Facial recognition using Dynamic Image Processing

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DECLARATION

We, hereby declare that this thesis is based on the results found by ourselves. Materials of work found by other researcher are mentioned by reference. This Thesis, neither in whole or in part, has been previously submitted for any degree.

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ABSTRACT

In this paper, we are prompting to detect a particular object (human face) from multiple objects (crowd) where multiple objects are present. We will try to recognize that particular object by using two pattern recognition algorithms, Eigenfaces, Hidden Markov model. Basically the reason to use more than one algorithm or process however that's mention is because more accuracy hence therefore with one process the results however never become absolute and perfect, therefore filtering away the results from one algorithm and make it more efficient the second algorithm may come handy. An identified way that has been most famous is using particular algorithm or process and having a full-formed Dataset.

CHAPTER 01

INTRODUCTION

1.1 Motivation

Technology influences human existence by bringing new risks as well as improvements to our lives by its collection of techniques, skills, methods and processes used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation. Technology can be the knowledge of techniques, processes, and the like, or it can be embedded in machines which can be operated without detailed knowledge of their workings. The world's getting into everything at on-line and thus face to face transaction is leaning in front of online periods with just a dial at pin or what so ever security module. But does this really verify or authenticate actual validity over that transaction and really creep over the valuation of that particular privacy or clearance

Face recognition from still and video images is emerging as an active research area with numerous commercial and law enforcement applications., to control the entry of people into restricted areas, and to recognize people in specific areas (banks, stores), or in a specific database (police database). A robust face identification system must operate under a variety of conditions, such as varying illuminations and back-grounds, it must be able to handle non-frontal facial images of both males and females of different ages and races, and be robust in the presence of two or more faces within an image [1]. In this is research we are going to develop a technique by which we will be able to cover to detect desired human face from video feeds and still images.

And for that we will require use of Hidden Markov model and Eigenfaces algorithm and AT&T face Database.

1.2 Contribution Summary

- The first approach to use the facial recognition system is train a data set from which the input image is going to be compared. For this process we choose AT&T dataset which however is relatively small and faster compared to other downloadable datasets from the internet,
- The second approach is to enlist the coefficients of the dataset and setting out the algorithms in succession.
- The last and final approach is to identify the far out reached percentage of results and reaching out the goals mentioned at the Abstract part.

1.3 Thesis Orientation

- Chapter 02 : Some background Information, Necessity Tools Description and Workflow Illustration
- Chapter 03 : Difficulties throughout Face Recognition System
- Chapter 04 : Important Terminologies
- Chapter 05 : Method that will be implemented
- Chapter 06 : System Implementation

CHAPTER 02

BACKGROUND INFORMATION

Image processing has been a standout assessment at stabilizing and validating object from Particular scenario for times and thus has been using at many aspects of modern technological appliances**.** The further advancement over this aspect intelligence has been spread after the time being it has been served. Many application now-a-days efficiently working behind the scene of this appliance and subsequently been used at many notable performance oriented efforts.

2.1 Facial Recognition: A revolution

Woody Bledsoe, Helen Chan Wolf, and Charles Bisson were the first persons to identify the effectiveness of automated Facial Recognition idea. [2]

During 1964 and 1965, the pioneers, who's been working on a system to identify the face of a human from a particular dataset started. But there were some funding issues and thus they had the funding provided by an anonymous intelligence agency and thus only having a little of their workload to left couldn't get the recognition they deserved.

Later After Bledsoe, Stanford_Research_Institute continued working under this progress, had a dataset of over 2000 photographs, and escalated everyone while It really worked! And this was the first recognized step towards the project After that some graduate student from Germany made a system that even beat most systems with having an outstanding record for those of Massachusetts Institute of Technology and the University of Maryland and claimed better however. Having funded by United States Army Research Laboratory.The Bochum system was developed through an

application which was priced to having used by customers such as Deutsche Bank and some airports and some public places. The software was "robust enough to make identifications from less-than-perfect face views. It can also often see through such impediments to identification as mustaches, beards, changed hair styles and glasses—even sunglasses" [3].

2.2 Tools and Training

In today's environment for image processing purposes OpenCV, Emmu guru and Matlab has been one pioneer towards image processing. However, paying attention towards GPU model and programming efficiency and effectiveness we chose Matlab for this thesis.

Other tools of which's contribution cannot be ignored are Computer Vision Toolbox and MatLab libraries for image processing . Image Processing Toolbox sets a complete set of allusion-standard algorithms and process oriented software for image processing, examination, conjuring up and developing algorithm. Performing image division, image augmentation, and reduction of noise, matrix division and 3-dimentional image processing.

2.3 Matlab

MATLAB (**mat**rix **lab**oratory) is a multi-paradigm mathematical computing environment and fourth-generation programming language. A proprietary programming language developed by MathWorks, MATLAB allowing matrix handlings, plotting of utilities and using of existing of library, working UI , and it supports programming languages such as : C, C++, C#, Java, Fortran and Python [4] .

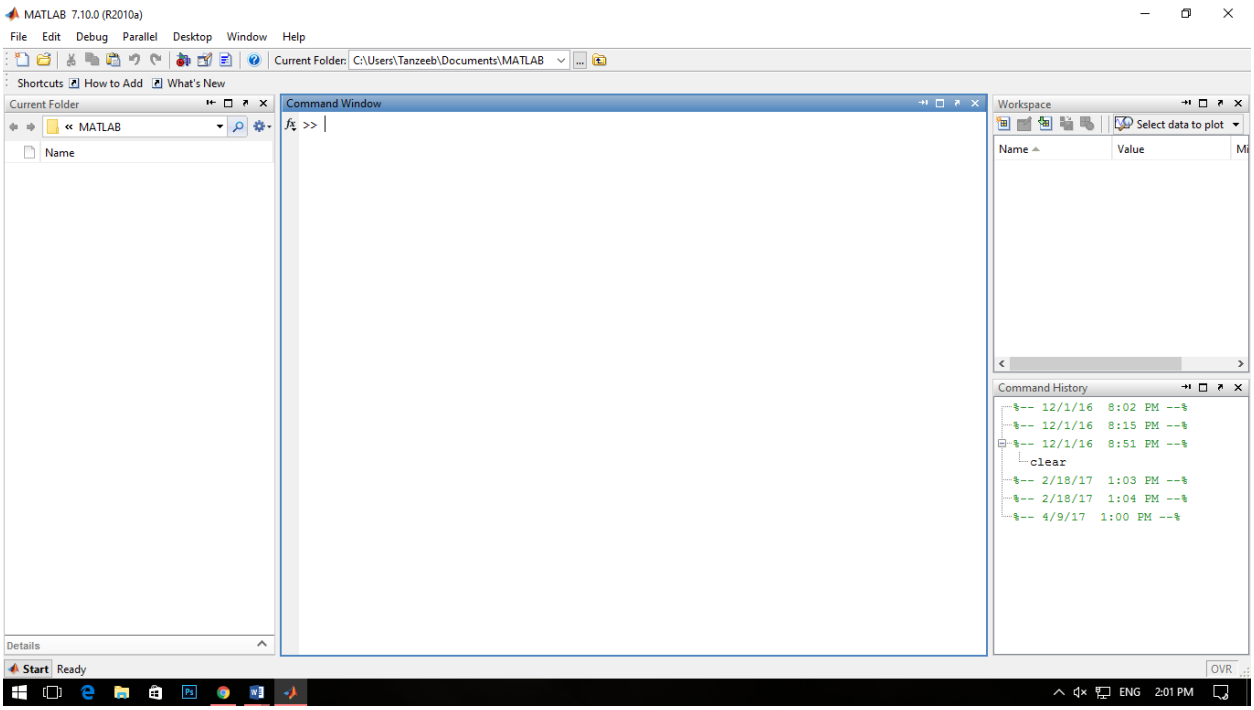


Figure 2.1 – Interface of Matlab

2.4 How Recognition Results by System:

For our experimental evolution we will have number of experiments using Hidden Markov model and then using eigenface face algorithm and later the developed technique designed by us will be evolved and analyzing the state will make the perfection out of the dataset that has already been taken out as a data sample for our project. For this analysis we will be using AT&T 3D dataset since it already has been established over its state and has been taken at real-life scenario and has 5 different expressions mentioned over as sample.

Initial approach to get the better survey results going through the studies found over analyzing the data analysis first by Hidden Markov model and secondly Eigenfaces algorithm and finally analyzing over our profound model suitable best results will be found and thus analysis will be sustainable and resourceful.

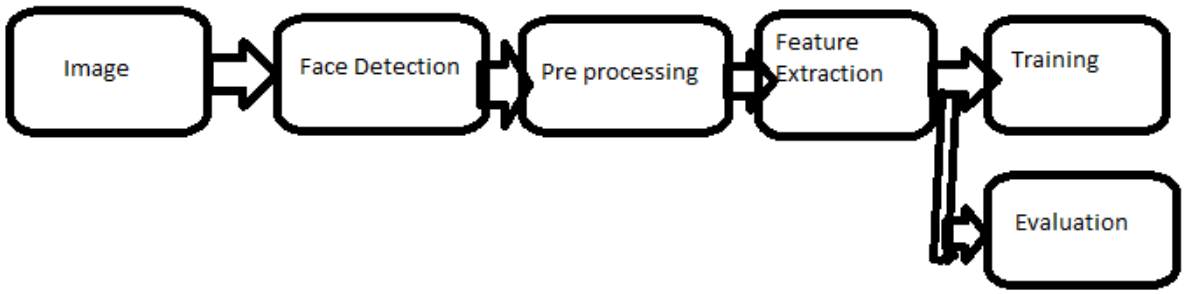


Figure 2.2: Flowchart of Workflow

A common approach to facial expression recognition in video is to first convert variable-length expression sequences into a vector representation by computing summary statistics of image-recognition [5].

2.5 AT&T Dataset:

AT&T dataset, which was known as 'The ORL Database of Faces before, has a set of photos taken between 1992 to 1994 from the lab using 3D image camera which contains ten distinct images for each having each of 40 different proposals. During taking these photos a lot of variations between taken into the constraints such as: lighting, facial expressions (open / closed eyes, smiling / not smiling) and facial details (glasses / no glasses).

All images are of PGM format, and can classified for viewing on LINUX systems by the program named 'xv'. The dimension is off 92x112 pixels, with 256 grey levels per pixel. Having 40 different distinct directories for each impacts (one for each subject), In each of these directories, with having 10 images in each directory with our systems [6].

Figure 2.3: AT&T Dataset Sample [1]

2.6 Hidden Markov Model (HMM):

Observation of Modeling through two different distinct variability layers of which one is invisible and other one is visible and both has distinct impacts on classifying and identifying into a categories of numbers or commonly known as class labels. If the instances taken of voice recognition system, the HMM has been used meaningfully for several projects that has already came into limelight on the other hand at background what it does is taking large variables isn't a particularly enhanced solution and thus original classes cannot be directly identified and while they are called for understandings.

Consider a system that may be describer at any time as being in one of a set of N distinct states and at discrete times the system undergoes a change of state according to a set of probabilities associated with the state. That's when the first order discrete time Markov Chain depends on the previous state only with having some properties.

Assembly, a key component in the development was the integration of local probability values over the sequence. By using HMMs to build an isolated word recognizer while having a vocabulary of N words to be recognized and that each word is modeled by a distinct HMM.

2.7 Eigenfaces Algorithm:

Face recognition based on PCA is generally referred to as the use of eigenface. PCA is used to remove information which is not useful and therefore reduce the dimension of the data and accurately decompose the face structure into orthogonal principal components known as "eigenfaces".

Simple processes that helps identifying using Eigenfaces:

- Acquire training sample and calculate the eigenfaces (Keep M' images that correspond to the largest eigenvalues)
- Projecting the face images into the face space
- Project the testing face images onto face space
- Get its Eigenface components
- Calculate the Euclidian distance between the input face image and training samples [7]

The complexity of calculation is greatly reduced with the construction an M by M matrix and calculation of M eigenvectors and with this analysis from the order of the large number of pixels of the face images to the order of the number of training face images.

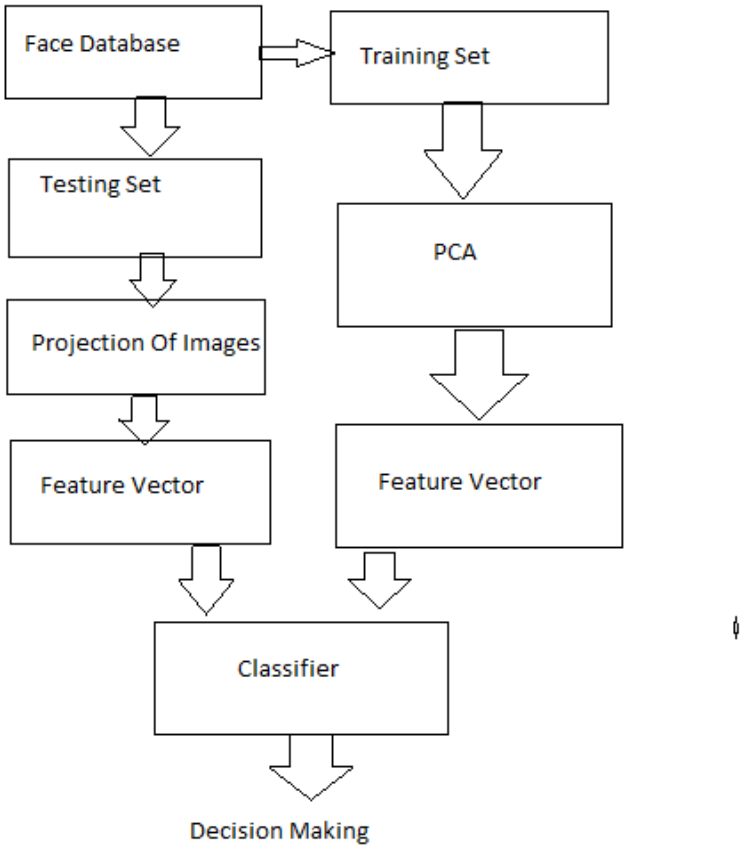


Figure 2.5: An illustration of Eigenface Algorithm

CHAPTER 03

CHALLENGES TO FACE DETECTION

Object detection is the problem of determining whether or not a sub-window of an image belongs to the set of images of an object of interest. Thus, anything that increases the complexity of the decision boundary for the set of images of the object will increase the difficulty of the problem, and possibly increase the number of errors the detector will make. Suppose we want to detect faces that are tilted in the image plane, in addition to upright faces. Adding tilted faces into the set of images we want to detect increases the set's variability, and may increase the complexity of the boundary of the set. Such complexity makes the detection problem harder. Note that it is possible that adding new images to the set of images of the object will make the decision boundary becomes simpler and easier to learn. One way to imagine this happening is that the decision boundary is smoothed by adding more images into the set. However, the conservative assumption is that increasing the variability of the set will make the decision boundary more complex, and thus make the detection problem harder.

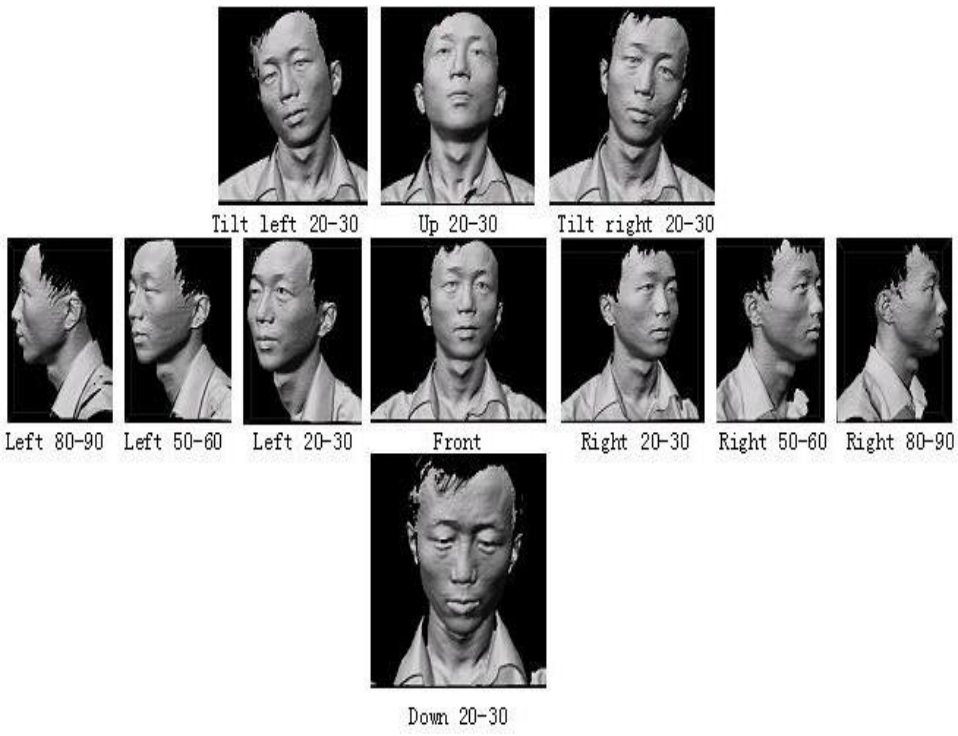


Figure 3.1: Different Frontal Face with Different Expression [2]

3.1 Differentiate between Image Plane

Each a different types of variable is able to express independently of the face toward itself, even after rotation, translation, scaled and mirrored image formation and furthermore the overall brightness, saturation and contrast of that particular image itself.

3.2 Pose Variation:

It's also is importation how the image plane pose has been verified. A simple photo with having different pose variation may even be difficult for the system to get perspective results without distortion. An image can come up with camera-face pose with frontal, side, upside down or half circle and even nose and eye of some images can become half or full occluded.

3.3 Induced Expression

Even a simple image of a person can come up with taking the photo from different angle and also having different expressions of that person. One may find a image more recognized while getting the full view of that image whether difficult to recognize while only be able to see half or partial of that image.

3.4 Lighting and Texture Variation

While taking a photo and having the light source having difficulties to take photo because of low light might follow redundancy into the results and variation towards the result while having same environment specially. Because all that matters are the light source to reflect some lights towards that particular object hence human face over that camera to identify itself.

Figure 3.2 : Lighting and Texture difficulties [3]

3.5 Image appearance

Even when the formed image may vary because of some factors such as lightning and camera characteristics and such on. Even an un- identificated photo at dataset cannot result even when input source is good enough to bisect the image properties.

3.6 Background Variation

To identify an image property first and foremost step is to differentiate itself from its own background. While at unpredictable boundary setup the background which can't be masked off and ignored may differentiate with bad result itself. While it isn't possible to extract an image only having contamination of pixels within a human face and to ignore the background.

Figure 3.3: Background Variation Difficulties [4]

3.7 Having Unwanted Components

Somewhat images with people having beards, mustaches and glasses and the system have to identify the image between shape and color along with the size itself.

Figure: Face with different Components [5]

CHAPTER 04

SOME IMPORTANT TERMINOLOGIES

4.1 Matrix Transpose

The code we wish to optimize is a transpose of a matrix of single precision values that operates out-of-place, i.e. the input and output are separate arrays in memory. For simplicity of presentation, we'll consider only square matrices whose dimensions are integral multiples of 32 on a side. It consists of several kernels as well as host code to perform typical tasks such as allocation and data transfers between host and device, launches and timing of several kernels as well as validation of their results, and de-allocation of host and device memory.

In addition to performing several different matrix transposes, we run simple matrix copy kernels because copy performance indicates the performance that we would like the matrix transpose to achieve. For both matrices copy and transpose, the relevant performance metric is effective bandwidth, calculated in GB/s by dividing twice the size in GB of the matrix (once for loading the matrix and once for storing) by time in seconds of execution. [8]

4.2 Binary Image Formation:

Images having only two possible values for each pixel is denoted as Binary Image having the formed names as white and black or B & W. Segmentation and thresholding are the terms that has particular operation at Binary images which actually is formed by grey scale or color images.

An in this formation which varies from components to components may have identified black as 0 and white as 1.

4.3 Greyscale Image Formation:

Indifferent from Binary Image formation at greyscale image formation has values of every pixel with single sample formerly known as RGB color combination having different values for each RGB functions and distinct them vice-versa towards different color combination and shades of unlimited possibilities.

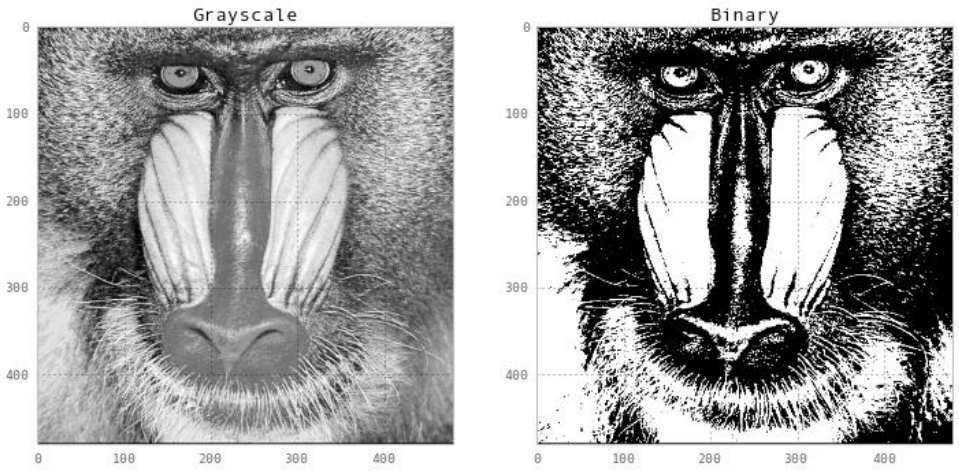


Figure 4.1: Greyscale Image Vs Binary Image [6]

4.4 Pixilation System

Defines a single point of a graphical image having abstract sample. Each pixel denoted by its intensity towards dimension and having a different color combination such as CMYK . Pixilation System actually defines the smallest components of a particular image and the identifying the

maximum number of images having similar values as CMYK field with that image field denotes values having same entities.

CHAPTER 05

METHOD IMPLEMETATION

To enhance modernization and security in human life, the evolution of computer technology has become more advance and day by day is moving toward to developing more and more machinery intelligence. Such as computer vision systems have been used in tedious and repetitive visuals tasks of assembly line inspection, now is moving toward to face recognition and video coding techniques in visionary applications.

Face recognition techniques are one of the most researched part in computer vision. This technique can assume the availability of frontal faces of smaller size, but sometimes it cannot hold due to various face appearances and environmental conditions. For recognizing reliable face, the background of images is excluded.

To include the background image, locate and extract the face region from the background a visual Front-end processor is used now-a-days. But in reality, the task of face background detection in computer vision cannot be compared to human vision. As this vision which human can do effortlessly, this processor has to calculate extraction, segmentation, possibly facial features with illumination, orientation, camera distance etc.

Now-a-days face detection has become an emphasized research in computer vision as it is highly needed for video surveillance and security control system, intelligent human computer interface,

content based image retrieval, multimedia applications on the web like video conferencing and face database management etc.

To detect face various approaches has been developed. These techniques utilize various techniques such as:

- Principal component Analysis,
- Neural Networks
- Machine Learning
- Information Theory
- Geometric Learning
- Template Machine
- Hough Transformation
- Motion Extraction
- Colors Analysis and many more [9]

CHAPTER 06

APPROACH TOWARDS IMPLEMENTATION

To get application towards real life implementation from dataset and survey with eigenface and Hidden Markov Model conversion of variables profound length sequences into vector representation toward result has some sequence onto it.

- Step 1: find approximate face position
- Step 2: refine position and size
- Step 3: refine size and find aspect ratio
- Step 4: local distortion

Setting the dataset:

```
Columns 1 through 7

  's1'          's10'         's11'         's12'         's13'         's14'         's15'
  {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}
  {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}
  {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}
  { 1x5 cell}   { 1x5 cell}   { 1x5 cell}   { 1x5 cell}   { 1x5 cell}   { 1x5 cell}   { 1x5 cell}
  { 1x2 cell}   { 1x2 cell}   { 1x2 cell}   { 1x2 cell}   { 1x2 cell}   { 1x2 cell}   { 1x2 cell}

Columns 8 through 14

  's16'         's17'         's18'         's19'         's2'          's20'         's21'
  {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}
  {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}
  {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}   {52x5 cell}
  { 1x5 cell}   { 1x5 cell}   { 1x5 cell}   { 1x5 cell}   { 1x5 cell}   { 1x5 cell}   { 1x5 cell}
  { 1x2 cell}   { 1x2 cell}   { 1x2 cell}   { 1x2 cell}   { 1x2 cell}   { 1x2 cell}   { 1x2 cell}

Columns 15 through 21
```

Training the dataset into Experiment:

```
Loading Faces ...
s1 s10 s11 s12 s13 s14 s15 s16 s17 s18
s19 s2 s20 s21 s22 s23 s24 s25 s26 s27
s28 s29 s3 s30 s31 s32 s33 s34 s35 s36
s37 s38 s39 s4 s40 s5 s6 s7 s8 s9

Training ...
s1 s10 s11 s12 s13 s14 s15 s16 s17 s18
s19 s2 s20 s21 s22 s23 s24 s25 s26 s27
s28 s29 s3 s30 s31 s32 s33 Warning: Algorithm did not converge with tolerance 0.01 in 10 iterations.
> In hmmtrain (line 297)
  In gendata (line 80)
  In mainmenu (line 28)
  In hmmtrain (line 233)
  In gendata (line 80)
s34 s35 s36
s37 s38 s39 s4 s40 s5 s6 s7 s8 s9
done.
```

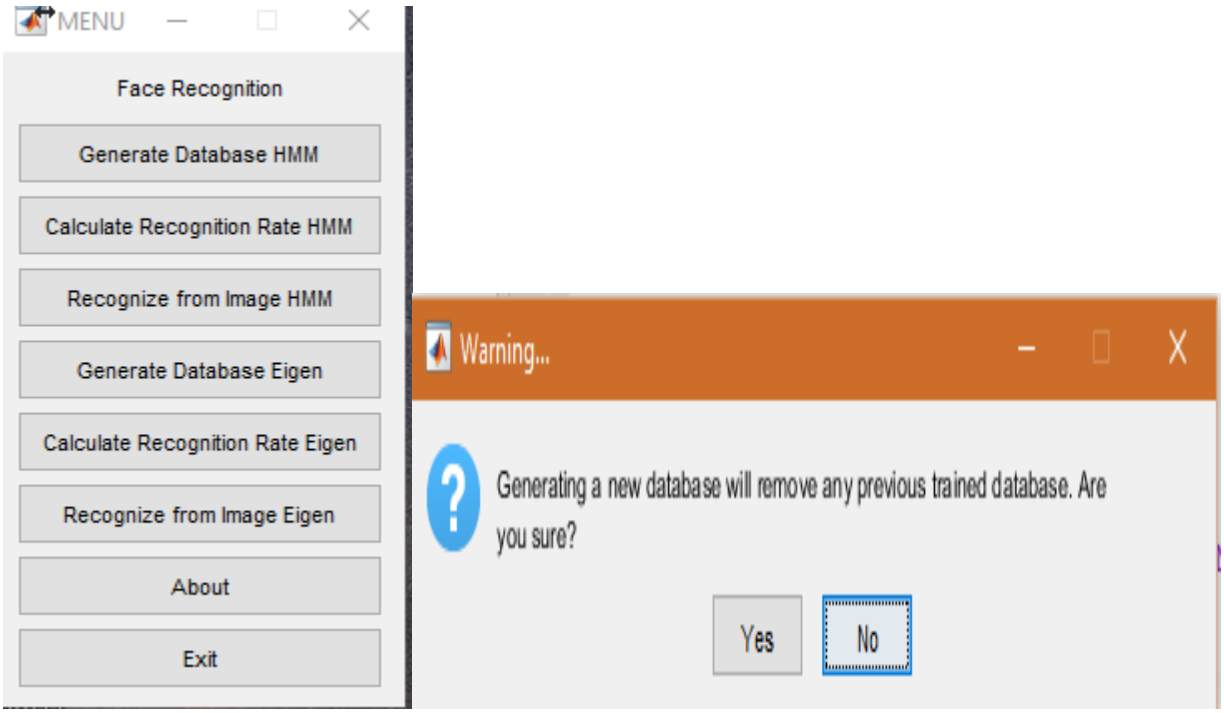
```
Please Wait...
s1
This person is s1.
This person is s1.
This person is s1.
This person is s1.
This person is s1.
s10
This person is s4.
This person is s10.
This person is s10.
This person is s10.
This person is s10.
s11
This person is s11.
This person is s11.
This person is s11.
This person is s11.
This person is s11.
s12
This person is s12.
This person is s12.
This person is s12.
This person is s12.
This person is s12.
```

Identification of Result:

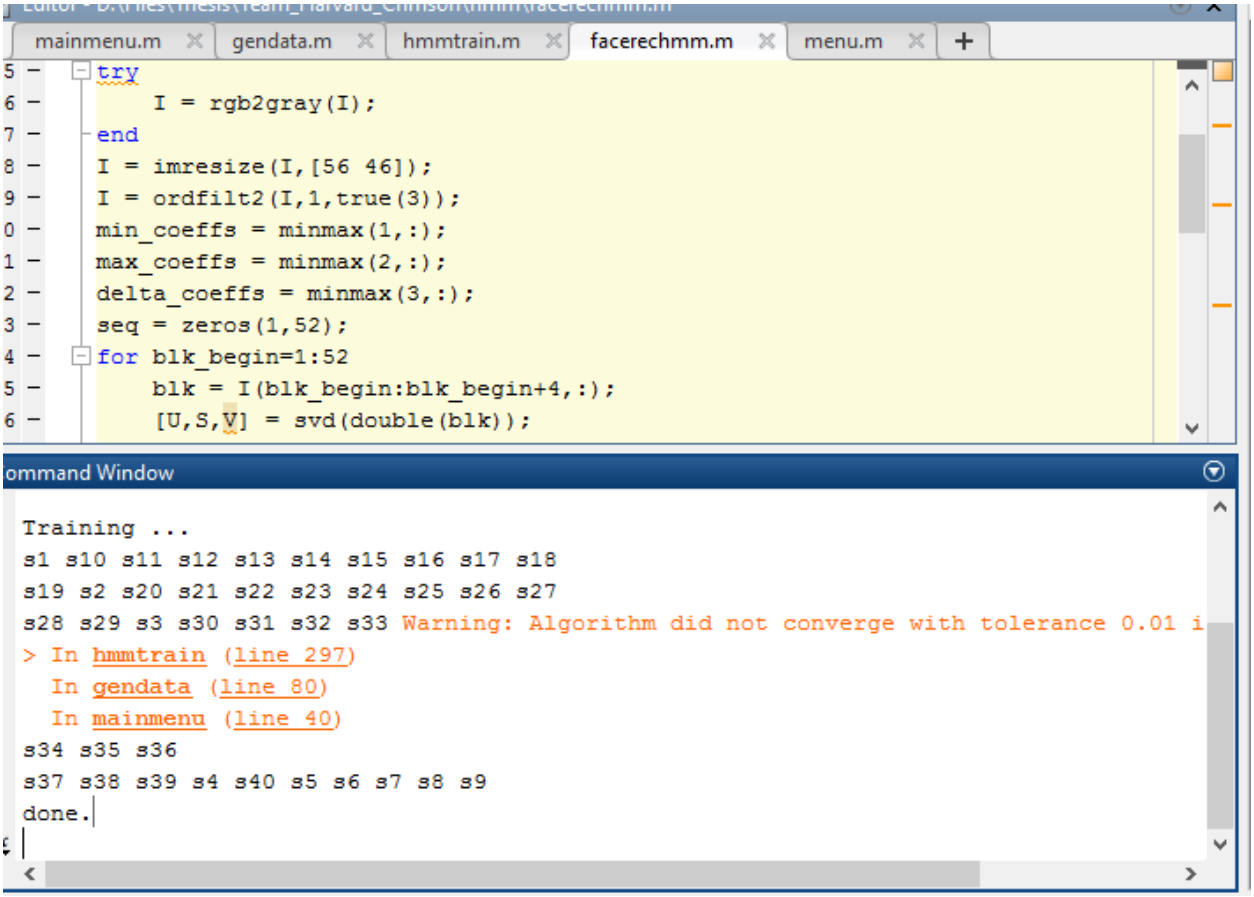
```
This person is s7.
This person is s7.
This person is s7.
This person is s7.
This person is s7.
s8
This person is s4.
This person is s8.
This person is s8.
This person is s8.
This person is s8.
s9
This person is s9.
This person is s9.
This person is s9.
This person is s9.
This person is s9.

Recognition Rate is 96.5% for a total of 200 unseen faces.
```

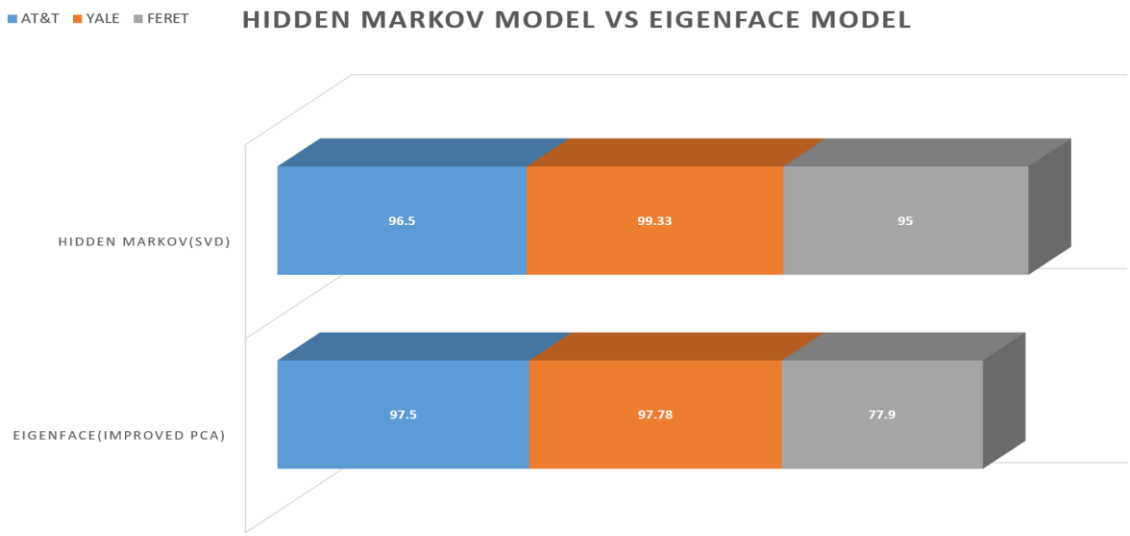
Prompt Menu:



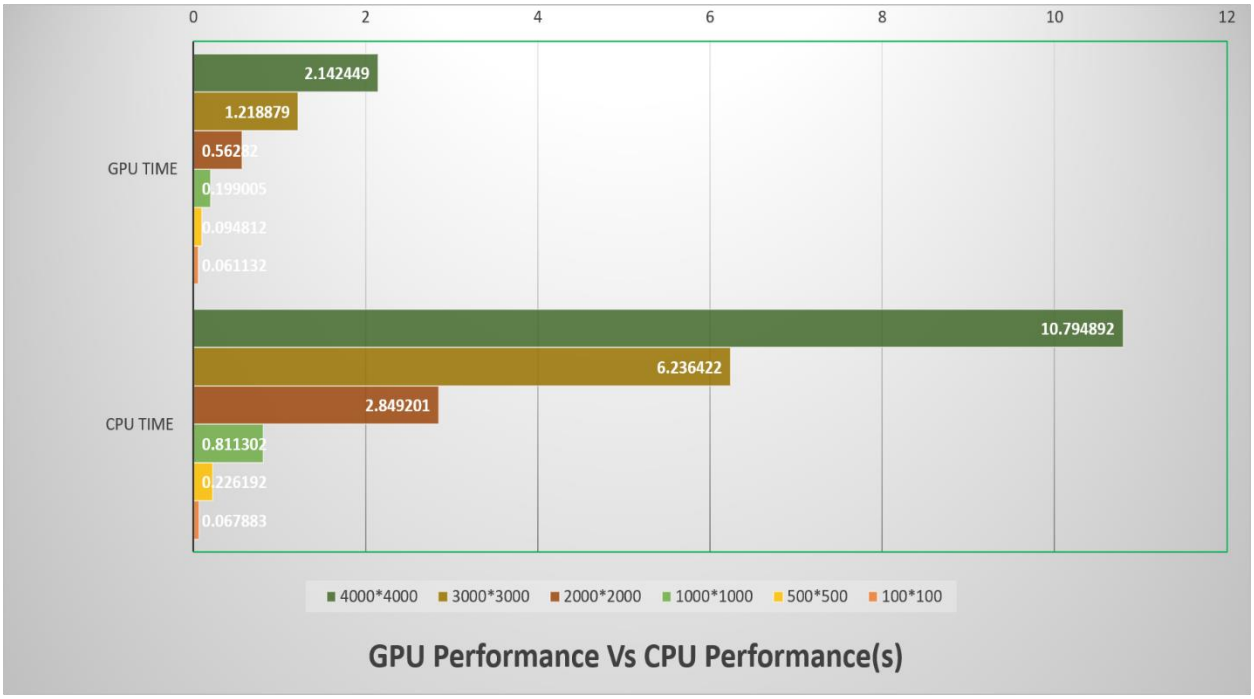
A short Snippet of The application itself:



Face Recognition Rate During Experiment:



GPU Performance VS CPU Performance:



CHAPTER 07

APPLICATIONS

The basic application is however to identify an object, and that depends on the dataset that's going to use. If that dataset contains of people's face, then definitely this's be an extremely pivoting application towards security policies towards real life implementation. In this thesis, implementation method of detecting frontal human faces in color images and determining the result of what that person's gradually helps to understand the matching template such that we can detect human frontal face.

The main application of this article are:

1. Transformation of a color image towards a grey scale image where the grey value at a pixel represents belonging to the skin
2. Locating face from different intensities
3. Locate face from those template matching [10]

All the method that has been described here has been lab tested with hundreds of experiments and the results show that this method has vast accuracy towards real life implementation.

Despite of not getting results from side-face detection, this application can make vast advancement toward real life implementation and thus make a good impact at further implementation towards this in other scenarios that lab tests.

Another important point that not to be avoided is this all are lab tested methods with results and real life is not even half easier that this so for this methods to get advancement a lot of tests other than labs has to be implemented and thus this can come up with real life expertise and another important advancement can be machine learning Artificial Intelligence. Without machine learning this day any application isn't completed. So further- saying AI implementation can be the next way to make this application or system however you may call it to come up with extremely accurate.

Figure 7.1: Real Life Face Recognition System Implementation [7]

CHAPTER 08

FUTURE WORKS and APPLICATION DOMAIN

In future we plan to make this process even more real life oriented and more efficient with the help of binarization using adaptive thresholding since now we have been using the basic method of global one and use of and experimented value for this application. Since all we've seen a lot of cases the image has shown positive results that the project has been remarkable at real life implementation yet a good GPU may cover all this even better. But redundancy is a reason why many a part of this project hasn't been quite easily implemented. At one instance we've seen a person hasn't been identified because of same background having similar image as background and while using adaptive thresholding process this error can be fixed and thus this can be more accurate.

This can be also improved by surface clipping off regions though that won't be very real life oriented but yet that may come up with better result and this error would be largely fixed. And in further study while using adaptive thresholding this problem can be solved with improved version of this application.

Another advancement can be a milestone if -

- Side Face can be detected

We will encounter as many images as possible to encounter this problem by individuals and therefore as an achievement in real life for our thesis. We hope we can come up with a technique that can identify side face detection with greater value.

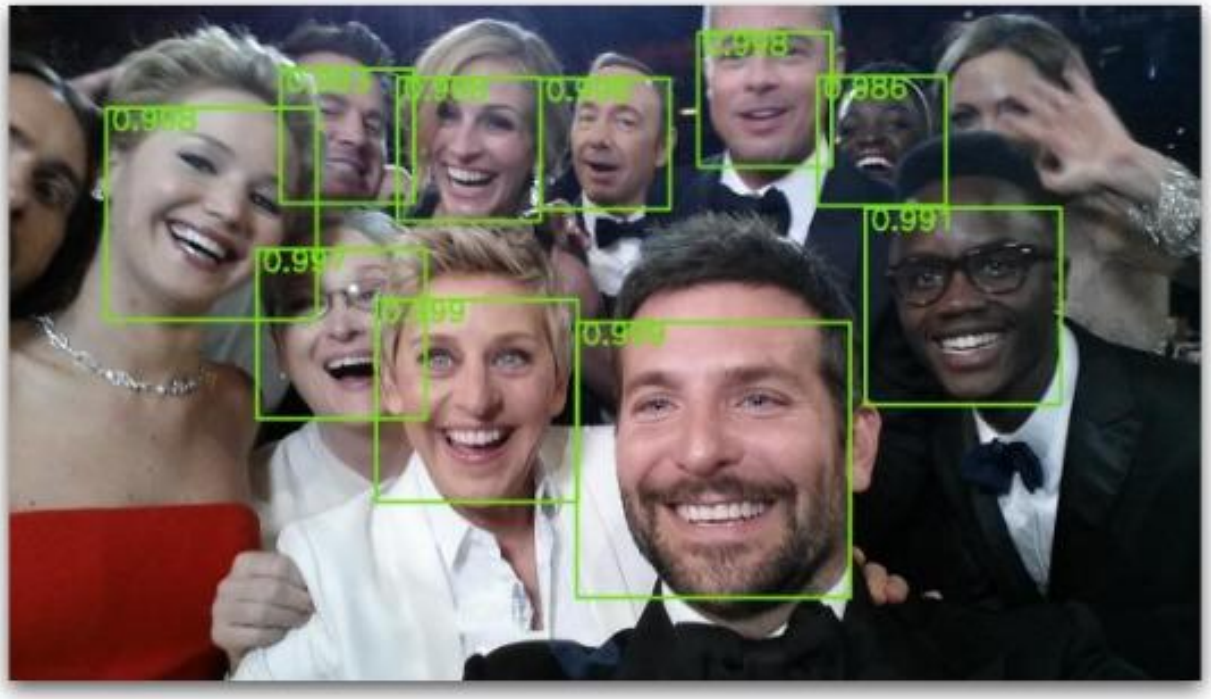
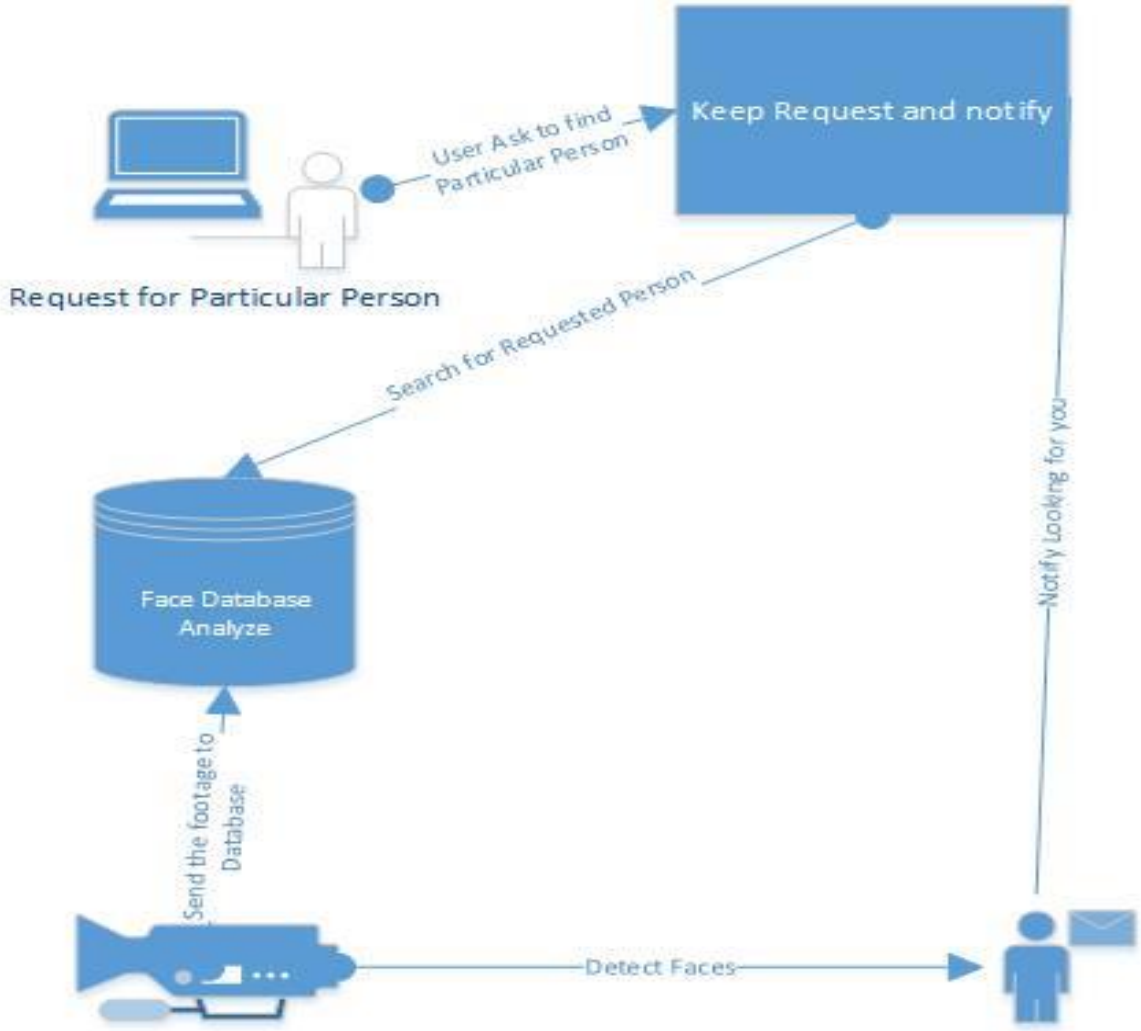


Figure: Recognizing Face from Dataset [8]

Application Domain:



Here from this extensive diagram the whole process shows the illustration the work process of the system itself. First the illustration shows the significance of Image acquisition in which the static image with the technology itself generates images with sufficient quality and resolution. High-quality enrolment is essential to eventual verification and identification enrolment images define the facial characteristics to be used in all future authentication events.

This process is followed by the system to follow Image processing steps to work as an identifier. Cropped Images are such that to ovoid facial image remains and coloured images black and white converted and thus the process follows its further steps. And for Standard Linear Algebra technique the whole point is generated into a template and works with the template gathered from above steps.

Furthermore, the gathered template tries to find it's matched identities with match of the nodal points and distinctively 80 different nodal points are followed to verify and identify the located clustered template for verification and so on.

Images is assimilated and recorded in contradiction of the registration, thus prompting a 1:1 corroboration inside the process that consists of 14 to 22 match attempts take place within 1 to 2 seconds.

This system noticeably is not as actual as thumb-scan or retina-scan in classifying from a huge dataset.

Notable Users:

- The London Borough of Newman, in the UK has a system that is introduced into real life CCTV system
- Griffin investigation are famous for their system that is used at casinos to catch card counters and other blacklisted persons
- At Australia, the customs service has an automated system “Smart Gate” by which they came to compare e-passport microchip and passport towards owners.
- 2000 Presidential Election at Mexico, face recognition software was used to get voter fraud.
- The similar technology was used at United States to prevent people from fake ID’s and driver’s license.

Criticisms Over Face Recognition System:

- At Boston's Logan Airport the face recognition system that has been introduced to find potential terrorists couldn't manage to come up with good results
- Live Criminal Recognition system at London Borough of Newham as of 2004 hasn't find a single criminal and yet is implement the desired service.

CHAPTER 09

CONCLUSION

9.1 CHALLENGES

The problem is challenging first on the GPU architecture. Programming with GPU is not easy since none of us are more familiar with programming on GPU environment. We two only know about the programming in terms of CPU environment. The architecture of GPU is different from CPU, which is more challenging to have proper utilization of all the available resources. But at real life environment that higher powered GPU isn't found always.

9.2 RESOURCES

For this project, we need the compiler of Matlab and I'll use the machine which has NVIDIA 980 GPU. Specifically, the GPU I will use is NVIDIA GeForce GTX 840M graphics processor is a collection of 15 multiprocessors, with 64 streaming processors each.

9.3 CONCLUSION

A Face recognition system having particularly good efficiency can be very alarming for security purposes and enables a new era of security and recognition system and relies at lot on machine itself. Security systems can come up with a helping hand towards their system and a lot can be made through human resource and just dataset implementation can make life easier to find unwanted people.

This thesis however can make a reliable impact into real life implementation towards the society and make security without a question.

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Figures:

[1]. Figure 2: Example images (after rotation) from the Radboud Faces Database (reproduced with permission). (n.d.). doi:10.7717/peerj.1801/fig-2

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