MAJOR PROJECT REPORT

ON

REAL TIME IRIS RECOGNITION

Submitted for the Partial Fulfillment of the Degree

MASTER OF TECHNOLOGY

IN

SIGNAL PROCESSING AND DIGITAL DESIGN

BY

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(SESSION 2015-2017)

CERTIFICATE

This is to certify that the thesis entitled "Real Time IRIS Recognition" being submitted by Vikram Singh Kardam, 2K15/SPD/18 for partial fulfillment of the degree "Master of Technology" in "Signal Processing and Digital Design"from Delhi Technological University, is based on work carried out by Vikram Singh Kardam under my guidance and supervision. The matter contained in this thesis has not been submitted elsewhere for award of any other degree to the best of my knowledge and belief.

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ACKNOWLEDGEMENT

I would like to express my heartily gratitude and thanks to my project guide Prof. Rajesh Rohilla, Associate Professor in Department of Electronics and Communication Engineering, Delhi Technological University, for continuous inspiration, encouragement and guidance in every stage of preparation of this thesis work.

I am also extremely thankful to Dr. S. Indu, Head of the Department of Electronics and Communication Engineering, Delhi Technological University, for the support provided by her during the entire duration of degree course and especially in this thesis.

I would like to thank my batch mates for their support throughout the entire duration of the degree.

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ABSTRACT

Any biometrics method refers to recognizable proof and validation of people depending upon their physical and behavioral characteristics. One of the biometric that is profoundly reliable, robust and have high recognition precision is iris recognition. However the precision of iris acknowledgment generally influenced angle, pupil dilation, limbus occlusion, intensity variations, and improper focus. So finally our aim is to increase accuracy and to accomplish high recognition rate. The different difficulties in iris acknowledgment incorporate legitimate iris region localization, segmentation, local/global feature extraction of the iris design, feature code estimate decrease, and quick calculation so that no procedure will expend much time and assets. Also, the iris recognition will work in real time.

In our project, we have set ‘HP Truevision HD' webcam with resolution of 640x480. Besides, we took the eye pictures while attempting to keep up proper settings, for example, lighting and separation to camera.

In this project, it has been showed that our algorithm gives better performance as compared to previous methods with less recognition error and 100% accuracy. Also the average recognition time taken by this algorithm is 31.01 seconds, which shows a great success of our proposed algorithm over the others.

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1. INTRODUCTION

1.1 Biometric Identification

Biometric stands for "Measurement of Life" by using the person's characteristics that may be physiological or behavioural to determine his identity. Recognition of pattern is utilized as biometric system.

Biometric technologies are "Digital automated method' that recognized the personality. Many biometric technologies have been developed and used to authenticate the person's identity. Iris is a standout amongst the most promising, reliable, and vigorous biometric innovation.

The immense advance demonstrates that iris recognition still needs quick, reliable, real time, and durable calculations in order to have better accuracy.

1.2 Types of Biometrics

1. Recognition of IRIS
2. Matching of DNA
3. Recognition of ear
4. Recognition of Retina
5. Recognition of Face
6. Recognition of Fingerprint
7. Recognition of Finger Geometry
8. Recognition of Gait Pattern
9. Recognition of Hand Geometry
10. Recognition of Odour
11. Recognition of Signature
12. Recognition of Typing
13. Recognition of Vein
14. Recognition of Voice(Figure1)

1.3 Why only Biometrics

Biometrics offers novel advantages for identifying people. Any type of ID card can be lost, stolen, copied or left anywhere, passwords can be overlooked shared or watched however Biometrics holds the guarantee of quick, simple to-utilize, precise, reliable, and more affordable authentication for a variety of applications.

Biometric ID procedures replaces the token acknowledgment framework where a man is checked utilizing his license or passwords and favoured over old passwords and PIN-based strategies.

In future biometric will emerge in the recognition of Brain and Heart. This type of 'futuristic' technology is totally fraud resistant comparable to other old biometrics. This technology is called “Biometric Intent”. This technology will check the eye movement, body temperature, breathing etc. and will find any dangerous or hostile attack. Recently, a biometric technology has been developed to scan the whole body for better identification. But this is not accepted yet worldwide because of its complexity.

India is now one of the countries which have its own world’s largest biometric recognition system, 12 digits “Unique Identification Number”, called ADHAAR.

Figure 1: Types of Biometrics

1.4 IRIS Recognition

Iris is unique to every person. No one can have a similar iris design even indistinguishable twins have distinctive iris designs. Also the right iris of one eye is completely different from left eye in same person. Generally, the left eye is utilized.

Human eye is taken as input to the camera and is presented to subtle infrared beams, CCD (Charge Coupled Device) cameras or webcams. The picture of the eye is acquired and iris recognized device investigates the elements in the iris which have more than sufficient points that can be utilized for comparison. Then iris patterns are getting and afterward these are used for matching the user.

Iris recognition is widely utilized as a part of airport terminals in place of the passport, Personal Computer (PC) sign in, Automated Teller Machines, using as password for building's entrance and secured industrial database.

With an adjustable circular opening in the center (called pupil), iris is a flat and ring-shaped membrane behind the cornea of the eye. This is the structure that gives an individual eye color.

Together with the pupil, the iris is controlling the amount of light that gets into the eye. Excessively or too minimal light can hamper vision. The strong iris moves to shrink the pupil if there is excessively light and widen it if there is insufficient. This is an involuntary function of eye, controlled by the human brain. Iris is made up of muscle fibers and connective tissue (Figure 2).

1.4.1 Advantages

There are many reasons which makes Iris recognition an attractive technology.

1. Due to flat characteristics of Iris, it is easily predictable and very accurate.
2. Biometric technology is most accurate and robust.
3. Iris fine texture does not changed in whole life.
4. Recognition of iris depends on pattern not on sight, so any blind person can also used this technology.

5. A digital photo is used for iris design (from video), and producing an encrypted template. Therefore, it manages high level protection against identity theft.
6. Iris recognition is the only biometric authentication innovation intended to work on huge databases without degradation in authentication accuracy.

1.4.2 Disadvantages

Like all other biometric recognition, iris recognition also comes with some disadvantages.

1. Iris scanner should be properly placed at good light condition.
2. Scanner and the person's eye should be at proper distance.
3. Iris recognition suffers from many occlusions like eyelashes, eyelids, lens and reflections from the cornea.
4. Setting up of these frameworks can be costly as you have to purchase the hardware equipment and install it for any entryway you need it on.
5. It can be hacked by the intruders by using the high quality image of individual.
6. Sometimes it is difficult to capture iris image of some individual's.
7. For the most part, we utilize infrared beams (IR beams) to check the iris of an individual. There are conceivable outcomes that infrared beams may harm his eye.
8. Another drawback is related to somatic death (brain dead), his iris matches and he is automatically accessed.

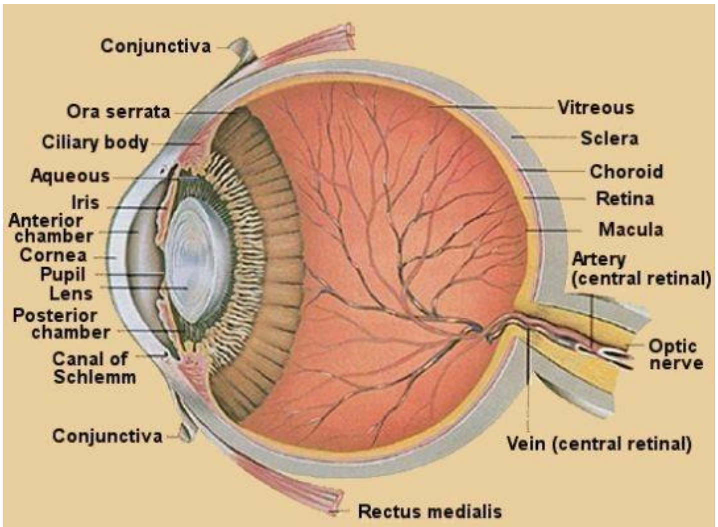


Figure2: Iris Anatomy

2. LITERATURE SURVEY

2.1 Existing System

2.1.1 Conventional Iris Recognition System

Conventional iris acknowledgment is made out of two stages. In the initial step, the iris area is localized and in the second step, interesting iris codes are extracted from the distinguished iris region. Additionally, ordinary iris acknowledgment camera has the IR (Infra Red)-Pass filter (through which IR-LED (Infrared Light Emitting Diode) light is passed to camera sensor and the noticeable light is cut off) in front of camera focal point and IR-LED illuminators are utilized on the grounds that the human iris designs are appeared in subtle elements with the light of the wavelength of 750nm~880nm.

2.1.2 Real-time Iris Localization for Iris Recognition in Cellular Phone [8]

The iris pictured is captured by utilize Samsung SPH-S2300 phone. It has the 324M pixels CCD camera with optical 3times zooming usefulness. The inside IR cut channel has been expelled and extra incandescent light has been used for catching iris picture.

2.1.3 Real-Time Iris Recognition System [9]

In this testing framework utilized two unique cameras to procure the picture as input. Initially camera is a basic web camera with specification 240 x 320 CMOS (complementary metal-oxide semiconductor) Resolution, 1.3 Megapixel Camera, and USB 2.0 and the second is Casia's camera (Made by Pattek Corporation and 280 x 320 CCD Resolution).

2.1.4 Real-Time Image Restoration for Iris Recognition Systems [7]

For assessing the iris picture restoration calculation, the pictures have been caught by Logitech Quickcam ace 4000 CCD and AlphaCam-I CMOS camera. They have utilized a Logitech Quickcam expert 4000 with a fixed focal length and used a Sharp LZ24BP CCD sensor.

For brightening, two IR-LEDs (750 and 850 nm) were utilized. Also, the IR cut filter was removed, and an IR pass filter was appended to the front of the camera lens.

2.1.5 Limitations in Existing Systems

1. Too much dependence on the CCD cameras, CMOS cameras and IR-LEDs.
2. The equipments used are very expensive (it could cost almost as much as five times the cost of fingerprint scanning).

2.2 Proposed System

2.2.1 Webcam

Picture securing is viewed as the most basic venture since every single ensuing stage depends mainly on the picture quality. Keeping in mind the final objective to achieve this, we have used the Webcam. For our experiment we have set 'HP Truevision HD' with resolution of 640x480 webcam, the sort of the picture to '*bmp', and the mode to white and dark for more prominent subtle elements.

```
webcamlist

ans =

   'HP Truevision HD'

cam=webcam

cam =

  webcam with properties:

                        Name: 'HP Truevision HD'
                        Resolution: '640x480'
                        AvailableResolutions: {'640x480'  '160x120'  '320x240'  '1280x720'}
                        WhiteBalance: 4600
                        ExposureMode: 'auto'
                        BacklightCompensation: 1
                        Gamma: 300
              Sharpness: 50
                        Brightness: 0
                        Saturation: 64
              Exposure: -6
              Contrast: 50
```

2.2.2 Segmentation of Face

This is the principal module in which the face is segmented from the input image through a video recorded by the camera will be fragmented into the frames and afterward into the picture; this image will be given as input for segmenting the face.

2.2.3 Iris Match

Template matching is used for classification against the stored template for verification by one-to-one matching or by identification one to many matching. In matching step, Hamming Distance, Euclidean Distance, Weight Vector, Dissimilarity Function is used to classify feature vectors.

2.2.4 Blink Match

Important factor which helps in recognizing of user's iris is the condition of eyes, i.e. whether they are open or closed. This is done by relying on the difference of brightness intensity of the pupil in the image and its symmetry. The position of the eye can be distinguished by drawing on geometrical and symmetrical properties.

2.2.5 Architecture

The proposed algorithm can be explained as following data flow architecture (Figure 3).

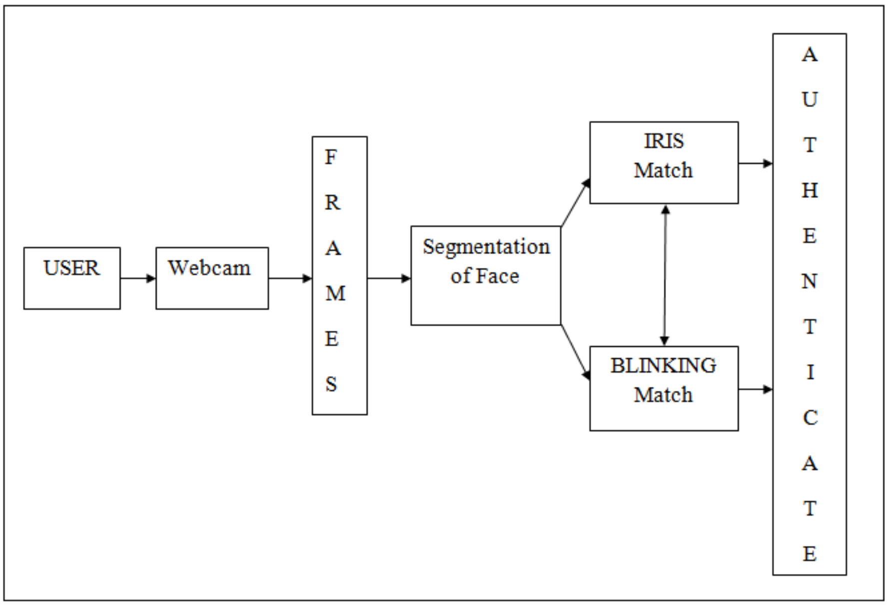


Figure3: Architecture

3 .HOW IRIS RECOGNITION WORKS

Enrolment phase and the matching phase are the two stages for this recognition. Firstly, an iris image is captured and iris feature vector is stored in the database, called enrolment phase. Second, matching of this stored iris image with the input iris picture is done. For matching, stored iris image feature vector (Templates) is compared with the input iris feature vector. Iris picture obtaining, iris image acquisition, iris localization, iris normalization, iris image enhancement, and feature extraction are the whole steps for doing these two phases (Figure 4).

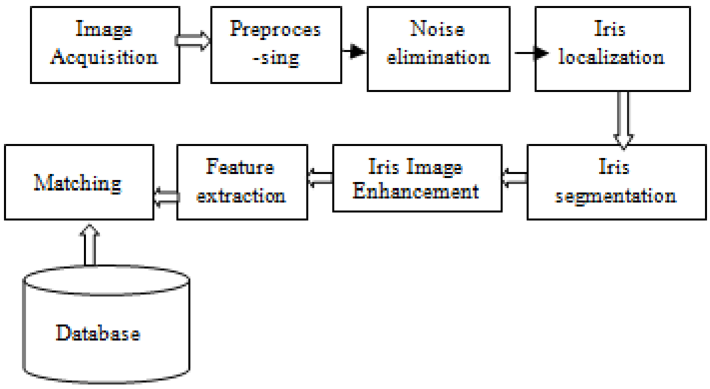


Figure4: Block Diagram

3.1 Iris Localization and Segmentation

Eyelid and eyelashes are the obstacles for capturing the iris image. Such noise components can be removed by iris localization. In this process iris and pupil boundary is called the internal boundary and iris and sclera boundary is called the external boundary.

As we know the pupil is darker than the iris, that's why evaluation on internal limits is simpler than external limit. Generally, the iris pictures are influenced by motion blurring, camera diffusion, noise, out-of-focus imaging, occlusion from eyelids or eyelashes, head tilting, off-axis gaze or camera angle, specular reflection, poor contrast, and natural luminosity factors, that's why it is very difficult to evaluate the iris localization and segmentation. Powerful pre-processing calculations are expected to upgrade the nature of such pictures before handling them (Figure 5).

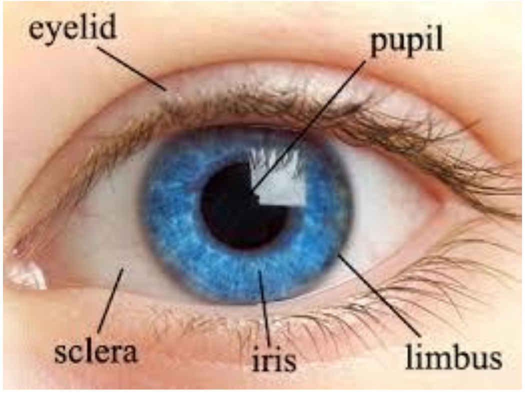


Figure5: Iris Diagram

Centre coordinates and radius of the iris and pupil can be found by the Circular Hough Transform. Image outline is done by the Canny Edge Detection. For segmentation of iris the Region Growing Segmentation algorithm is used.

3.2 Feature Extraction

It is done by wavelet transforms. Mostly used feature extraction method is Gabor filter. Log filter can also be used for this.

After finding the pupil, this process is started. Here, we find the both local and global information. We take only important features of iris, that's why template matching is simpler.

Energy compaction can also be used for feature extraction which reduces the feature vector size. For feature vector, low frequency components have to be taken. For transformation of images, Cosine, Walsh, Haar, Hartley Transforms, and their wavelets are used.

3.3 Classification

It is done by template matching. The stored template is matched with the input template by one-to-one or by one-to-many matching. The features vectors are classified by the Hamming Distance, Euclidean Distance, Weight Vector, Dissimilarity Function, or Neural Network algorithms. Finally the identification and the verification have been done.

4. DESIGN

4.1 Algorithm

1. Real time video input is given by the user through webcam.
2. The video recorded by the camera is fragmented into the frames and then this image will be given as input for segmenting the face.
3. Find out the eye position in the frame and distinguish it by drawing geometrical and symmetrical properties.
4. Matching of two iris images are done by “Hamming Distance”.

    1. If HD <= 0.32 decide that it is same person
    2. If HD > 0.32 decide that it is different person

    (Or left and right eyes of the same person)

5. In this step the real time input iris is matched with the database.
6. (i) If the iris is not matched with the database then the process terminates by showing user as an “Unknown Person”.

    (ii) If the iris is matched with database then the next step is to check the blink detection of the user. It is the important factor which helps in recognizing of user’s iris.
7. Now the blink detection (both open and closed condition of eyes) of user with the database is matched.
8. (i)If the blink detection does not match with the database then the process terminate by showing user as an “Unknown Person”.

    (ii) If blink detection is matched with the database then the process is terminated by showing the user as an “Authenticate Individual”.

4.2 Flowchart

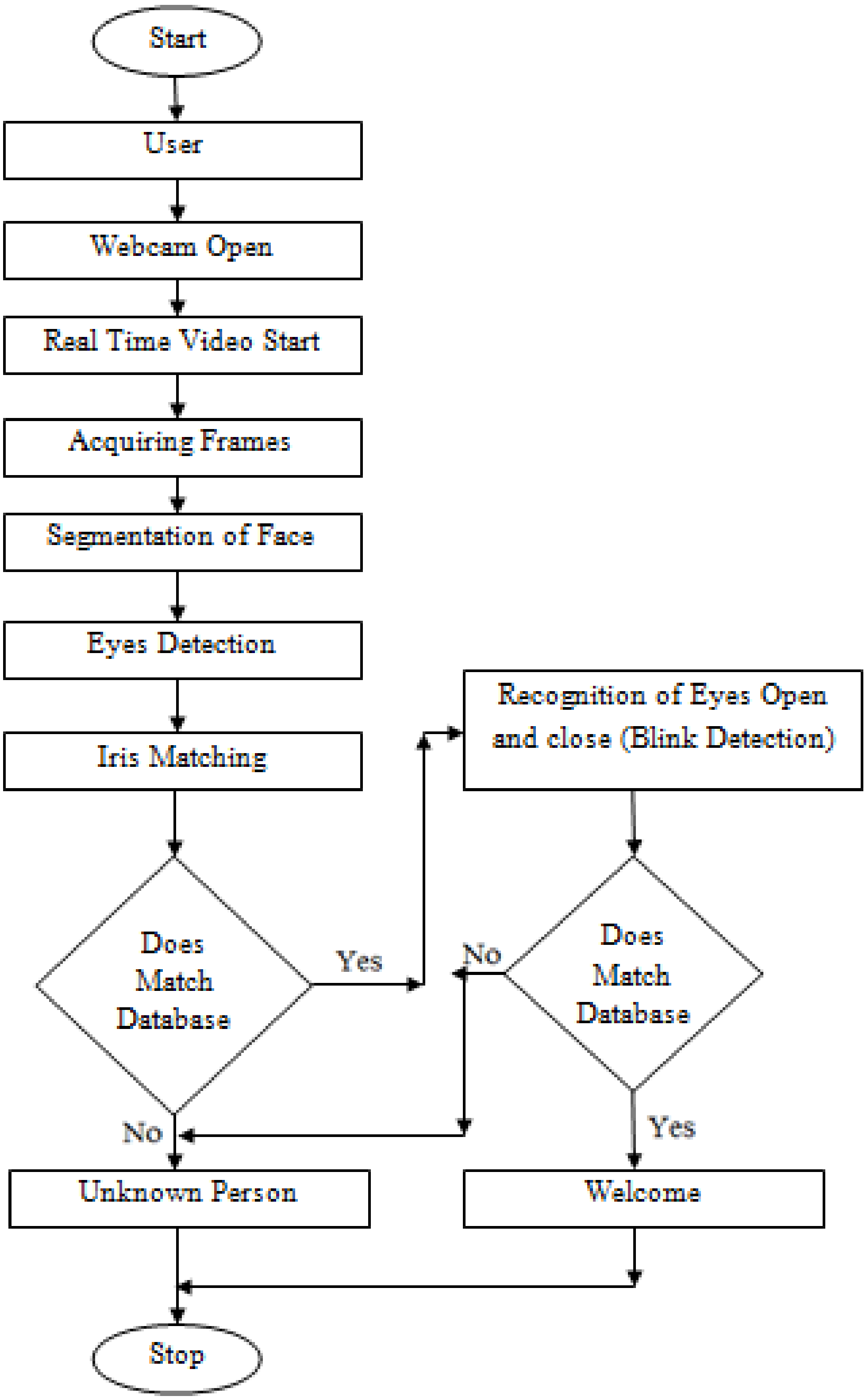


Figure6: Flowchart

5. SYSTEM IMPLEMENTATION

5.1 Real Time Iris Recognition

In our project we have made an iris recognition system and have analysed our results. For finding the iris' boundaries we have used both Canny Edge Detection and Circular Hough Transform. Then we apply the Haar wavelet to find the iris patterns as a feature vector. Using the Hamming Distance, we compare the quantized vectors and find whether the two iris' are similar or not.

Iris is a biometrical technology to find personal identity by iris patterns of a person. Iris recognition is very accurate and stable. Iris is unique to every person. The iris designs of two persons are always different, even twins have different iris designs. Also same person's iris of left and right eye is completely different. Generally, the left eye is utilized.

Firstly, we have to capture the eye image using webcam. Then, we have to reprocess the image and localize the iris and unwrap it. Now, using the Haar Wavelets, we find the iris texture. Then, this coded image is compared with the stored iris coded image and finds the verification

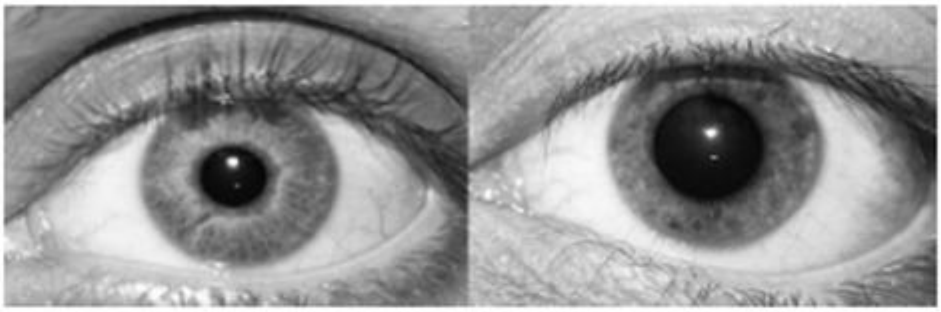


Figure7: Distinctiveness of Human Iris

5.1.1 Image Acquisition

This part of our project is very important because all remaining parts depend on the quality of image obtained from this step. Keeping in mind the final objective to achieve this, we have used the Webcam. For our experiment we have set 'HP Truevision HD' with resolution of 640x480 webcam, the sort of the picture to '*bmp', and the mode to white and dark for more prominent subtle elements (Figure 7).

5.1.2 Image Manipulation

Then, we have to convert our image from RGB to Gray level and 8 bit to double precision for doing further steps on our image.

5.1.3 Iris Localization

For matching the iris, we have to localize the iris boundary. It is done by finding the area between the limbus and the pupil boundary (the border between the sclera and the iris). We down sample the image by a factor of 4 and used the Gaussian Pyramid for faster processing. Now, find the gradient image using the Canny Edge Detection with default threshold value.
Now, apply the circular summation to calculate the intensities summation for all circles. Higher summation and biggest radius circle is the outer boundary. Then, the centre and radius can be found from the original image by further evaluation. After finding the outer edge, next step is to find the inner edge which is difficult to find because it cannot be easily accessible by Canny Edge Detection especially for dark eyed people. After finding the iris outer boundary, test the iris pixel intensities. Canny threshold is selected by this intensity. For dark iris, the lower threshold is used for Canny Operator to detect the inner circle between the iris and the pupil. And the higher threshold is used for light iris people (blue or green) (Figure 8).

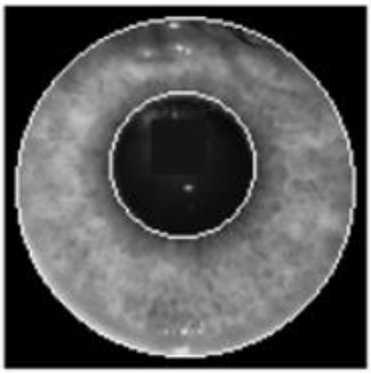


Figure8: Localized Iris

5.1.4 Mapping

After finding the boundary of the iris we have to store this iris image. Here, the main problem is of the pupil dilation that’s why we are changing our coordinate system and unwrapping the lower part of the iris (lower 180degree) and by polar coordinates plots all points of the iris (Figure 9 & 10).

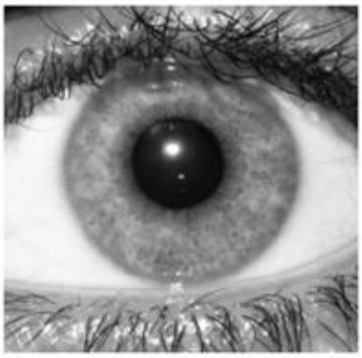


Figure9: Original Image

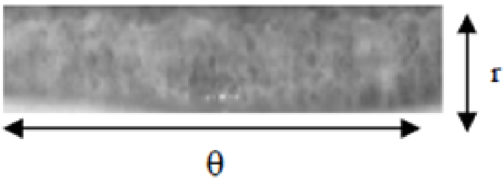


Figure10: Iris Located Image

5.1.4 Feature Extraction

A number of patterns can be observed throughout the world. A pattern is basically an arrangement, which represents the order of vectors instead of their properties. In this section, the arrangement of the iris image is extracted and then is compared with the neighbouring pixels. For this purpose, we will use the wavelet transform (Haar wavelet) (Figure 11).

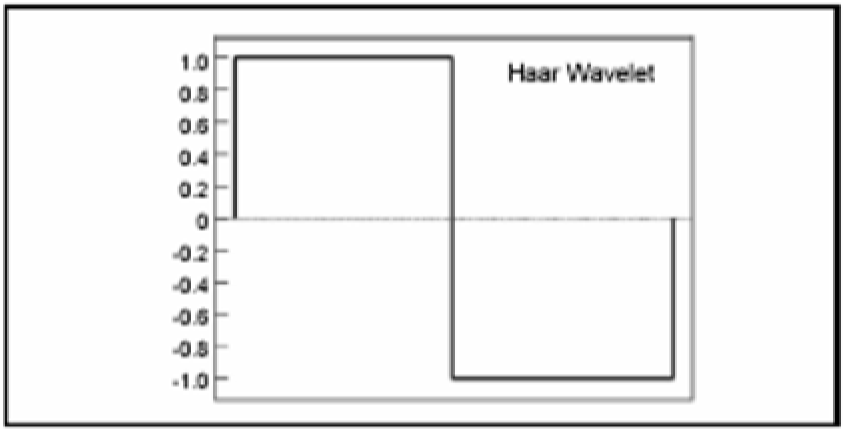


Figure11: The HAAR Wavelet

5.1.4 Haar Wavelets

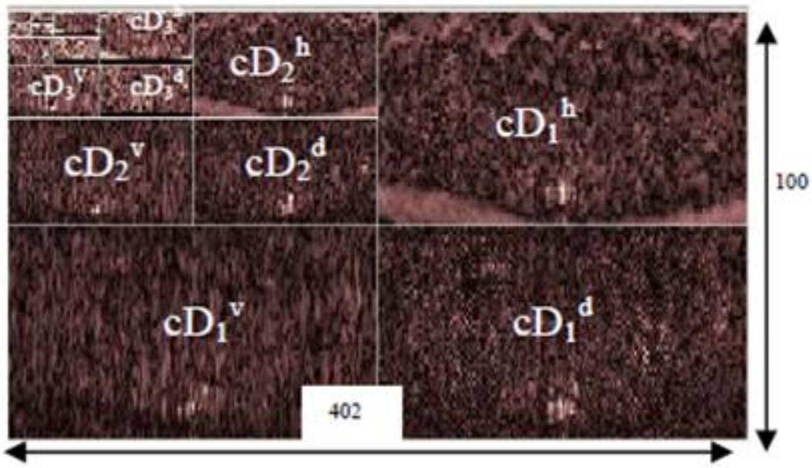


Figure12: Conceptual Diagram for Organizing a Feature Vector

We are using the wavelet tool, as we want to reduce the computation time, the option of neural network would be too time consuming, so we have used the Haar Wavelet in order to the extract the features out of the iris image.

After applying the 5 level Haar Wavelet, we get the detail and approximation coefficients. We compare the test results of both the wavelets that are Haar wavelet and other one is wavelet tree, we found that the results were slightly better by using Haar wavelet.

So we decompose the iris image by using 5 levels Haar Wavelet transform, these are viz.

D_1^h to D_5^h – These are the horizontal coefficients

D_1^v to D_5^v – These are the vertical coefficients

D_1^d to D_5^d – These are the diagonal coefficients

Now, we will eliminate the coefficients which represent the redundant information and pick only those which represent the core of the iris. D_1^h to D_4^h- these horizontal coefficients are almost same, so we can choose only one to reduce the redundancy, whereas $D_5^h$is different than the rest of the coefficients, so we have to choose it as it represents the new information.

So, as per the horizontal coefficients, the vertical and diagonal coefficients have the same pattern, so we can choose the 4th and 5th vertical and diagonal coefficients, so that all the information is preserved and all the redundancy is removed.

The coefficients considered are as follows:

D_4^h to D_5^h – These are the horizontal coefficients

D_4^v to D_5^v – These are the vertical coefficients

D_4^d to D_5^d – These are the diagonal coefficients

Now, we combine all the coefficients in to one vector and the resulting vector formed is called feature vector (Figure 12).

5.1.5 Binary Coding Scheme

In this section, we represent the vector in binary form, so that the distance between them can easily be calculated,

The algorithm which is used to convert the given vector into binary code word is

- If Coef(i) >= 0 then Coef(i) = 1
- If Coef(i) < 0 then Coef(i) = 0

The subsequent stage is to compare two code-words to find out whether they represent to a similar individual or not.

5.1.5 Test of Statistical Independence

The test of statistical independence is used to find the distance between the two iris patterns. The parameter used is Hamming Distance, greater the Hamming distance between two feature vectors more is the difference between two iris patterns.

The Hamming distance between two Boolean vectors is

$$HD = \frac{1}{N}\sum_{j=1}^{N} C_A(j) \oplus C_B(j)$$

Where, CA and CB are coefficients of iris images and N are the number of the elements in the feature vector.

The decision is taken on the basis of the following algorithm

If Hamming distance is less than or equal to 0.32, than the two iris images belong to the same person.

If Hamming distance is greater than 0.32, than the two iris images belong to different persons or they could be the left and right eyes of the same person.

1. If HD <= 0.32 decide that it is same person
2. If HD > 0.32 decide that it is different person

(Or left and right eyes of the same person)

5.2 Real Time Blink Detection

Implementation is the phase of the project when the theoretical outline is transformed into a working framework. Hence, it can be considered as the basic stage in accomplishing a new framework and providing it to the user with the certainty that this framework will work more effectively.

The implementation of this stage involves careful planning, examination of the current framework and its requirements on usage, planning of strategies to accomplish and assessment of progress over techniques.

The proposed system includes two modules which are as follows:

- Segmentation of face
- Detection of eyes condition

5.2.1 Segmentation of face

This is the principal module in which the face is segmented from the input image that is at first the video that is recorded by the camera will be fragmented into the frames and afterward into the picture, this image will be given as input for segmenting the face.

In partial segmentation of an image, it is divided into two classes-background and foreground, by selecting the appropriate threshold. Fundamentally the selection of an appropriate threshold value as per image histogram requires a major concern. This division is based on thresholding value or border as the brightness intensity. The value of brightness intensities is taken 1 if it is greater than threshold and zero if it is less than threshold.

5.2.2 Histogram

With the help of a histogram, we can represent distribution of univariate data graphically.

There are two types of histogram which are as follows:

- Image histogram
- Color histogram

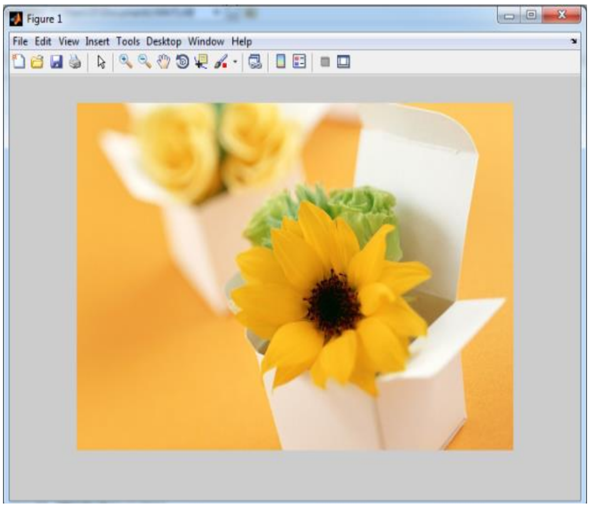
In first kind of histogram, the graphical portrayal of the tonal distribution is represented into a digital image. In this, pixels count corresponding to every tonal value is plotted. There are several advanced digital cameras on which these histograms are available. In graph, the tonal variations are represented on horizontal axis and pixels count is represented on vertical axis. This type of histograms can be very helpful for finding threshold value as thus computed threshold value is used in Segmentation of an Image, evaluating Co-occurrence Matrix and in Edge Detecting

Representation of Image histogram in Matlab is as follows:

A=imread('sample.jpg');

hist(A);

Here, imread() is used to read the colored or grayscale image of a specified filename given in form of string. Basically here we are changing over an image to histogram just to get the threshold values final objective to isolate the foreground and background class.
An RGB color version of an image and its corresponding histogram is shown in Figure 13 & 14 respectively.



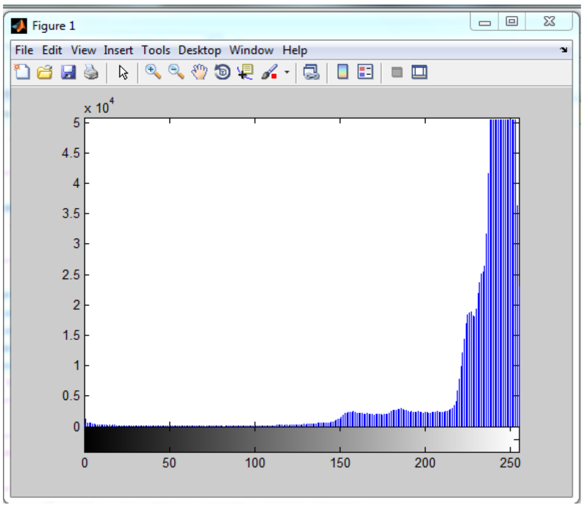


Fig13: Digital Image

Fig14: Histogram Of An Image

5.2.3 YCbCr Color Space

At first the camera will record the video of a user so that each of the images in that recorded video will be in the RGB color space that incorporates user face along with surrounding area. In order to identify the user's eyes position the detection of face has significant role as it helps in limiting the error rate in recognizing the eyes.

A color space family consisting YCbCr, Y′CbCror Y Pb/Cb Pr/Cris used in color image of a video and digital photographs. Here the luma part is denoted as Y' and CB represents the blue- difference chroma segment, while CR representsred-difference chroma segment. The Y′ is luminance as compared to Y.

Y′CbCr, which is not a color space completely, is used to encode RGB data. In signal display the RGB primaries are used that acts a basis of actual color of an image. Therefore, the value of Y′CbCr can be detected only by using primary chromaticities of standard RGB.

Skin segmentation is used for face detection. Then, the image is divided into two segments: color and luminosity segment by an YCbCr domain. This conversion of an image into YCbCr space is done with the aim of luminosity influence removal while the image is processed. In the RGB domain, every segment of an image has different brightness while in YCbCr space, Y-segment gives the whole information related to brightness as the other segments Cr (red) and Cb (blue) does not depend on the luminosity.

There are numerous methods for segmenting sign on whether a pixel is a piece of the skin or not. With the help of minimum and maximum values of threshold corresponding to Cr and Cb segments, the faces and background can be recognized.

Considering there is no standard color-image database which can evaluate the faces in pictures, we set up the color image database with 500 skin pictures. There are some example pictures that are appeared in the following Figure 15:

Fig15: Sample of Skin Images

Steps for converting an RGB image to YCbCr image

$$Y=0.299R+0.5879G+0.114B$$

$$Cb=-0.169R-0.331G+0.5B$$

$$Cr=0.5R-0.419G-0.081B$$

Step 1: Reading an input image

RGB= imread('sample.jpg'); (Figure 16)

Step 2: Converting an RGB image to YCbCr image

YCBCR = rgb2ycbcr(RGB)(Figure 17)

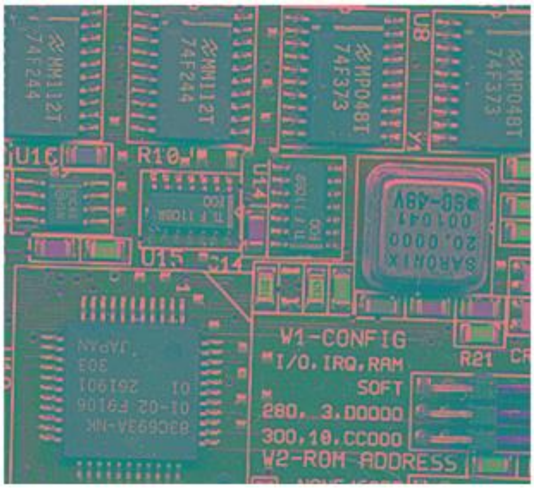


Fig16: Image in RGB Color Space

Fig17: Image in YCbCr Color Space

5.2.4 Detection of Eyes Condition

The next important step is to detect whether the eyes of a user are closed or open in order to reorganize the iris. This detection is based on the symmetry of an image and the brightness intensity difference which occurs in the pupil of image. It is very difficult to find out the eyes location in the frame which is extracted from user's face. This is done by using geometrical and symmetrical properties. The location of the pixels with a significantly high brightness is identified and used for finding Edging. For edge detection Sobel operator is one of the effective operator.

Using an appropriate value of threshold user's eye position is found out. The edge detection is used in separating these two areas and as per and additionally with the property of eyes symmetry, the eye's gravity centre is computed. At last, we can identify the pupil.

Pixel intensity transitions are localized by Edge detection. Mainly, there exist a few edge detection techniques like Sobel .These strategies are developed in order to find an image's transitions detection. The finest gradient operator to identify variations of sharp intensity can be found in literature.

In this work, an edge detection technique Sobel is considered which uses one horizontal and one vertical mask. Generally, a matrix of dimension 3 (edge.m in Matlab) is used by these masks whose dimension can also be extended to 5. These new networks toolboxes are used to create a Sobel matrix of dimension 5 in Matlab.

Algorithm for Sobel edge detection

Step 1: Accept the input image.

imread(input image)

Here, imread() is used to read an RGB image of a specified filename given in form of string.

Step 2: Specifies the Sobel method and the dimension of image

BW = edge (I,'sobel')

In Sobel method, an image is sent as input and a binary image namely BW is returned of the same size as that of input image with its entries as 1's if there is an edge in I and 0's if there is no edge in I. And this syntax also specifies the dimension of the image to be 1 dimension.

Step 3: Reading the BW image

imread(BW)

Here, imread() is used to read a grayscale image of a specified filename given in form of string.

Step 4: Specifies the threshold for the Sobel method

BW = edge (I, ’sobel' ,thresh)

In this a threshold value ‘thresh’ is sent as input which helps ‘edge’ function to ignore those edges which have less value than ‘thresh’ and if the‘thresh’value is not specified, thenit is chosen automatically. Threshold values are ranging from 365 to 535.

Step 5: Specifies the direction of detection for the Sobel method

BW = edge (I,'sobel', thresh, direction)

It specifies the direction of detection for the Sobel method. Direction is a string specifying whether to look for 'horizontal' or 'vertical' edges i.e. gh and gv or 'both' (the default).

Step 6: Returns the threshold value.

[BW, thresh] = edge (I,’sobel’,___)

It gives us an option of 'no thinning'in which case the computations become fast as it skips a stage of edge thinning. We can also specify the value of this'thinning'.

Step 7: Two masks are used for having the maximum edge at vertical and horizontal level i.e. gv and gh.

Mask along horizontal direction i.e. gh (Figure 18)

A11	A12	A13	……	A1K
A21	A22	A23	……	A2K
A31	A32	A33	……	A3K
:	:	:	:	:

Input image

+

M11	M12	M13
M21	M22	M23
M31	M32	M33

Mask

→

B11	B12	B13	…..	B1K
B21	**B22**	B23	…..	B2K
B31	B32	B33	…..	B3K
:	:	:	:	:

gh output image

Fig18: Input Image, Mask and gh Output Image

$$B22=(A11*M11)+(A12*M12)+(A13*M13)+(A21*M21)+(A22*M22)+(A23*M23)+(A31*M3)+(A32*M32)+(A33*M33)$$

Mask along vertical direction i.e. gv(Figure 19)

A11	A12	A13	……	A1K
A21	A22	A23	……	A2K
A31	A32	A33	……	A3K
:	:	:	:	:

Input image

+

M11	M21	M31
M12	M22	M32
M13	M23	M33

Mask

→

B11	B12	B13	…..	B1K
B21	**B22**	B23	…..	B2K
B31	B32	B33	…..	B3K
:	:	:	:	:

gv output image

Fig19: Input Image, Mask and gv Output Image

B22=(A11*M11)+(A12*M21)+(A13*M31)+(A21*M12)+(A22*M22)+(A23*M32)+(A31*M1)+(A32*M23)+(A33*M33)

Step 8: Returns vertical and horizontal edge responses to Sobel Operators.

[BW,thresh,gv,gh] = edge(I,'sobel',...)

The threshold value of eyes along vertical and horizontal value and the status of the eyes is returned.

Step 9: Template matching is done based on status of eyes obtained from step8.

5.2.5 Eye Template Generation Process

After successful face feature detection, the condition of eyes in all the frames can be found by using "Correlation Coefficient Template Matching strategy". The region consisting of eyes is determined by taking into account the areas where the pixels are close to each other and matches to the eyes pixels. Now, the accurate boundaries of eyes are detected using Sobel Technique. Our technique begins from left and right side, to detect eyes, in this way we can distinguish the eyes independently. After this, the eyes are segmented from an image and a template is generated using them. The eye template obtained in this manner is more stable to analyse the states of the eyes and is more effective with reduced reflections of light. The process of generating this eye template is shown in Figure 20.

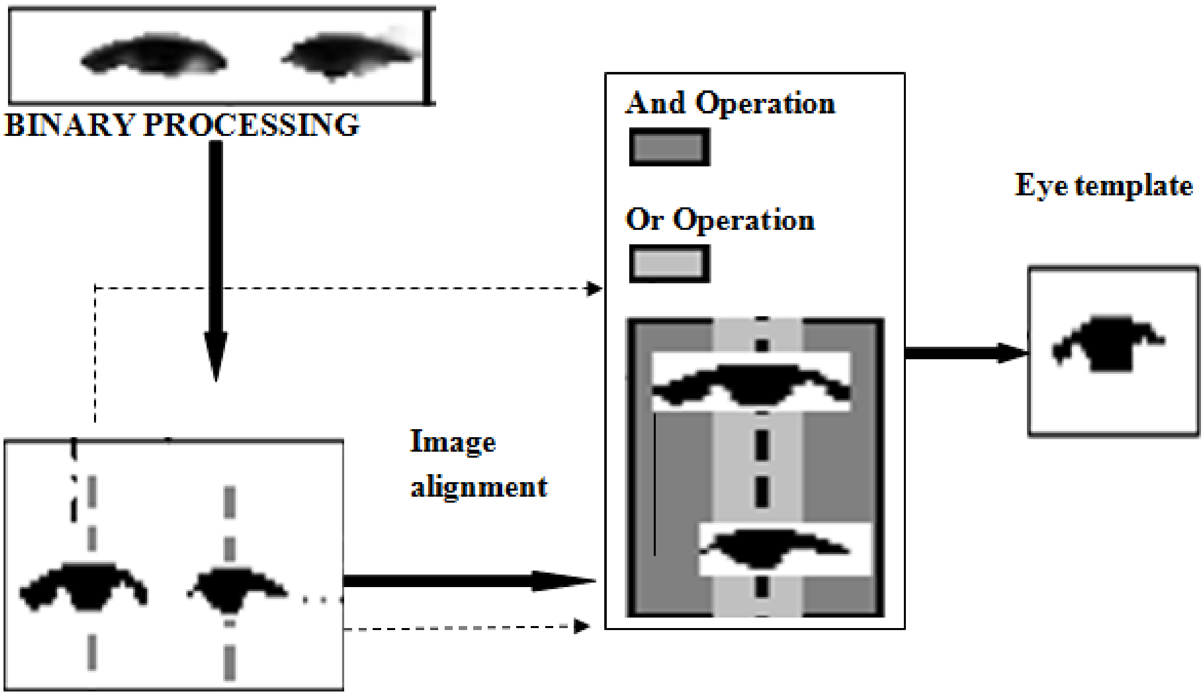


Figure20: Eye Template Generation Procedure

In order to identify the status of user's eyes, the state of eyes ought to be divided further. The eyes size in a given frame can be affected by two things. The first one is that human eyes vary in size and the second reason is distance between camera and human eyes. In order to overcome this effect, the eye layout is normalised to 30×60 size before the next step of extracting the features. The important factors, in identifying the status of eyes from a given eye template, are shown in the following table:

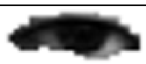
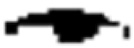
	Eye Region	Area(pixel)	Eye Template	Average Height	Ratio
Open		200		7.6	2.8750
Closed		114		6.0	3.1667

Figure21: Eye States and Features

There are mainly two conditions of eyes i.e. either the eyes are open or closed. In Figure 21, the various features of different eye's conditions are shown. By analyzing changes in user's eye states, we found that user is properly blinking or not.

6. EXPERIMENTAL RESULTS

To measure experiments for iris recognition in real time, we used the "Laptop-Webcam" to collect the iris images. We tested our project on 10 iris images using a 'Pentium Core-i3 Processor' and 'Matlab-2015' software.

6.1 User 1

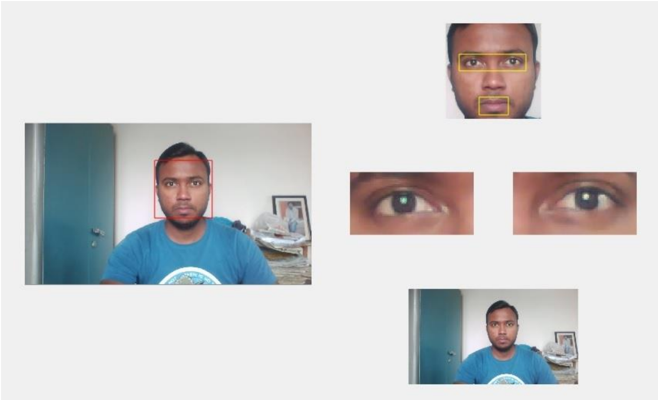


Figure22: User 1

6.1.1 Table 1

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	30.30 sec.	0.2813	"Welcome"	100%
Real Time User's Image Input	28.20 sec.	0.3403	"Unknown"	100%
Real Time User's Video input	27.06 sec.	0.3503	"Unknown"	100%
Real Time Unknown Person Image Input	13.26 sec.	0.6215	"Unknown Person"	100%
Real Time Unknown Person Video Input	14.18 sec.	0.5486	"Unknown Person"	100%

6.2 User 2

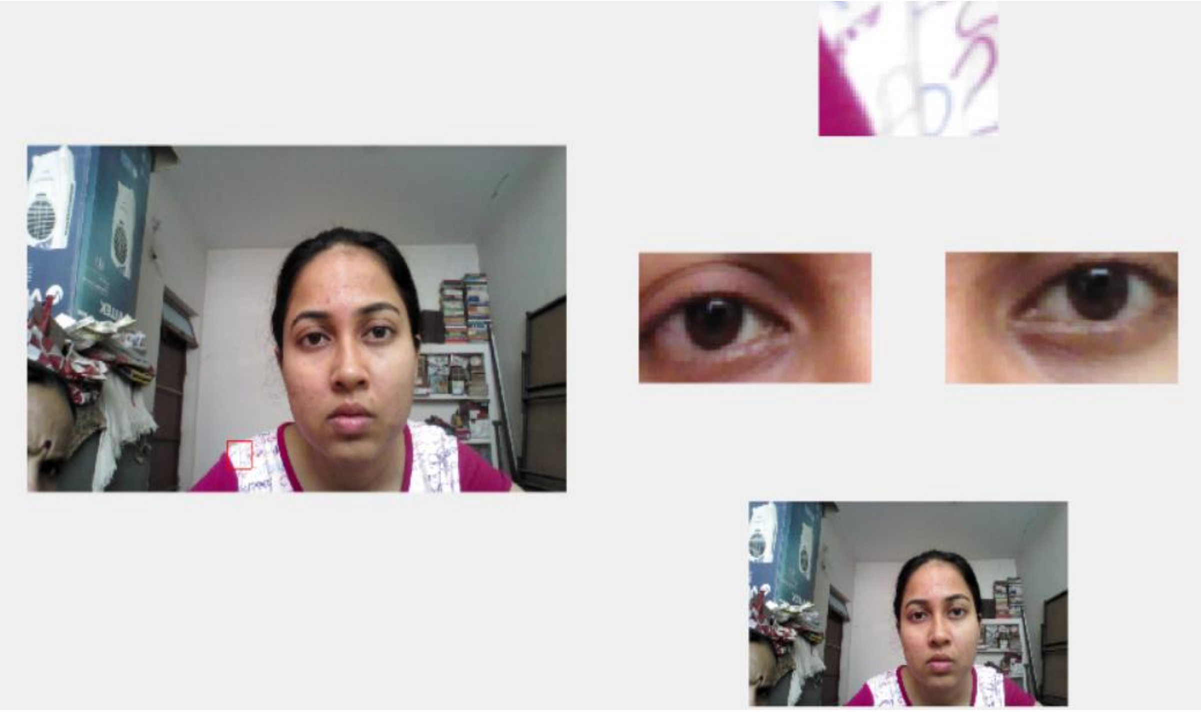


Figure23: User 2

6.2.1 Table 2

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	31.25 sec.	0.3023	"Welcome"	100%
Real Time User's Image Input	30.10 sec.	0.3603	"Unknown"	100%
Real Time User's Video input	29.16 sec.	0.3303	"Unknown"	100%
Real Time Unknown Person Image Input	14.33 sec.	0.5515	"Unknown Person"	100%
Real Time Unknown Person Video Input	15.28 sec.	0.6486	"Unknown Person"	100%

6.3 User 3

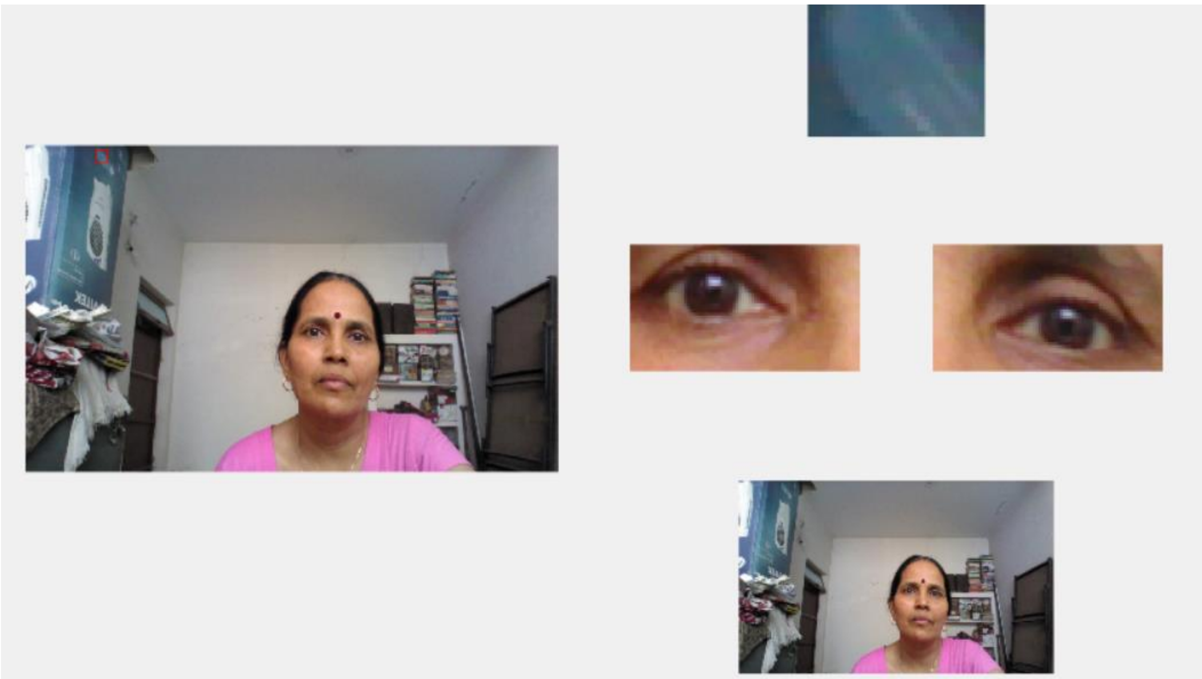


Figure 24: User 3

6.3.1 Table 3

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	29.35 sec.	0.2913	"Welcome"	100%
Real Time User's Image Input	25.20 sec.	0.3583	"Unknown"	100%
Real Time User's Video input	32.26 sec.	0.3153	"Unknown"	100%
Real Time Unknown Person Image Input	13.43 sec.	0.6415	"Unknown Person"	100%
Real Time Unknown Person Video Input	14.18 sec.	0.5260	"Unknown Person"	100%

6.4 User 4

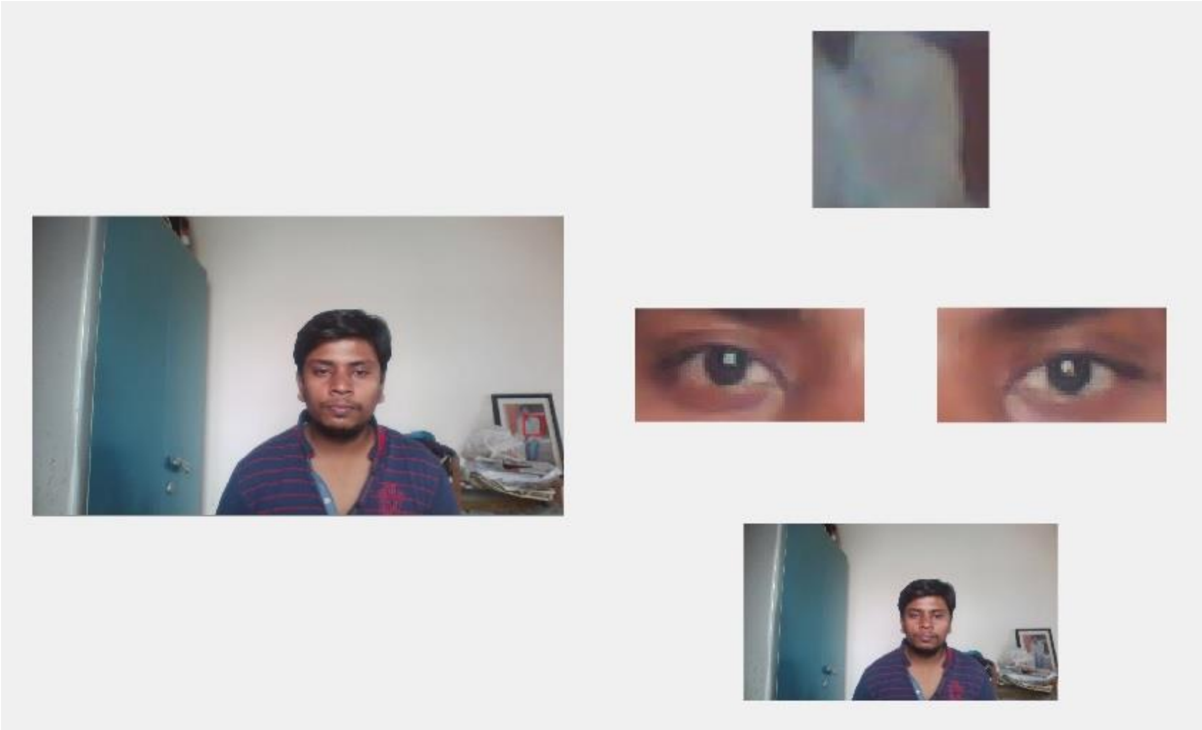


Figure25: User 4

6.4.1 Table 4

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	30.45 sec.	0.4411	"Welcome"	100%
Real Time User's Image Input	24.30 sec.	0.4593	"Unknown"	100%
Real Time User's Video input	35.36 sec.	0.4400	"Unknown"	100%
Real Time Unknown Person Image Input	14.44 sec.	0.6012	"Unknown Person"	100%
Real Time Unknown Person Video Input	16.11 sec.	0.5584	"Unknown Person"	100%

6.5 User 5

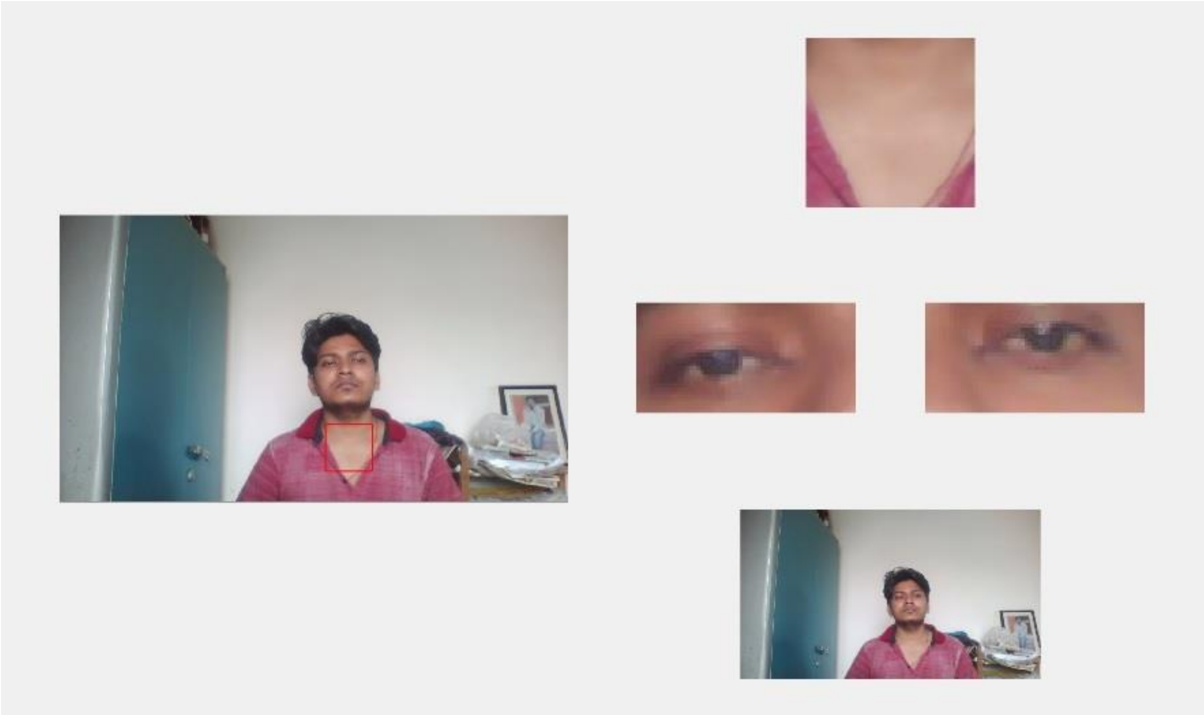


Figure26: User 5

6.5.1 Table 5

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	25.20 sec.	0.2548	“Welcome”	100%
Real Time User’s Image Input	30.30 sec.	0.4582	“Unknown”	100%
Real Time User’s Video input	22.22 sec.	0.3698	“Unknown”	100%
Real Time Unknown Person Image Input	14.36 sec.	0.5746	“Unknown Person”	100%
Real Time Unknown Person Video Input	14.55 sec.	0.5589	“Unknown Person”	100%

6.6 User 6

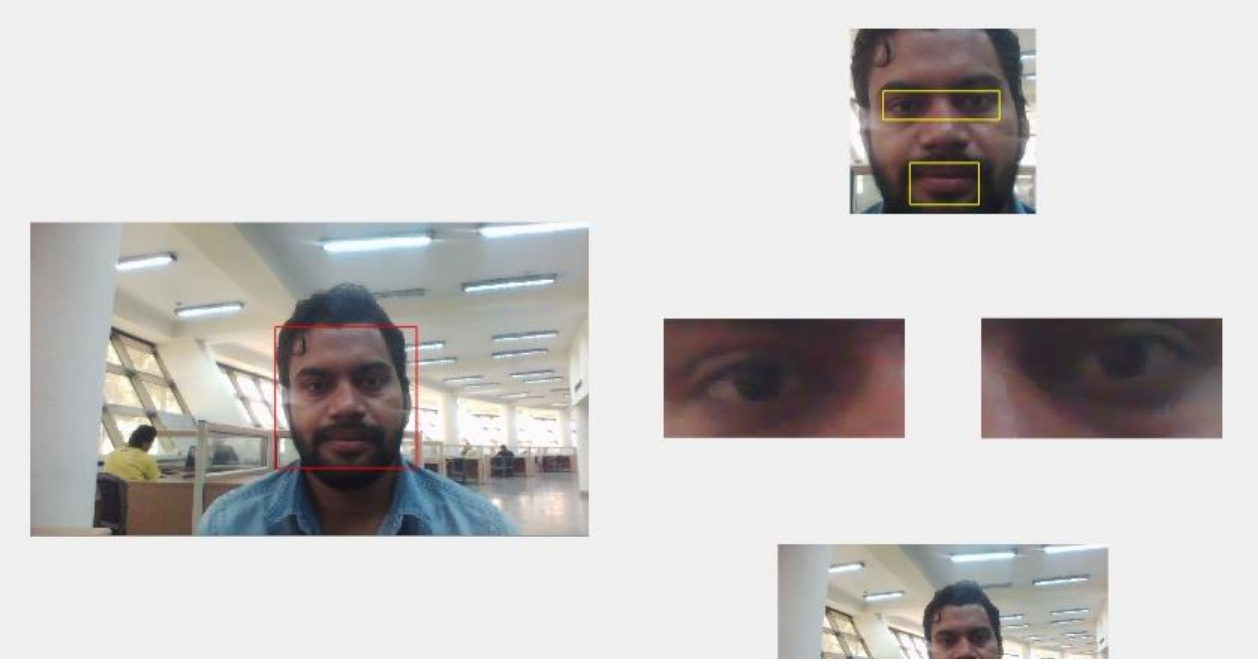


Figure 27: User 6

6.6.1 Table 6

Details	**Time Elapsed**	**Hamming Distance**	**Status**	**Accuracy**
Real Time User Input	30.20 sec.	0.2935	"Welcome"	100%
Real Time User's Image Input	28.25 sec.	0.4125	"Unknown"	100%
Real Time User's Video input	29.24 sec.	0.3589	"Unknown"	100%
Real Time Unknown Person Image Input	13.25 sec.	0.5587	"Unknown Person"	100%
Real Time Unknown Person Video Input	15.14 sec.	0.6547	"Unknown Person"	100%

6.7 User 7

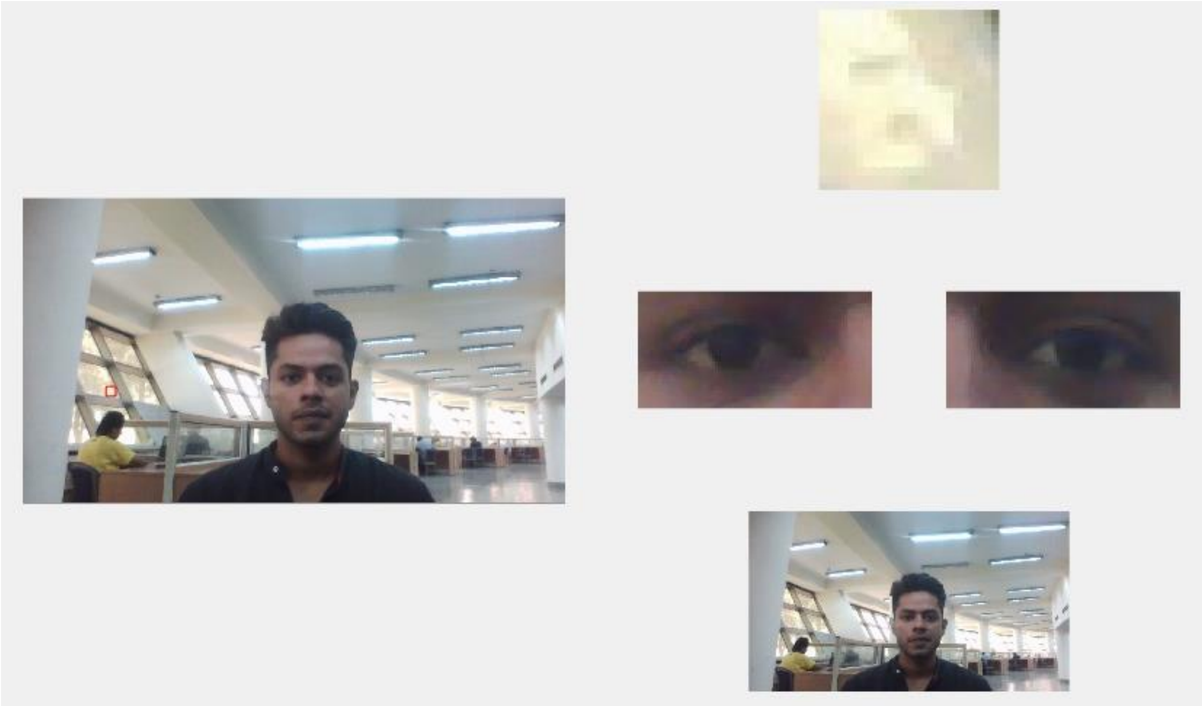


Figure28: User 7

6.7.1 Table 7

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	33.25 sec.	0.3471	“Welcome”	100%
Real Time User’s Image Input	38.45 sec.	0.4477	“Unknown”	100%
Real Time User’s Video input	39.54 sec.	0.4035	“Unknown”	100%
Real Time Unknown Person Image Input	14.33 sec.	0.5524	“Unknown Person”	100%
Real Time Unknown Person Video Input	14.14 sec.	0.6685	“Unknown Person”	100%

6.8 User 8

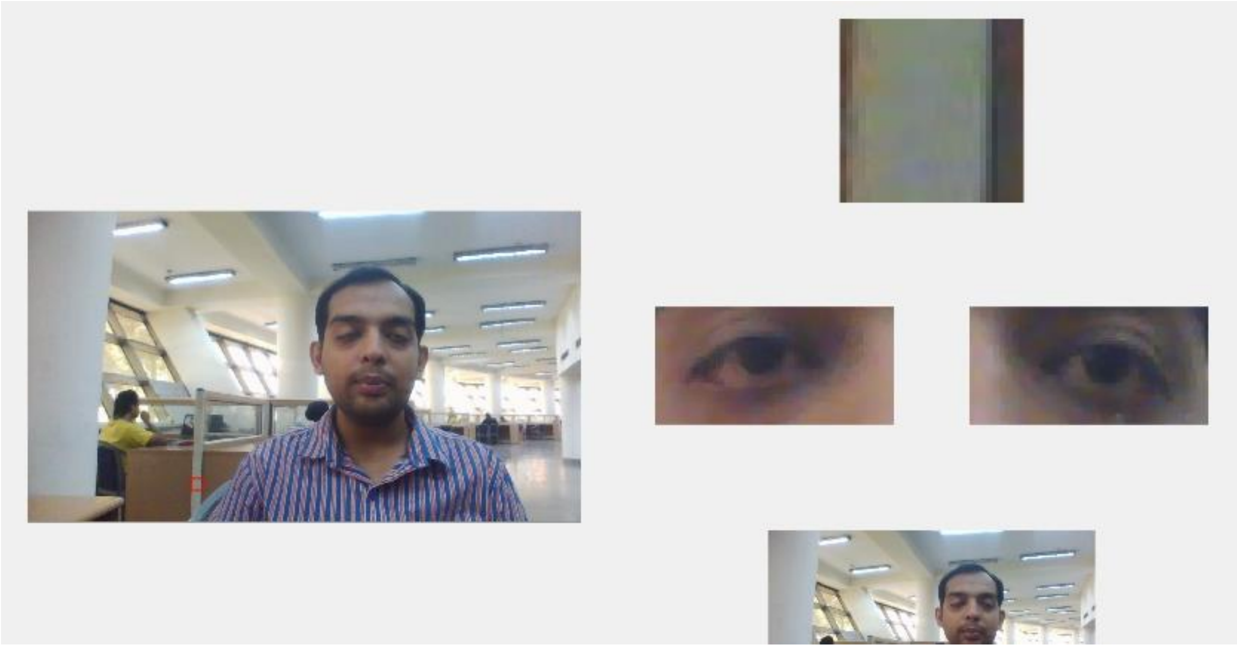


Figure29: User 8

6.8.1 Table 8

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	35.45 sec.	0.4025	"Welcome"	100%
Real Time User's Image Input	39.55 sec.	0.4014	"Unknown"	100%
Real Time User's Video input	40.55 sec.	0.3025	"Unknown"	100%
Real Time Unknown Person Image Input	15.25 sec.	0.6502	"Unknown Person"	100%
Real Time Unknown Person Video Input	13.25 sec.	0.7025	"Unknown Person"	100%

6.9 User 9

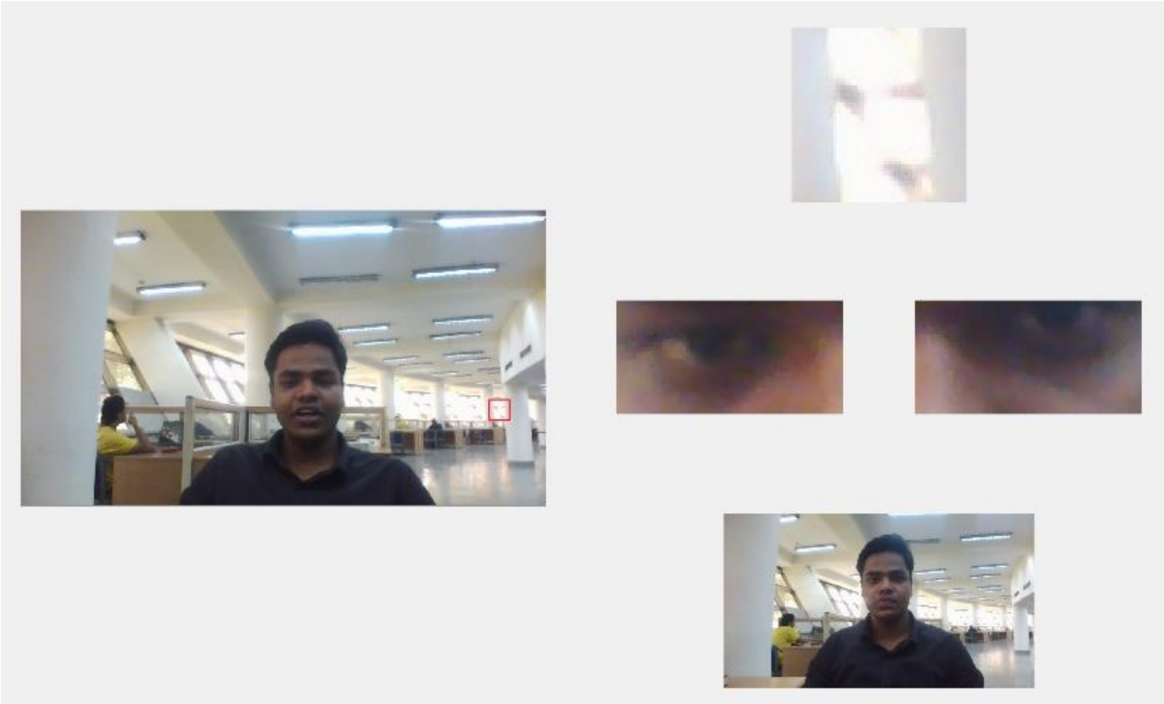


Figure30: User 9

6.9.1 Table 9

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	35.45 sec.	0.4025	"Welcome"	100%
Real Time User's Image Input	39.55 sec.	0.4014	"Unknown"	100%
Real Time User's Video input	40.55 sec.	0.3025	"Unknown"	100%
Real Time Unknown Person Image Input	15.25 sec.	0.6502	"Unknown Person"	100%
Real Time Unknown Person Video Input	13.25 sec.	0.7025	"Unknown Person"	100%

6.10 User 10

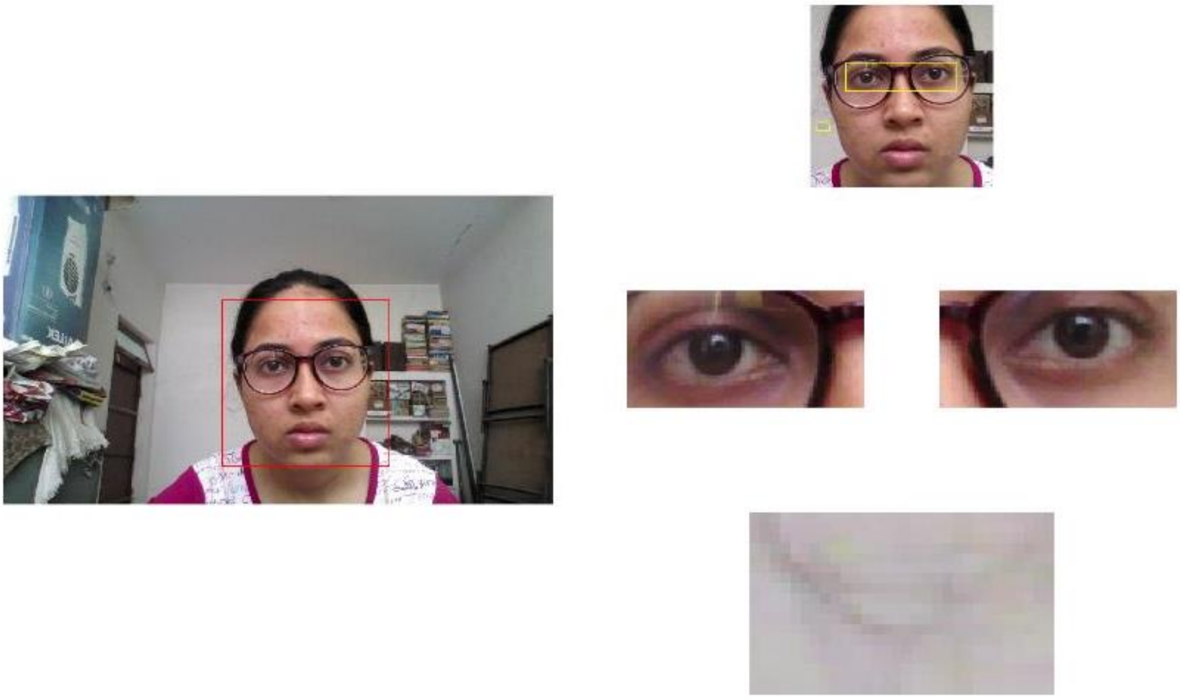


Figure 31: User 10

6.10.1 Table 10

Details	**Time Elapsed**	**Hamming Distance**	**Status**	**Accuracy**
Real Time User Input	25.25 sec.	0.4133	“Welcome”	100%
Real Time User’s Image Input	33.01 sec.	0.3847	“Unknown”	100%
Real Time User’s Video input	38.47 sec.	0.4521	“Unknown”	100%
Real Time Unknown Person Image Input	14.28 sec.	0.7052	“Unknown Person”	100%
Real Time Unknown Person Video Input	13.99 sec.	0.6021	“Unknown Person”	100%

6.11 User 11

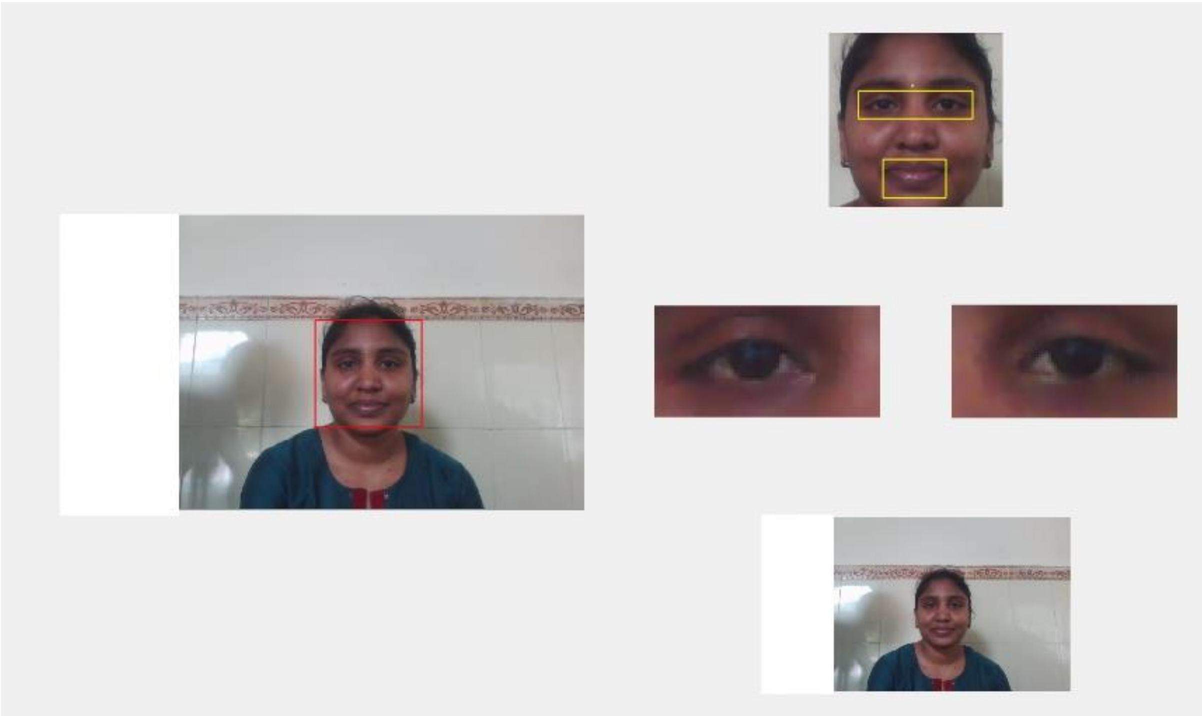


Figure 32: User 10

6.11.1 Table 11

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	29.35 sec.	0.4258	“Welcome”	100%
Real Time User’s Image Input	35.11 sec.	0.3478	“Unknown”	100%
Real Time User’s Video input	48.27 sec.	0.3585	“Unknown”	100%
Real Time Unknown Person Image Input	14.85 sec.	0.7145	“Unknown Person”	100%
Real Time Unknown Person Video Input	15.11 sec.	0.6523	“Unknown Person”	100%

6.12 User 12

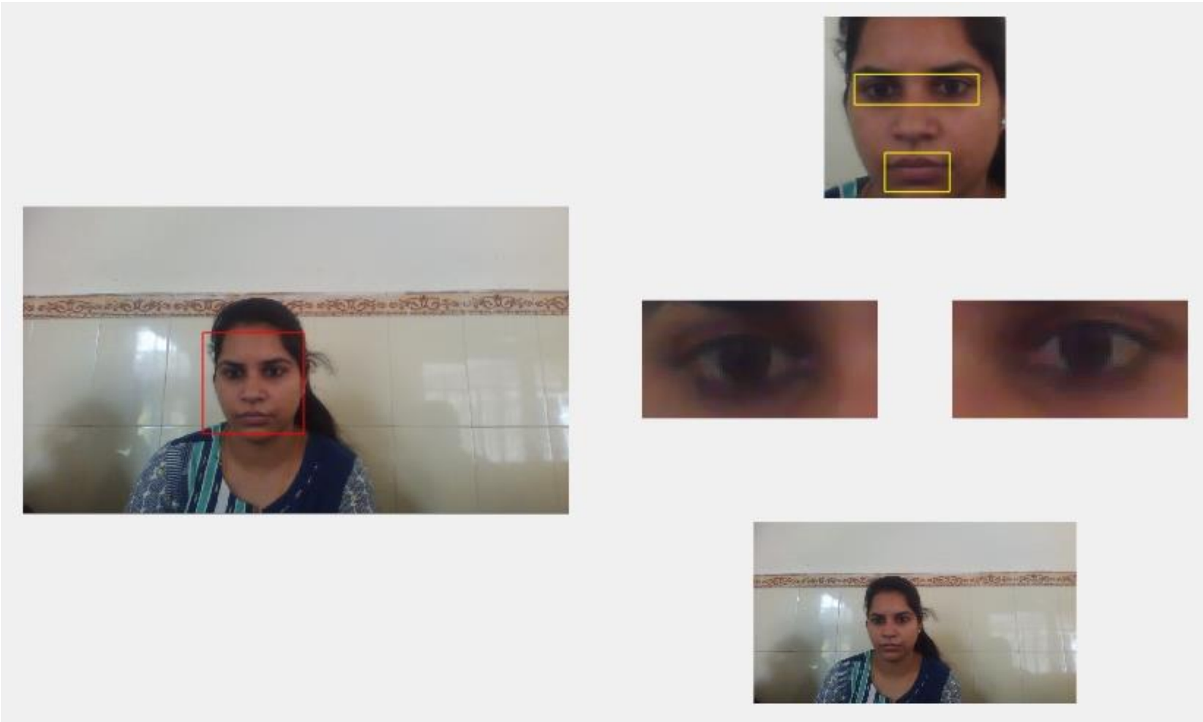


Figure 33: User 10

6.12.1 Table 12

Details	Time Elapsed	Hamming Distance	Status	Accuracy
Real Time User Input	35.33 sec.	0.4785	"Welcome"	100%
Real Time User's Image Input	34.11 sec.	0.3547	"Unknown"	100%
Real Time User's Video input	47.01 sec.	0.4123	"Unknown"	100%
Real Time Unknown Person Image Input	13.30 sec.	0.6012	"Unknown Person"	100%
Real Time Unknown Person Video Input	14.77 sec.	0.7125	"Unknown Person"	100%

CONCLUSION

The proposed method in our project gives best results than others and recognition error is decreased. The accuracy attain is 100% and average recognition time is 31.01 sec, which shows the successfulness of our proposed algorithm.

Another measures of a biometric framework are FAR (False Acceptance Rate), FRR (False Rejection Rate), and EER (Equal Error Rate). A false acceptance happens when the framework acknowledges a fraud to be a certifiable person. A false reject happens when the framework rejects a genuine individual to be a faker. Biometric execution is additionally shown by Receiver Operating Characteristic (ROC) curve, which is a plot of False Acceptance Rate against False Rejection Rate. The EER is a point on the ROC where the False Acceptance Rate is equivalent to the False Rejection Rate. As, any biometric framework require certain satisfactory estimations of FAR and FRR, limit esteem Ts can be resolved. The performance of any two biometric frameworks can be analyzed by EER and by ROC curve. The lower the EER, the better the framework is. The nearer the ROC bends to the origin point, the better the framework is.

In our project, FAR, FRR and EER are equal to zero. Therefore, the ROC curve for our method shows the best framework as shown below (Figure31).

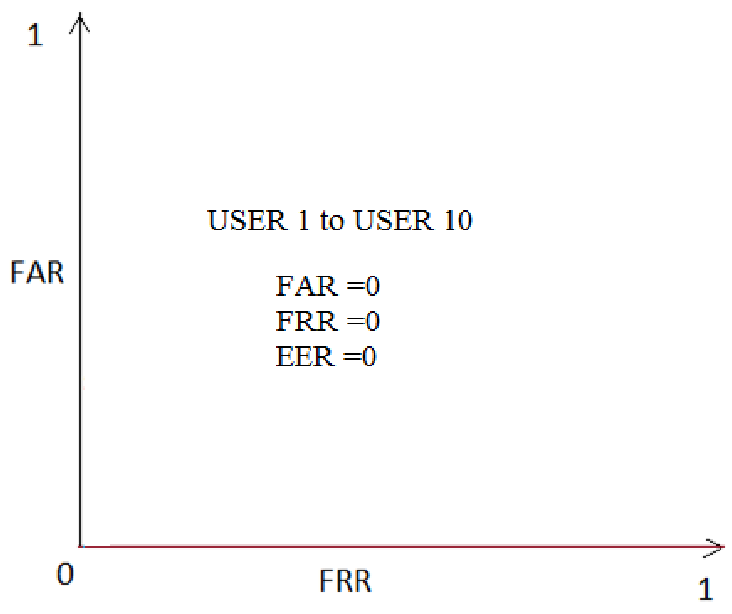


Figure 34: ROC Curve

FUTURE WORK

Iris recognition frameworks additionally have innovative work openings in the ranges of iris capturing sensors, catching and perceiving the iris at greater distances with movement of an individual likewise diminishing the extent of the equipment, increasing speed of calculation. Security, integrity, and reliability can also be considered as an emerging research area. Information security research is required that addresses the issues of biometric frameworks, for example, preventing assaults in view of the fake biometrics, the reissue of previously captured biometric samples, and the concealment of biometric traits.

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