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FACE RECOGNITION SYSTEM

A Report for the Evaluation 3 of Project 2

Submitted by

ABHINAV

BHATTACHARYA

(18032030066)

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Under the Supervision of

Mr. Praveen Dominic,
Professor

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SCHOOL OF COMPUTING AND SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

Certified that this project report **"FACE RECOGNITION SYSTEM"** is the bonafide work of **"ABHINAV BHATTACHARYA(18032030066)"** who carried out the project work under my supervision.

SIGNATURE OF HEAD
Dr. MUNISH SHABARWAL,
PhD (Management), PhD (CS)
Professor & Dean,
School of Computing Science & Engineering

SIGNATURE OF SUPERVISOR
Mr. PRAVEEN DOMINIC,
Professor,
School of Computing Science & Engineering

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ABSTRACT

A face detection system is a computer application for automatically detecting human faces from a digital image or a video frame from a video source. Face detection is a pre-processing of face recognition. Face (facial) recognition is the identification of humans by the unique characteristics of their Faces. Face recognition technology is the least intrusive and fastest biometric technology. It works with the most obvious individual identifier the human face. With increasing security needs and with advancement in technology extracting information has become much simpler. This project aims on building an application based on face recognition using different algorithms and comparing the results. The basic purpose being to identify the face and retrieving information stored in database. It involves two main steps. First to identify the distinguishing factors in image n storing them and Second step to compare it with the existing images and returning the data related to that image. The various algorithms used for face detection are PCA Algorithm, SVM (Support Vector Machine), FS (Feature Scaling), SVC (Support Vector Classifier) and Grey Scale Algorithm.

INTRODUCTION

A face detection system is a computer application for automatically detecting human faces from a digital image or a video frame from a video source. Face detection is a pre-processing of face recognition.

OVERALL DESCRIPTION

Face (facial) recognition is the identification of humans by the unique characteristics of their Faces. Face recognition technology is the least intrusive and fastest biometric technology. It works with the most obvious individual identifier the human face. With increasing security needs and with advancement in technology extracting information has become much simpler. This project aims on building an application based on face recognition using different algorithms and comparing the results. The basic purpose being to identify the face and retrieving information stored in database. It involves two main steps. First to identify the distinguishing factors in image n storing them and Second step to compare it with the existing images and returning the data related to that image. The various algorithms used for face detection are PCA Algorithm, SVM (Support Vector Machine), FS (Feature Scaling), SVC (Support Vector Classifier) and Gray Scale Algorithm.

MOTIVATIONS AND SCOPE

Biometrics: Biometrics is used in the process of authentication of a person by verifying or identifying that a user requesting a network resource is who he, she, or it claims to be, and vice versa. It uses the property that a human trait associated with a person itself like structure of data with the incoming data we can verify the identity of a particular person. There are many types of biometric system like detection and recognition, iris recognition etc., these traits are used for human identification in surveillance system, criminal identification, face details etc. By comparing the existing fingerprint recognition.

Face Recognition: Human beings have recognition capabilities that are unparalleled in the modern computing era. These are mainly due to the high degree of interconnectivity, adaptive nature, learning skills and generalization capabilities of the nervous system. The human brain has numerous highly interconnected biological neurons which, on some specific tasks, can outperform supercomputers. A child can accurately identify a face, but for a computer it is a cumbersome task. Therefore, the main idea is to engineer a system which can emulate what a child can do. Advancements in computing capability over the past few decades have enabled comparable recognition capabilities from such engineered systems quite successfully. Early face recognition algorithms used simple geometric models, but recently the recognition process has now matured into a science of sophisticated mathematical representations and matching processes. Major advancements and initiatives have propelled face recognition technology into the spotlight. Face recognition technology can be used in wide range of applications. Computers that detect and recognize faces could be applied to a wide variety of practical applications including criminal identification etc. Face detection and recognition is used in many places nowadays, verifying websites hosting images and social networking sites. Face recognition and detection can be achieved using technologies related to computer science. Features extracted from a face are processed and compared with similarly processed faces present in the database. If a face is recognized it is known or the system may show a similar face existing in database else, it is unknown. In surveillance system if an unknown face appears more than one time then it is stored in database for further recognition. These steps are very useful in criminal identification. In general, face recognition techniques can be divided into two groups based on the face representation they use appearance-based, which uses holistic texture features and is applied to either whole-face or specific face image and feature-based, which uses geometric facial features (mouth, eyebrows, cheeks etc.), and geometric relationships between them.

An important aspect is that such technology should be able to deal with various changes

in face images, like rotation, changes in expression. Surprisingly, the mathematical variations between the images of the same face due to illumination and viewing direction are almost always larger than image variations due to changes in face identity. This presents a great challenge to face recognition. At the core, two issues are central to successful face recognition algorithms: First, the choice of features used to represent a face. Since images are subject to changes in viewpoint, illumination, and expression, an effective representation should be able to deal with these possible changes.
Secondly, the classification of a new face image using the chosen representation. Face Recognition can be of two types:

- ➢ Feature Based (Geometric)
- ➢ Template Based (Photometric)

In geometric or feature-based methods, facial features such as eyes, nose, mouth, and chin are detected. Properties and relations such as areas, distances, and angles between the features are used as descriptors of faces. Although this class of methods is economical and efficient in achieving data reduction and is insensitive to variations in illumination and viewpoint, it relies heavily on the extraction and measurement of facial features. Unfortunately, feature extraction and measurement techniques and algorithms developed to date have not been reliable enough to cater to this need. In contrast, template matching and neural methods generally operate directly on an image-based representation of faces, i.e., pixel intensity array. Because the detection and measurement of geometric facial features are not required, this type of method has been more practical and easier to implement when compared to geometric feature-based methods.

PURPOSE

Face Recognition human facial features like the mouth, nose and eyes in a full frontal face image. We have adapted a multi-step process in order to achieve the goal. To detect the face region, we have used a skin-color segmentation method. Morphological techniques are adapted to fill the holes that would be created after the segmentation process. From the process of obtaining a skeleton like structure, a skeleton of the face is obtained from which face contour points could be extracted. Facial features can be located in the interior of the face contour. We have used several different facial-images to test our method.

Trying to find a face within a large database of faces. In this approach the system returns a possible list of faces from the database. The most useful applications contain crowd surveillance, video content indexing, personal identification (example: driver’s license, voter id etc.), mugshots matching, etc.

Real time face recognition: Here, face recognition is used to identify a person on the spot and grant access to a building or a compound, thus avoiding security hassles. In this case the face is compared against a multiple training samples of a person.

PROBLEM STATEMENT

The study and analysis of faces captured by digital cameras address a wide range of challenges, as detailed below, which all have a direct impact on the computer automated face detection and recognition.

Pose variations

Fig. 1. Variations in pose

Head's movements, which can be described by the egocentric rotation angles, i.e. pitch, roll and yaw , or camera changing point of views could lead to substantial changes in face appearance and/or shape and generate intra-subject face's variations as illustrated in the figure, making automated face recognition across pose a difficult task.

Since AFR is highly sensitive to pose variations, pose correction is essential and could be achieved by means of efficient techniques aiming to rotate the face and/or to align it to the image's axis.

Presence/absence of structuring elements/occlusions

Fig. 2. Presence/absence of obstructions

The diversity in the intra-subject face's images could also be due to the absence of structuring elements or the presence of components such as beard and/or moustache, cap, sunglasses, etc. or occlusions of the face by background or foreground objects.

Thus, face's images taken in an unconstrained environment often require effective recognition of faces with disguise or faces altered by accessories and/or by occlusions, as dealt by appropriate approaches such as texture-based algorithms.

Facial expression changes

Fig. 3. Changes in facial expression

Some more variability in face appearance could be caused by changes of facial expressions induced by varying person's emotional states which are displayed in Figure.

Hence, efficiently and automatically recognizing the different facial expressions is important for both the evaluation of emotional states and the automated face recognition. In particular, human expressions are composed of macro-expressions, which could express, e.g., anger, disgust, fear, happiness, sadness or surprise, and other involuntary, rapid facial patterns, i.e. micro-expressions; all these expressions generating non-rigid motion of the face. Such facial dynamics can be computed, e.g., by means of the dense optical flow field.

Ageing of the face

Fig. 4. Ageing effects on the face

Another reason of face appearance's changes could be engendered by the ageing of the human face, and could impact on the entire AFR process if the time between each image capture is significant, as illustrated in the figure.

To overcome face ageing issue in AFR, methods need to take properly into account facial ageing patterns. Indeed, over time, not only face characteristics such as its shape or lines are modified, but other aspects are changing as well, e.g. hairstyle.

Varying illumination conditions

Fig. 5. Varying lighting conditions

Large variations of illuminations could degrade the performance of AFR systems. Indeed, for low levels of lighting of the background or foreground, face detection and recognition are much harder to perform, since shadows could appear on the face and/or facial patterns could be (partially) indiscernible. On the other hand, too high levels of lights could lead to over-exposure of the face and (partially) indiscernible facial patterns.

Robust automated face detection and recognition in the case of (close-to-) extreme or largely varying levels of lighting apply to image-processing techniques such as illumination normalization, e.g. through histogram equalization, or machine-learning methods involving the actual image global image intensity average value.

Image resolution and modality

Other usual factors influencing AFR performance are related to the quality and resolution of the face image and/or to the set-up and modalities of the digital equipment capturing the face. For this purpose, ISO/IEC 19794-5 standard has been developed to specify scene and photographic requirements as well as face image format for AFR, especially in the context of biometrics. However, real-world situations of face image acquisition imply the use of different photographic hardware, including one or several cameras which could be omnidirectional or pan-tilt-zoom, and which could include, e.g. wide-field sensors, photometric stereo, etc. Cameras could work in the range of the visible light or use infrared sensors, leading to multiple modalities for AFR. Hence, faces acquired in real-world conditions lead to further AFR challenges.

For example, as shown in figure, in some situations, a face could be captured at distance resulting in a smaller face region image compared to the one in a large-scale picture. On the other hand, some digital camera could have a low resolution or even very low resolution, if the resolution is below 10×10, leading to poor quality face images, from which AFR is very difficult to perform. To deal with this limitation, solutions have been proposed to reconstruct a high-resolution image based on the low-resolution one using the super-resolution method.

Availability and quality of face datasets

Each AFR technology requires an available, reliable and realistic face database in order to perform the 1: N or 1:1 face search within it. Hence, the quality such as completeness (e.g. including variations in facial expressions, in facial details, in illuminations, etc.) as well as accuracy (e.g. containing ageing patterns, etc.) and the characteristics (e.g. varying image file format and color/grey level, face resolution, constrained/unconstrained environment, etc.) of a face dataset are crucial to the AFR process. Moreover, when dealing with face data, people's consent and privacy should be respected as AFR systems should comply with the Data Protection Act 2010.

LITERATURE SURVEY

Several algorithms and techniques for face recognition have been developed in the past by researchers. These are discussed briefly in this section.

Face Recognition Based on Independent Component Analysis:

A number of current face recognition algorithms use face representations found by unsupervised statistical methods. Typically, these methods find a set of basis images and represent faces as a linear combination of those images. Principal component analysis

(PCA) is a popular example of such methods. The basis images found by PCA depend only on pairwise relationships between pixels in the image database. In a task such as face recognition, in which important information may be contained in the high-order relationships among pixels, it seems reasonable to expect that better basis images may be found by methods sensitive to these high-order statistics. Independent component analysis (ICA), a generalization of PCA, is one such method. We used a version of ICA derived from the principle of optimal information transfer through sigmoidal neurons. ICA was performed on face images in the FERET database under two different architectures, one which treated the images as random variables and the pixels as outcomes, and a second which treated the pixels as random variables and the images as outcomes. The first architecture found spatially local basis images for the faces. The second architecture produced a factorial face code. Both ICA representations were superior to representations based on PCA for recognizing faces across days and changes in expression. A classifier that combined the two ICA representations gave the best performance.

Eigen-spaces:

Eigenspace-based face recognition corresponds to one of the most successful methodologies for the computational recognition of faces in digital images. Starting with the Eigenface Algorithm, different eigenspace-based approaches for the recognition of faces have been proposed. They differ mostly in the kind of projection method used (standard, differential, or kernel eigenspace), in the projection algorithm employed, in the use of simple or differential images before/after projection, and in the similarity matching criterion or classification method employed. The aim of this paper is to present an independent comparative study among some of the main eigenspace-based approaches. We believe that carrying out independent studies is relevant, since comparisons are normally performed using the implementations of the research groups that have proposed each method, which does not consider completely equal working conditions for the algorithms. Very often, a contest between the abilities of the research groups rather than a comparison between methods is performed. This study considers theoretical aspects as well as simulations performed using the Yale Face Database, a database with few classes and several images per class, and FERET, a database with many classes and few images per class.

Elastic bunch Graph Matching:

The algorithm is modeled after the Bochum/USC face recognition algorithm used in the FERET evaluation. The algorithm recognizes novel faces by first localizing a set of landmark features and then measuring similarity between these features. Both localization and comparison uses Gabor jets extracted at landmark positions. In localization, jets are extracted from novel images and matched to jets extracted from a set of training/model jets. Similarity between novel images is expressed as function of similarity between localized Gabor jets corresponding to facial landmarks.

Linear Discriminant Analysis:

Both PCA and ICA do not use face class information. Linear Discriminant Analysis (LDA) finds an efficient way to represent the face vector space by exploiting the class information. It differentiates individual faces but recognizes faces of the same individual. LDA searches for vectors in the underlying space that best discriminate among classes. For all the samples of all classes, two measures are defined.

PROPOSED SYSTEM

The previous sections illustrate different techniques and methods of face detection and recognition. Each category of method performs well in certain criteria and also has drawbacks as well. Systems with robustness and certain level of accuracy are still far away. Keeping in view case study the following architecture is proposed for the detection and recognition system.

As discussed earlier that the robust system catering the needs of real world situation is a challenging task. The images will be scanned by scanner and stored into database. Again the image will be scanned and stored into the database. Now two images of the same candidate will be stored into the database. The first step is to select desired images from the database then for comparisons them the next step is to detect faces from each image. The next step is to recognize that images as of the same candidate or not.

In theory we have tried to hybridize selected algorithms to achieve better results in terms of processing speed and accuracy. The main goal of this paper was to achieve an improved recognition rate by hybridizing Gabor wavelet with Eigen-Faces face recognition features found by Principal Component Analysis(PCA), gray-scaling, Standard Scaler, Logistic Regression and SVM which would tune-up the recognition process by notable stats.

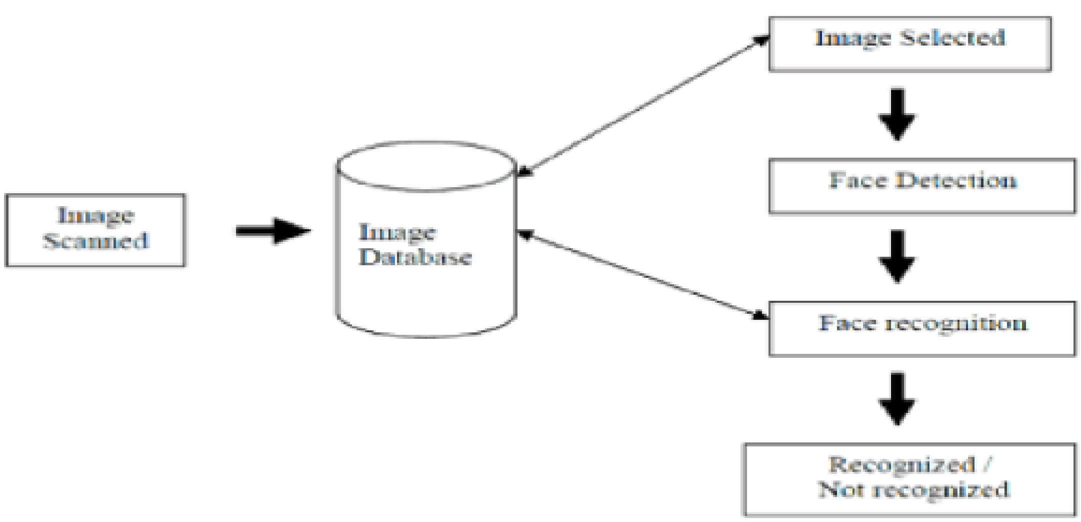

Fig. 6. Basic Structure of AFR

RESULT

The algorithm used here is as follows:

- Input the name of the user corresponding to the face to be read

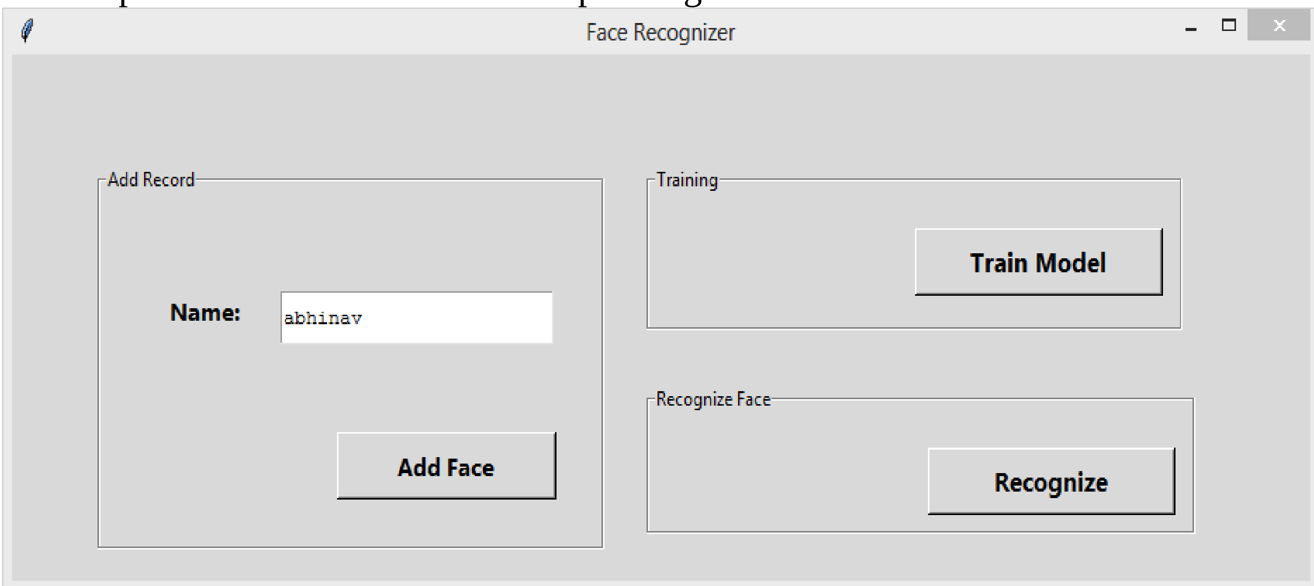

Fig. 7. The UI

- The face of the user is captured using the opencv_face function

Fig. 8. Sample face dataset

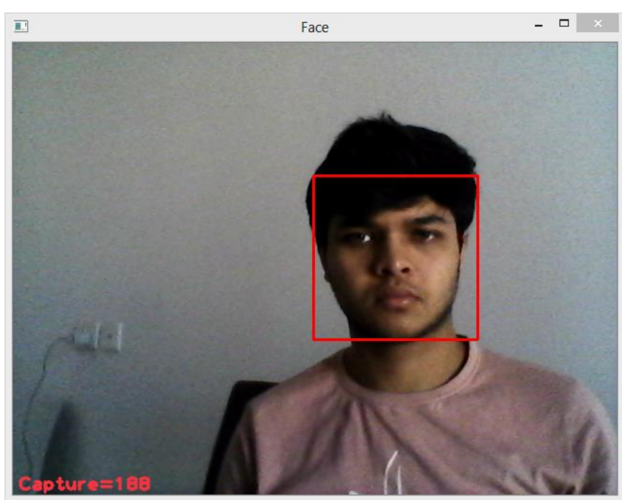

Fig. 9. The capturing of the user face data

- The image resolution parameter is set to 4 (im_{res})
- The PCA dimensionality parameter is set to (PCA_{DIM})
- The cropped images are converted to gray-scale
- The new face dataset of the corresponding user is ready
- Training data matrix ($M_{traindata}$) is formed
- Training class labels matrix ($M_{trainlabels}$) is formed
- PCA transformation matrix (tmatrix) is calculated
- Feature vectors of all training images are calculated using the derived tmatrix
- The trained feature vectors are stored in a matrix
- A message box appears stating the training is completed

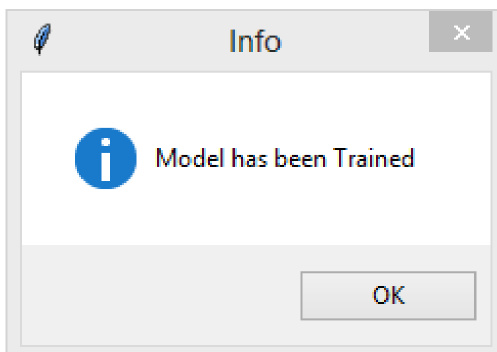

Fig. 10. Message box stating the completion of the training

- Recognize faces option is selected
- The face of the current user is captured using the opencv_face function for testing
- Read test faces for each test face
- The feature vector of a test face is calculated using tmatrix
- The distances between test feature vector and all training vectors is calculated
- The distances together with the training class labels is stored

- Error count is initialized to zero.
- For each test face repeat the same
- The distance data is used to determine the person ID of the closest matching training vector
- In case the test ID is found to be not equal to the ID of the face dataset image error count incremented
- The correct user name is displayed:

(1 - (error count/ total test image count))*100

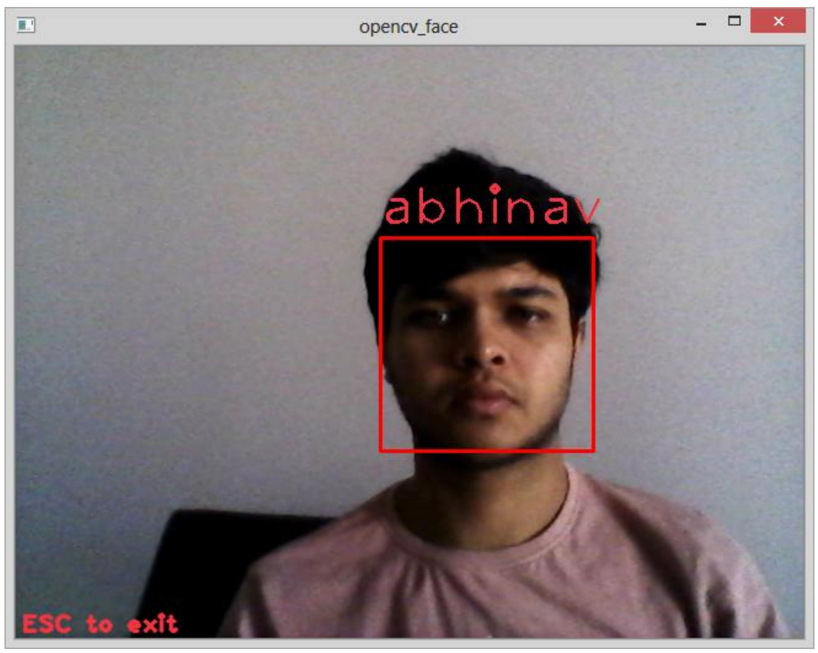

Fig. 11. The matched user name is displayed

CONCLUSION

Face recognition systems are useful in law enforcement and justice solutions by staying one step ahead of the world's ever-advancing criminals. This includes acclaimed CABS (computerized arrest and booking system) and the child base protection which is a software solution for global law enforcement agencies to help protect and recover missing and sexually exploited children, particularly as it relates to child pornography. It is also useful in Homeland defense which includes everything from preventing terrorists from boarding aircraft, to protecting critical infrastructure from attack or tampering (e.g. dams, bridges, water reservoirs, energy plants, etc.), to the identification of known terrorists. It is also applicable in airport and other transportation terminal security. Face recognition software, can enhance the effectiveness of immigration and customs personnel. The financial services industry revolves around the concept of security. Face recognition software, can improve the security of the financial services industry, saving the institution time and money both through a reduction of fraud case and the administration expenses of dealing with forgotten passwords. Furthermore, biometric-based access control units can safeguard vaults, teller areas, and safety deposit boxes to protect against theft. The use of biometrics can also ensure that confidential information remains confidential while deterring identity theft, particularly as it relates to ATM terminals and card-not-present e-commerce transactions. It allows capturing, archiving, and retrieving identifying characteristics as tattoos, marks, or scars. It can also analyze scenes from either streaming or archived video, “looking” for out-of-the-ordinary occurrences, the presence of certain vehicles, specific faces, etc. This is beneficial and can save significant time and money to those individuals who spend hours, days, or weeks monitoring video streams (i.e. examining a bank’s security in a criminal investigation).

In our project we are going to compare the two methods Face Recognition using PCA, SVM (Support Vector Machine), FS (Feature Scaling), SVC (Support Vector Classifier) and Grayscale algorithms for face detection and find their differences using constant tests and analysis.

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