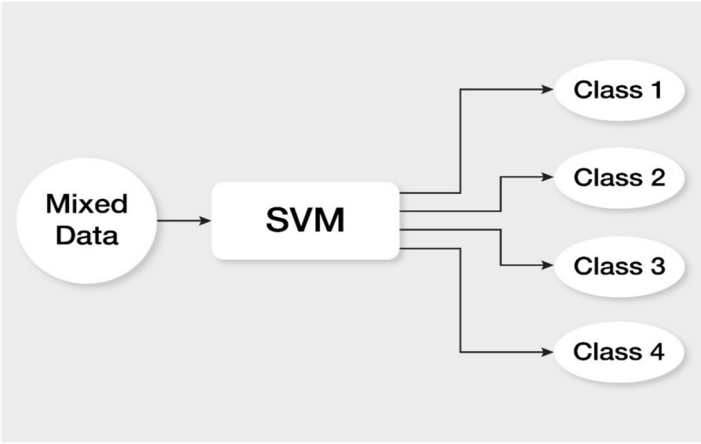

Fig: SVM Classification

As we see in above diagram the mixed data of an image is passed to the SVM where classification and regression of the data is take place. After this the regretted data is classified in different classes as we see in the above diagram that class 1, class 2, class 3 and class 4 etc.
These classifications of data into different classes will easier the process of face recognition.

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B. The complete process of SVM Algorithm

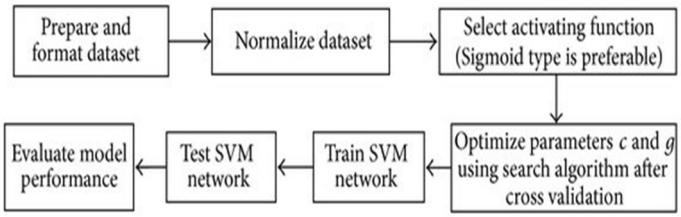

Fig: SVM Algorithm

In the above process first we have to prepare the dataset of an image then next we have to normalize the dataset according to the face and its features. After that we have to select the activating function for the face recognition. Then after activating the sigmoid type of function which is mostly prefer we have to optimize the parameters using various search algorithms after cross validation.
After optimizing the parameters of an image we have to train the SVM network after training we have to test that network to avoid any interruption/ error. At last after testing the SVM we have to evaluate the entire model for its performance.

V. CONCLUSION

This paper mainly aims at developing a significant system of face recognition in which machine learning is a key ingredient as well as image processing and SVM algorithm. It illustrates the importance of face recognition and its various processes of face detection. This article mainly reviews on a new face recognition system where we can easily compare the real time image of a person with the image stored in database. But apart from that the Face expression, occlusion, pose variation, and illumination problems are still a big challenge in this system.
The image coding and image enhancement techniques are most important for face detection. And for the face recognition SVM algorithm is important.
Hence for the implementation where the biometric system must verify and identify users real time image with the existing one. This facial scanning (Recognition and Verification) system is very effective and efficient in today's era.

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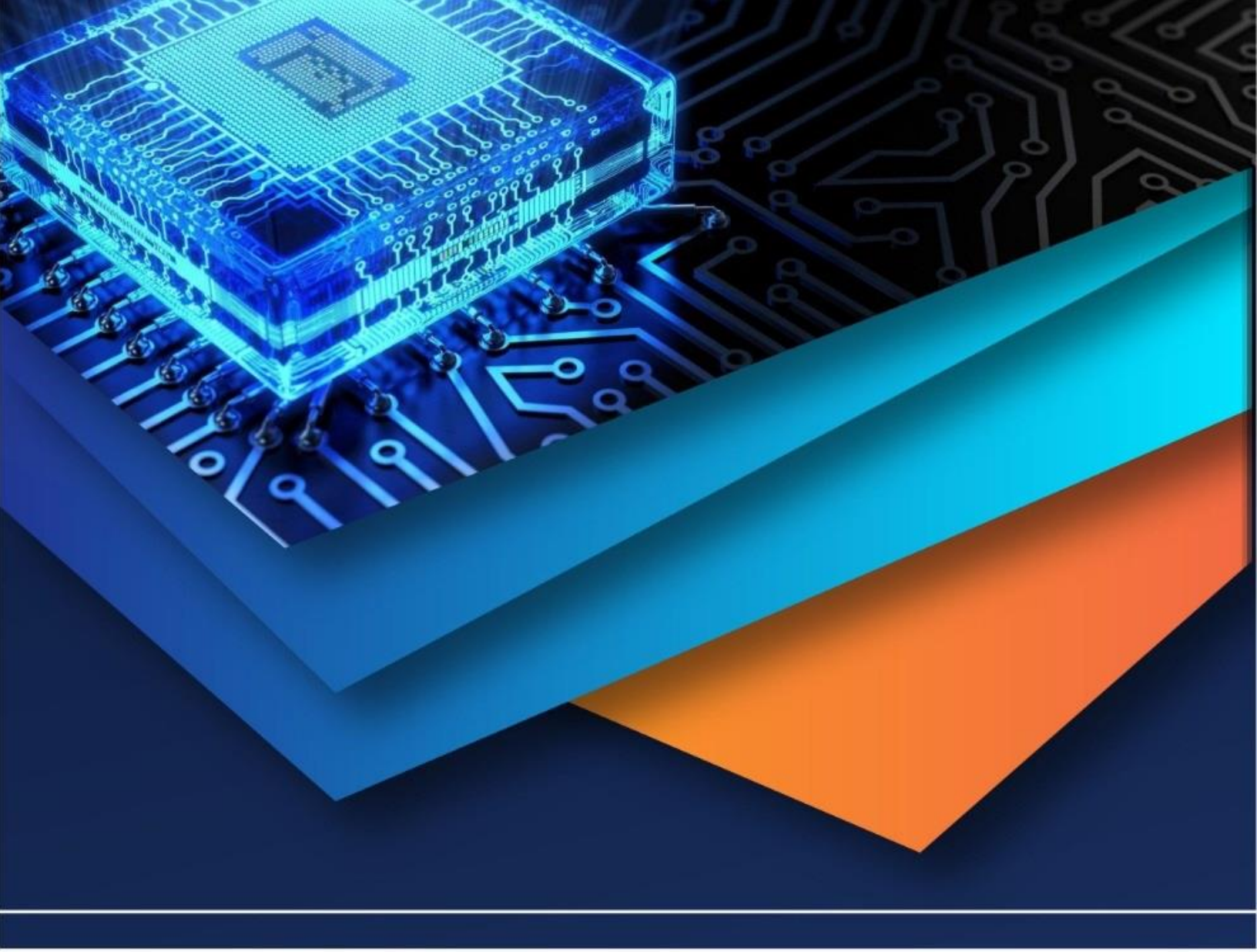

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