# MINI PROJECT REPORT

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# STUDENT ATTENDANCE SYSTEM
# ( USING PALM VEIN TECHNOLOGY)

by


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**2021-2022**

## <u>C E R T I F I C A T E</u>

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# ABSTRACT

This project presents a new approach to develop the appearance of palm vein verification that uses blood vessel patterns as a personal identifying factor. The proposed approach of the vein is hard for replacement, since veins are internal to the human body and the palm vein authentication technology offers a high level of accuracy.

The palm-vein-based approach attempts to more effectively accommodate the potential deformations, revolving and translational changes by encoding the orientation preserving features. An Image Analysis the technique for Vascular Pattern of Hand Palm, which in turn leads towards the Palm Vein Authentication of an individual. NearInfrared Image a Palm Vein pattern is taken and passed through four different processes or algorithms to process the Infrared Image in such a way that the future authentication can be done accurately or almost exactly. These four different processes are:  1) Junction point algorithm.

2) Hand Geometry algorithm

3) Pose invariant algorithm 4) Calculation of Rank Matrix.

The resultant Images will be stored in a Database, as the vascular patterns are unique to each individual, so future authentication can be done by comparing the pattern of veins in the palm of a person being authenticated with a pattern stored in a database

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# CHAPTER-1.INTRODUCTION

## 1.1 WHAT IS BIOMETRICS?

Automated measurement of Physiological and/or behavioral characteristics to determine or authenticate identity is known as Biometrics. Three components of the above definition will determine what is and what is not a biometric and also its different types and functionalities.

Let's start with the First component of the definition: "Automated measurement", which means no human intervention or involvement is required. Biometrics are automated as much as the processes involved in sample acquisition, feature extraction, record retrieval, and algorithm based matching are computerized or machine-based. Also the record retrieval and comparison against another measurement must take place in Realtime. So for an instance, DNA sampling is NOT a biometric measurement because today it still requires human intervention and it's NOT done in real time. The second component of the definition: "Physiological and/or behavioral characteristics, determine the two main biometric categories: behavioral and physiological. The behavioral characteristics measure the movement of a user, when users walk, speak, type on a keyboard or sign their name. The physiological characteristics would be the physical human traits like fingerprints, hand shape, eyes and face, veins, etc., and the last component of the definition is "determine or authenticate identity", which categorizes the two types of biometric functionalities. The first type is identification systems or the systems that answer the question who am I? and determine the identity of a person. The second type is verification systems or systems that answer the question, am I who I claim to be? and authenticate a person.

An example of an Identification System using biometrics would be: You approach an ATM with NO card, NO claimed identity, NO PIN. The ATM scans your iris and determines who you are and gives you access to your money. Chapter-1 INTRODUCTION TO BIOMETRICS Palm Vein Technology ECED, SVNIT Page 2 An example of a Verification System using biometrics would be: You approach an ATM and swipe a card or enter an account number. The ATM scans your iris and uses it as a password to authenticate you are the rightful owner of the card and therefore give you access to your money.

## 1.2 USAGE OF BIOMETRIC TECHNOLOGY MINIMIZES RISKS

- The person, who has my office id card, can…
- The person, who has my house key, can…

- The person, who knows my password, can…
- The person, who knows the pin number of my credit card, can…
- The person, who is able to forge my signature, can…
- The person, who steals my passport, can

## 1.3 BIOMETRICS - SECURITY & CONVENIENCE


Fig-1.1 Threats in various security systems

Biometrics is more convenient and secure than other security methods like key, ID card, PIN code etc., because someone can lose the key or ID card and may forget the PIN code but in case of Biometrics where your body part or the some of your behaviour is your identity which you cannot lose or forget. Even the palm vein patterns of identical twins don't match. Also no human is involved and the system is fully automated so chances of biasing or misuse of the identity is minimized. Also biometric features of an individual cannot be copied easily with perfection.

## 1.4 BIOMETRIC FEATURES

- It becomes obsolete to beware passwords safely or to remember all of them.
- Abuse of stolen id cards and passports will be reduced enormously.
- Abuse of stolen credit cards will be prevented.
- Taking over foreign identities will be impossible.
- Building access right to people without the right of admittance will be prevented.

- Access to devices/computers will be not possible for persons without the right of admittance.
- Unnecessary costs will be drastically reduced.
- Level of common convenience and safety will grow.

## 1.5 DIFFERENT BIOMETRIC TECHNOLOGIES

- Voice Print Technology
- Finger/palm Print Technology
- Face Recognition Technology
- Iris Scan Technology
- Retina Scan Technology
- Ear shape recognition Technology
- Dynamic Signature Recognition (DSR)
- Typing Pattern Technology
- Palm Vein Technology

# CHAPTER-2 HISTORY

## 2.1 THE BASICS OF PALM VEIN TECHNOLOGY

Every individual has a unique pattern of Palm veins, so the palm vein pattern is used to authenticate some individual’s identity. The process of authentication and registration is discussed in the next topics. An individual first rests his wrist, and on some devices, the middle of his fingers, on the sensor's supports such that the palm is held centimeters above the device's scanner, which flashes a near- infrared ray on the palm [6]. Unlike the skin, through which near infrared light passes, deoxygenated hemoglobin in the blood flowing through the veins absorbs near-infrared rays, illuminating the hemoglobin, causing it to be visible to the scanner.

Fig-2.1 Palm vein scanning

Arteries and capillaries, whose blood contains oxygenated hemoglobin, which does not absorb near- infrared light, are invisible to the sensor. The still image captured by the camera, which photographs in the near-infrared range, appears as a black network, reflecting the palm's vein pattern against the lighter background of the palm. An individual's palm vein image is converted by algorithms into data points, which is then compressed, encrypted, and stored by the software and registered along with the other details in his profile as a reference for future comparison. Then, each time a person logs in attempting to gain access by a palm scan to a particular bank account or secured entryway, etc., the newly captured image is likewise processed and compared to the registered one or to the bank of stored files for verification, all in a period of second .numbers and positions of veins and their crossing points are all compared and, depending on verification, the person is either granted or denied access.

## 2.2 REGISTERING THROUGH P.V.T.

STEP 1: Palm vein authentication technology consists of a small Palm vein scanner that's easy and natural touse, fast and highly accurate. Simply hold your palm a few centimetres over the scanner

Fig-2.2 A view from scanning device

STEP 2: Scanner makes use of a special characteristic of the reduced hemoglobin coursing through the palm veins; it absorbs near-infrared light. This makes it possible to take a snapshot of what's beneath the outer skin, something very hard to read or steal.

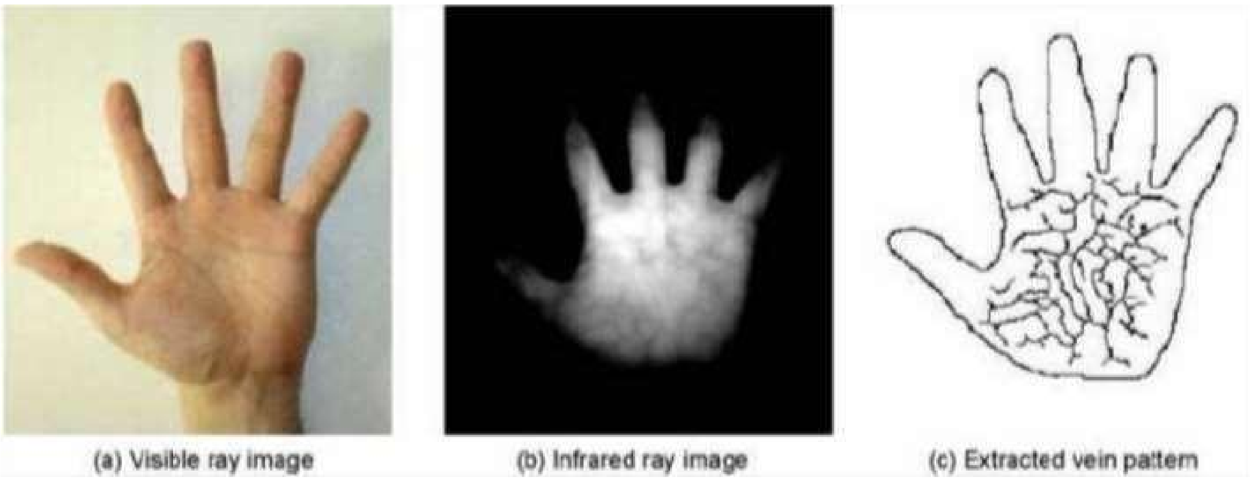



Fig-2.3 View of palm pattern at various stages of registering palm vein pattern

STEP 3: The integrated optical system in the palm vein sensor uses this phenomenon to generate an image of the palm vein pattern and the generated image is digitized, encrypted and finally stored as a registered template in the database.

## 2.3 WORKING OF PALM VEIN TECHNOLOGY

Once the palm vein pattern is registered in the system, user can authenticate him/herself in the system. The working of Palm Vein Technology is described in following steps [2]. STEP 1: Hold your palm over the palm vein image sensor and camera which will take the snapshot of palm.

Fig-2.4 Palm vein image sensor and palm image captured

STEP 2: Now palm image is processed and digitalized with the help of algorithm implemented in the system

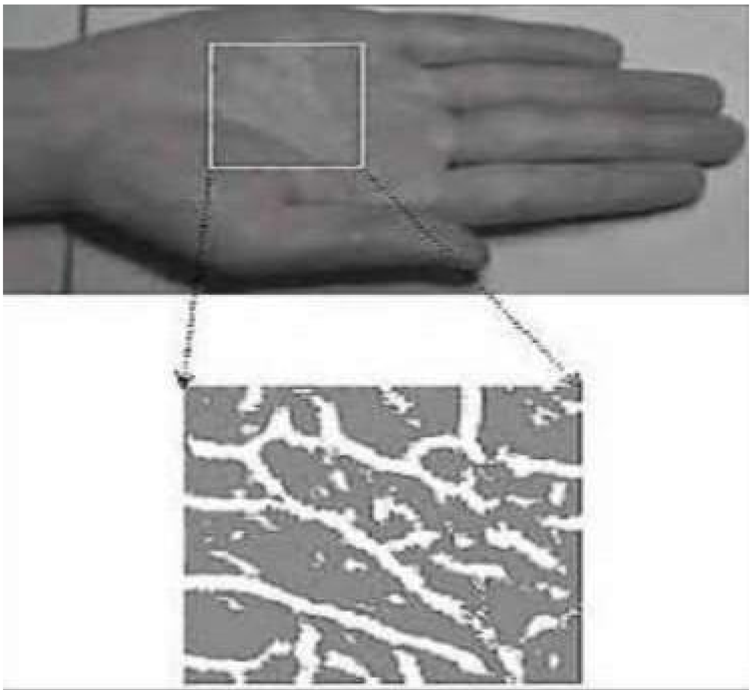


Fig-2.5 Magnified view of palm vein pattern

STEP 3: This digitized image is matched with the previously stored database and authenticates user identity.

## 2.4 PERFORMANCE METRICS OF BIOMETRIC SYSTEM FALSE

**ACCEPTANCE RATE (FAR)**

The probability that the system incorrectly matches the input pattern to a non-matching template in the database. It measures the percent of invalid inputs which are incorrectly accepted

## FALSE REJECTION RATE (FRR)

The probability that the system fails to detect a match between the input pattern and a matching template in the database. It measures the percent of valid inputs which are incorrectly rejected

## EQUAL ERROR RATE OR CROSSOVER ERROR RATE (EER OR CER)

The rate at which both accept and reject errors are equal. The value of the EER can be easily obtained from the ROC curve [5]. The EER is a quick way to compare the accuracy of devices with different ROC curves. In general, the device with the lowest EER is most accurate. Obtained from the ROC plot by taking the point where FAR and FRR have the same value. The lower the EER, the more accurate the system is considered to be.

## RELATIVE OPERATING CHARACTERISTICS OR RECEIVER OPERATING CHARACTERISTICS (ROC)

The ROC plot is a visual characterization of the trade-off between the FAR and the FRR. In general, the matching algorithm performs a decision based on a threshold which determines how close to a template the input needs to be for it to be considered a match[5]. If the threshold is reduced, there will be less false non-matches but more false accepts. Correspondingly, a higher threshold will reduce the FAR but increase the FRR. A common variation is the Detection error trade-off (DET), which is obtained using normal deviate scales on both axes. This more linear graph illuminates the differences for higher performances (rarer errors).

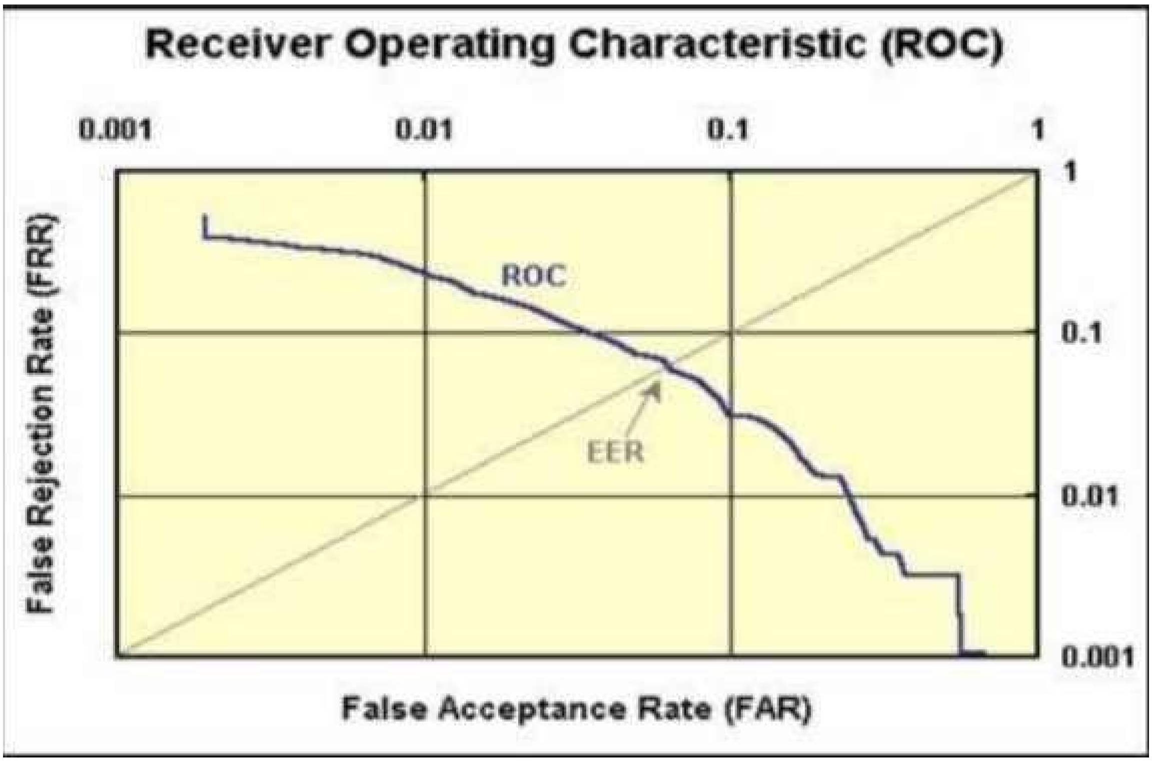



Fig-2.6 Receiver operating characteristics (graph between FRR and FAR)

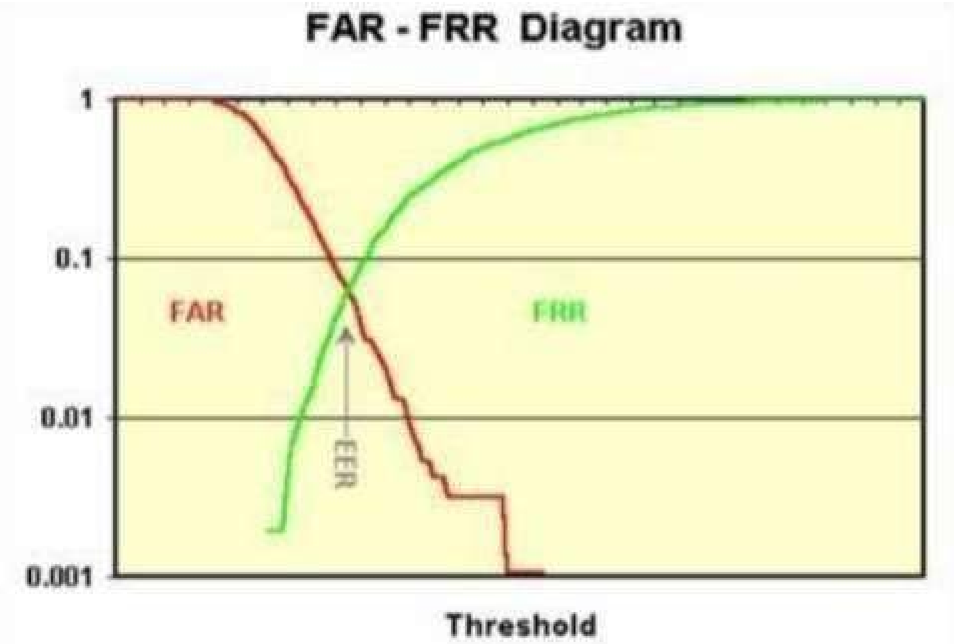



Fig-2.7 Graph showing EER identification by plotting FAR and FRR on the same graph.

## FAILURE TO ENROL RATE (FTE OR FER)

The rate at which attempts to create a template from an input is unsuccessful [5]. This is most commonly caused by low quality inputs. Palm Vein Technology ECED

**FAILURE TO CAPTURE RATE (FTC)**

Within automatic systems, the probability that the system fails to detect a biometric input when presented correctly .

**TEMPLATE CAPACITY**

The maximum number of sets of data which can be stored in the system.

## 2.5 HOW SECURE IS THE TECHNOLOGY ?

On the basis of testing the technology on more than 70,000 individuals , Fujitsu declared that the new system had a FRR of 0.01% FAR of 0.00008% . Also, if your profile is registered with your right hand, don't log in with your left - the patterns of an individual's two hands differ. And if you registered your profile as a child , it'll still be recognized as you grow, as an individual's patterns of veins are established in the uterus (before birth). No two people in the world share a palm vein pattern, even those of identical twins differ. In addition the device ability to perform personal authentication was verified using the following: 1. Data from people ranging from 6 to 85 years old including people in various occupations in accordance with the demographics realized by the Statistics Canter of the Statistics Bureau. 2. Data about foreigners living in Japan in accordance with the world demographics released by the United Nations. 3. Data taken in various situations in daily life including after drinking alcohol, taking bath, going outside and waking up.

## 2.6 FEATURES OF PALM VEIN TECHNOLOGY

1. The human palm vein pattern is extremely complex and it shows a huge number of vessels.
2. The biometric information is located inside the human body, and therefore it is protected against forgery and manipulation.
3. The position of the palm vein vessels remain the same for the whole life and its Palm Vein Technology ECED, SVNIT Page 10 pattern is absolutely unique.
4. The enrolment of the palm vein pattern can be done without any physical contact to the sensor. 5. Skin color, skin dirtying, surface wounds, skin humidity, skin temperature, aging do not have a major influence to enroll and to authenticate the palm vein pattern correctly.
6. Palm Secure is based on a near infrared method, and it has no negative influence on health.
7. Since it is contact less and uses infrared beams, it is more hygienic.

## 2.7 WHAT HAPPENS IF THE REGISTERED PALM GETS DAMAGED?

There may be a chance that the palm we had registered may get damaged then we cannot use this technology, so during the time of registration we take the veins of both the hands so that if one gets damaged we can access it through the second hand. When the hand gets damaged up to a large extent we can get veins because deeper into the hand veins are obtained.

Fig-2.8 registering vein pattern of both palms simultaneously

# CHAPTER-3 PALM VEIN PATTERN EXTRACTION

Palm Vein Technology uses different algorithms and programmes for different stages of the technology [6]. Also different algorithms are proposed for the same processes like ICP (Iterative Closest Point), P2PM (Point to Point Matching), SMM (Similarity based Mixed Matching) etc. which we will discuss in next chapter. Usually, in the image-based biometric systems, a number of pre-processing tasks are required prior to enhance the image quality, such as: contrast, brightness, edge information, noise removal, sharpen image, etc, furthermore, to produce a better quality of image that will be used on the later stage as an input image and assuring that relevant information can be detected. Actually, the better quality of image will gain the better accuracy rate to the biometric system itself. In this paper we propose three required pre-processing tasks which are as follow:

1. Vascular pattern marker algorithm

2. Vascular pattern extraction algorithm

3. Vascular pattern thinning algorithm

After vascular pattern thinning, the extracted image is matched with the previously stored database, for which various algorithms are used which are to be discussed in the next chapter. Here we will discuss the palm vein pattern extraction [6].

## 3.1 VASCULAR PATTERN MARKER ALGORITHM

1. Open Near-Infrared Palm Image File in input mode.

2. Convert the Loaded Image into Planar Image.

3. Set the Horizontal and Vertical kernels (3 x 3), respectively as follow:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 0 | -1 | | 1 | 3 | 1 | |
| 1 | 3 | 1 | 3 x 3 | 0 | 0 | 0 | 3 x 3 |
| 1 | 0 | -1 | | -1 | -3 | -1 | |

4. Generated Planar Image in Step2, is passed through kernels created in Step3.

5. Modified fine-grained Planar Image is stored into another Grayscale Image File.

6. Close all Image file(s).

Here we are considering monochrome binary Image, two-pass masking is used, namely, Horizontal and Vertical kernels. The Planar Image now passed through these masks or kernels. The Resulting transformed Image generates the distinct marks of the Vascular Pattern; the process is Smoothing the Image [6].

## 3.2 VASCULAR PATTERN EXTRACTION ALGORITHM

a. Open resultant Greyscale Image File from Vascular Pattern Marker Algorithm, in input mode

b. Open Binary Image File in output mode

c. While not End of File

d. LOOP

e.Read pixel intensity value

f. **If** pixel intensity value lies in between 20 and 130, then

g. Convert the intensity value to 0 (black)

h. **Else**

i. Convert the intensity value to 255 (white)

j. **End if**

k. Write the intensity value to Binary Image

l. **End Loop**

m. Close all Image Files

Thresholding is an image processing technique for converting a grayscale or color image to a binary image based upon a threshold value. If a pixel in the image has an intensity value less than the threshold value, the corresponding pixel in the resultant image is set to black. Otherwise, if the pixel intensity value is greater than or equal to the threshold intensity, the resulting pixel is set to white. Thus, creating a binarized image, or an image with only two colors, black (0) and white (255). Image thresholding is very useful for keeping the significant part of an image and getting rid of the unimportant part or noise. Palm Vein Technology ECED, SVNIT Page 13 This holds true under the assumption that a reasonable threshold value is chosen. In our case the threshold range is 20 to 130. Threshold range may vary but a large range results in higher EER [6].

## 3.3 VASCULAR PATTERN THINNING ALGORITHM

a. Open the Resultant Binary Image File generated from Vascular Pattern Extraction Algorithm, in input mode

b. Read each pixel intensity value and stored into corresponding location of a 2dimensional Matrix

c. Matrix processing as following steps:

```
int rows = Image Width, columns = Image Height;
{       for(int j = 0; j < columns; ++j)
        {
          if((i==0) || (j==0) || (i==(rows-1)) || (j==(columns-1)))
                        matrix[i][j] = -1;
```

```
        }

} for(int c = 1; c < columns-1; c++)

        {

            if((matrix[r][c] != -1))

                {

                    if (((matrix[r][c+1] != -1)

                    {

                                if      (((matrix[r][c+1]       !=      -1)     ||      (matrix[r][c-1]
    !=      -1))                &&((matrix[r+1][c] != -1) || (matrix[r-1][c] != -1)))

                                {

 matrix[r][c] =
            -1 ;

                                }

                }

                }

        }

        for(int r = 1; r < rows-1; r++)

            {

                for(int c = 1; c < columns-1; c++)

                {

                        if((matrix[r][c] != -1))

                        {

if(((matrix[r][c-1] == -1))
                                                        f(((matrix[r-1][c] == -1))
                                                        && ((matrix[r][c+1] == -1)))

                                                        {

                                        && ((matrix[r+1][c] == -1)))
```

```
                                    {
matrix[r][c] =
        -1;
                                    }
                              }
                      }
                }
          }
```

d. Write the 2 Dimensional Matrices into a Binary Image File.

e. Close all Image Files Generated Binary Image is stored in the Image Database.

For each individual one or multiple images are required to be stored. More Images for an individual are desired for perfect Identification of the corresponding individual in future. Thinning is done for capturing the Vascular Pattern of the Palm of an individual.

## 3.4 PALM VEIN EXTRACTION (Mathematical approach)

In the above sections, we have discussed the programming algorithm part of the palm vein extraction process. Here we will discuss the mathematical approach for the palm vein extraction. For palm vein extraction generally Multiscale Gaussian Matched filter is used. Details of this method including mathematical equations are as follows:

Fig 3.1(a) shows an infrared image of a palm, which contains palm vein information. ROI (with a fixed size of 128*128 pixels) is extracted according to the two key points between fingers, as shown in Fig 3.1(b). There may be different ways to select ROI for different devices [7].

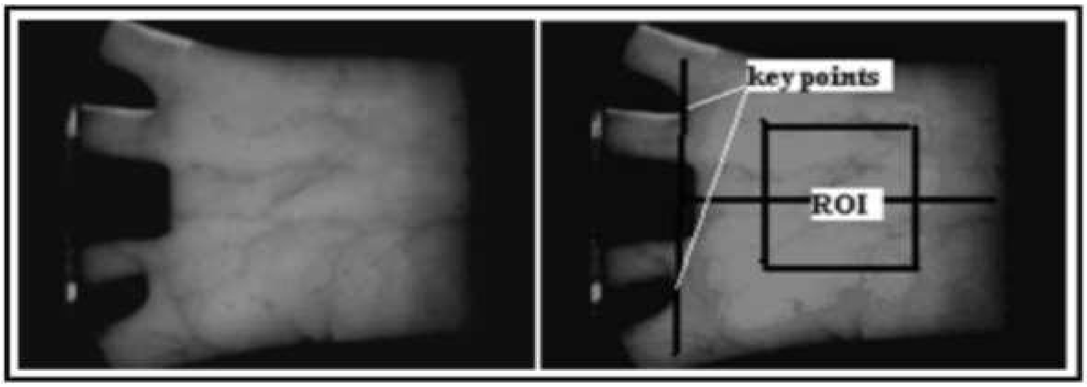



Fig-3.1 (a) an infrared palm image; (b) ROI extraction. [7]

After ROI is extracted, a Multiscale Gaussian Matched filter was used to extract the structure information of the palm vein. Since the cross-sections of palm veins are Gaussian Shaped lines, it is natural to choose a Gaussian Matched filter to extract palm vein [7]. The Gaussian Matched filter was defined as (3.1), where g(x,y) = Gaussian filter function **ϕ** = filter direction, **σ** = standard

deviation of Gaussian, **m** = mean

value of the filter,

**L** = length of the filter in y direction.

**S** = scale to reduce the window size.

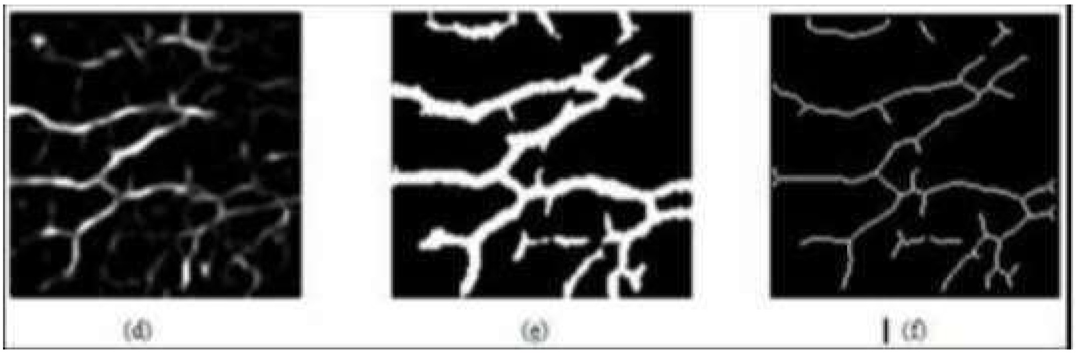



Fig 3.2 Palm vein extraction.(a) ROI; (b)&(c) response of match filter at different scales.[7] To reduce noise in the matched filter responses, a multiscale scheme is adopted. In this scheme, the scale s is used to regulate size of the filter window: $|x'| \leq 3s\sigma x$, $|y'| \leq sL/2$. By using two different scales, we can get two different filter responses. And it has been proved that the production of two filter responses at different scales can greatly reduce the noise.

Fig 3.2 (d) scale production of (b),(c); (e) binarized image of (d); (f) thinned image of (e).[7]

After a low-noise palm vein image is obtained, some post processing operations such as binarizing and thinning are applied. Fig-3.2 shows an example of the Multiscale Gaussian Matched filter responses and palm vein extraction of an infrared palm image.

# CHAPTER-4 PALM VEIN PATTERN MATCHING

In the previous chapter we have discussed the extraction of palm vein pattern by infrared imaging using infrared sensors and also discussed the different algorithms used in palm vein extraction. In this chapter we will discuss the next process in the palm vein authentication system
i.e. mathematical algorithms for different pre-processes and comparison among the different matching algorithms like ICP (Iterative Closest Point), P2PM (Point to Point Matching), SMM (Similarity based Mixed Matching) etc. Also differences, drawbacks and advantages of them will be discussed.

## 4.1 PALM VEIN MATCHING BY ICP ALGORITHM

Matching is very important for palm vein recognition. Here we introduce a new palm vein matching method based on the ICP algorithm. The key step of the ICP algorithm is to get the proper rotation R and translation T to align two point-sets from different coordinate systems [7]. This can be done by using optimization analytic methods, such as Singular Value Decomposition (SVD) method. For two point-sets P and Q, SVD method tries to find the proper R and T so as to minimize the total error of this transformation:

Let p and q be the centroids of the point-sets P and Q, respectively.

And let (4.2)

Denote H as

Let U and V be the SVD matrix of H, then it can be proved that the rotation R is:

R = VUT

And the translation T can be obtained by:

T = q – Rp

Let two point sets P and Q be the two palm vein images to be matched. These two palm vein images are represented by their respective pixel-sets:

## 4.2 ALGORITHM BASED ON ICP METHOD

**Begin**

**do**

1: For every point pi in P , find the closest point qi in Q. And for every point qi in Q find the closest point pi in P. Save the pairs of points which are closest to each other.

2: Calculate the distances of those point pairs obtained in step 1, and remove the point pairs whose distance is larger than a prescribed threshold.

3: Calculate the rotation Rk and translation Tk using the ICP

method. 4: Update

$P_{k+1} = \{ P_i^{k+1} \mid P_i^{k+1} = R_k P_i^k + T_k , P_i^k \in P^k \}$

5: Let C be the size of the point pairs obtained in step 1. If C does not increase, then calculate the matching score: Score = 2*C/(A+B); otherwise go back to step 1 and repeat

**While**

(The value of Score is larger than a prescribed small threshold or less than a prescribed large threshold; or the iterative number doesn't reach the maximal number N) Return the matching score of P and Q.

**End**

Two thresholds are set on the value of Score: a small threshold and a large threshold. If the Score in step 5 is less than the small threshold, then we believe those two images are determinately not from the same palm; if the score is larger than the large threshold, we consider that those two images must be from the same palm; in other cases, we cannot give a certain decision, so we use a prescribed iteration times to end the algorithm. It should be noted that all the thresholds in the algorithm are tuned according to a subset of our database, and the algorithm iterates till no more correspondences can be found. The proposed matching method can efficiently solve the problem of rotation and translation which may have great effect on other matching methods.

## 4.3 POINT TO POINT MATCHING METHOD

The point-to-point matching (P2PM) method is the most popular method in template matching. This method matches two images through logical "exclusive or" operation [7]. Let A and B be the two binarized images, then their matching score S(A,B) is calculated as:

Where A and B have the same size m x n. Though this method has many advantages such as low complexity, it suffers from the problem of rotation and translation. Hence the P2PM method cannot get high accuracy. The authors tried to overcome rotation and shift problem by translating the matching template vertically and horizontally. However, they cannot solve the problem thoroughly, especially the rotation problem. The input of the P2PM method is binarized images instead of thinned images. We have tested the performance of P2PM on the thinned images and found that P2PM got much lower accuracy. The reason is that thinned images lose much information which may be useful for template matching. To overcome these limitations, we improve P2PM and give another template matching method, which is called Similarity-based Mix Matching (SMM) method. This method is discussed briefly in the next topic.

## 4.4 SIMILARITY-BASED MIX MATCHING

The idea of this matching method can be summarized as follows: Denote Img1 and Img2 as two binarized images, and Thing1 and Thing2 as their thinned images respectively[7]. Let S1, S2 be the matching scores of (Img1 and Thing 2), (Img2 and Thin1) respectively. Then the matching score of Img1 and Img2 is (S1+S2)/2. We define the matching score of a binarized image and a thinned image as.

where I is the binarized image, H is the thinned image, H' is a sub-image of H which takes part in the matching. Experiments show that the performance of SMM is much better than P2PM. But it still has trouble with the rotation problem. In some situations, P2PM method and SMM method would give wrong judgments, especially when the rotation is large. Fig. 12(a) and (d) are two palm vein images from the same palm, where (d) is obtained by rotating (a) for 18 degrees clockwise. The matching scores calculated by the above three methods are listed in Table 1. From the results of these three matching experiments, we can see that only our method (denoted as ICPM) can decide that (a) and (d) are from the same palm when the rotation is large.

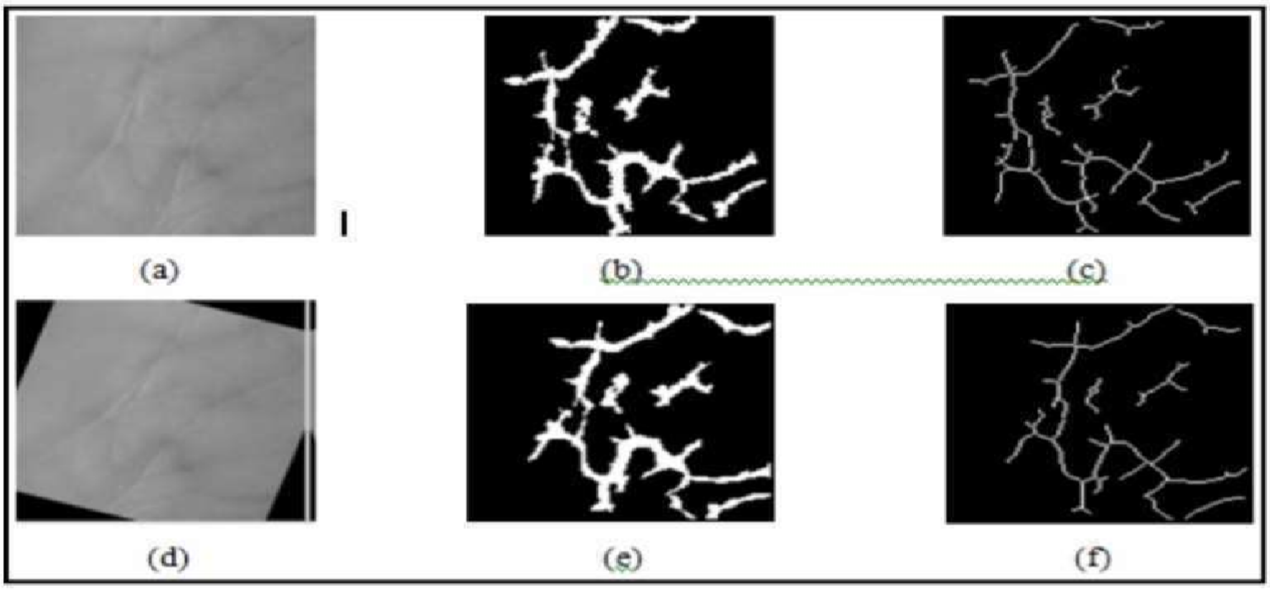



Fig-4.1 An example. (a) ROI; (b)binarized image; (c)thinned image; (d) an image obtained by rotating picture (a) for 18 degrees clockwise; (e)&(f)similar meaning as (b)&(c) respectively. [7]

## 4.5 EXPERIMENTS AND RESULTS

The experiments are based on a palm vein database which includes 6000 images from 500 different palms (12 samples for each palm). These images are captured by a self designed and low cost near infrared CCD camera. The process of a matching experiment includes several steps: palm vein extraction, matching and decision-making.

In the following experiments, Equal error rate (EER) is used to measure the performance of every method. EER is a classical criterion to evaluate a biometric system or algorithm [7]. It is the rate at which both false acceptance rate (FAR) and false rejection rate (FRR) are equal. The lower the EER is, the better the system's performance is. Firstly, the methods LHD and MHD which are used in hand vein matching are tested on a small database, which is a subset of the large database described above, containing 1000 images from 100 different palms (10 images for each palm). The experiment results show that the EERs of LHD and MHD are higher than 5%. The EERs of LHD method are both 0, but their databases are small, which only contain 270 and 108 images respectively, and the quality of hand vein images is better than palm vein images, since they used more expensive cameras. The EER of MHD in is 0 too. The reasons are similar as above, the testing database only has hand vein images from 47 people, and the images were captured by an expensive infrared thermal camera. Besides, the line features and minutiae features are very sensitive to the image noise, rotation and shift. Secondly, to compare the performance of P2PM, SMM and ICPM, the database is divided into two non-overlapping groups: gallery and probe group. The gallery group includes 500 images, where each palm provides one image. The probe group includes the rest of 5500 images. In the following experiments, each image in the probe group is compared with all of the images in the gallery group. Hence, there would be 500×5500=2,750,000 times of matching. A successful matching is called intra-class matching or genuine if the two samples are from the same class (i.e. the same palm). Otherwise, the unsuccessful matching is called interclass matching or impostor.

Fig-4.2(a) gives the Receiver Operating Characteristic (ROC) curves for the P2PM, SMM and ICPM methods respectively. From this figure, we can find that the ICPM method has Palm Vein Technology ECED, SVNIT Page 22 much higher accuracy than P2PM and SMM since for every same false accept rate, ICPM has higher genuine rate than the other two methods.

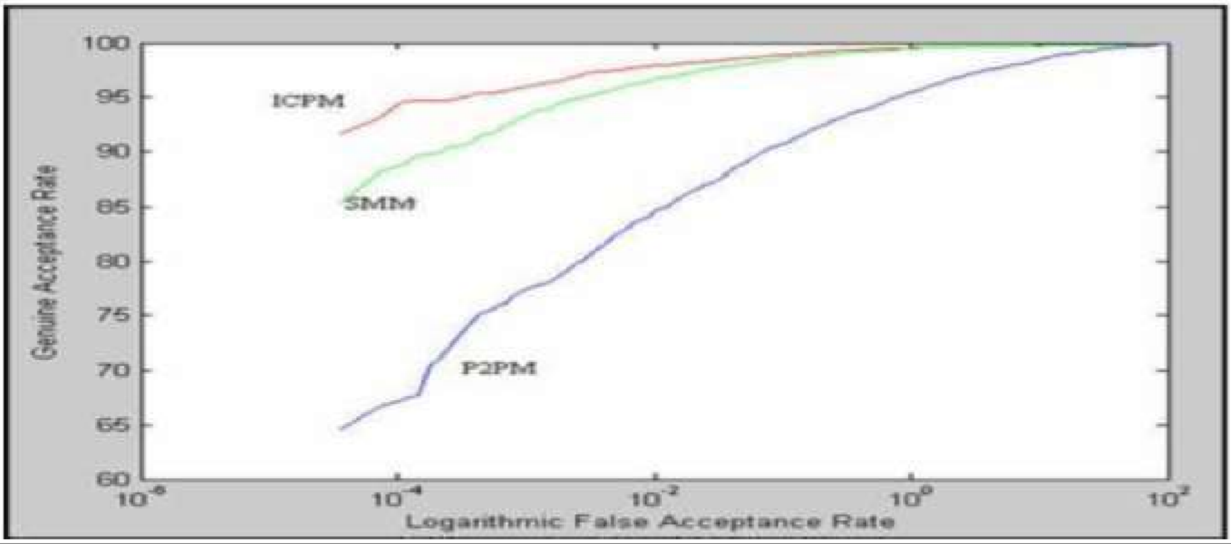



Fig 4.2 Experiment results: (a) ROC curves of the P2PM, SMM and ICPM. [7]

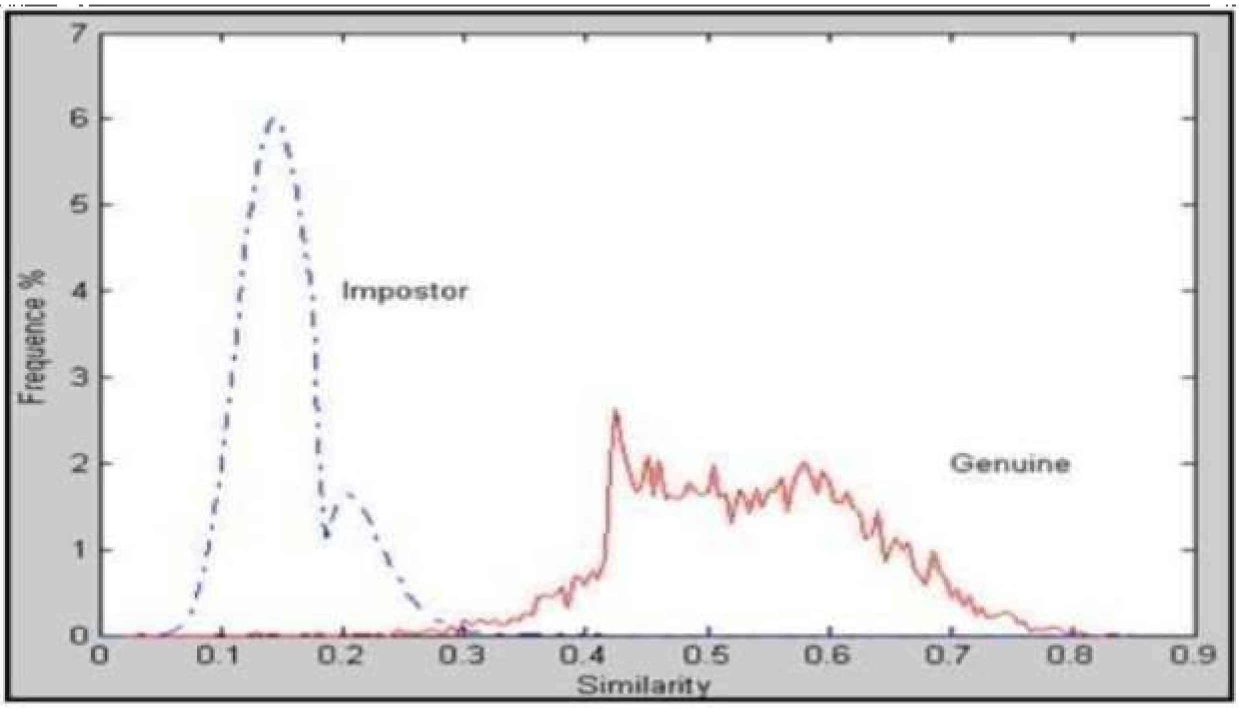



Fig-4.2 Experiment results: (b) Similarity distribution of the ICPM method. [7

Fig 4.2(b) plots the curve of Genuine and Impostor similarity distribution for the ICPM method. The distribution curves help to set up a threshold to separate the genuine from the impostor. The threshold value is obtained from the intersect point of these two curves. So the less these two curves overlap, the lower EER the corresponding method has.

Table 2 lists the detail comparison of these three methods. It can be seen that the proposed ICPM method has the lowest EER. The P2PM method is achieved 98.8% recognition rate where the false acceptance rate is 5.5%. Authors got a 99% recognition rate where the FAR is 6%~7%. According to the experiment results, the ICPM method can operate at genuine acceptance rate e (GAR) of 99.41% while the corresponding false acceptance rate is 0.53%

.

Table 1: Results of three matching experiments [7].

| | score | Threshold | Decision |
|---|---|---|---|
| P2PM | 0.69725 | <0.28000 | wrong |
| SSM | 0.28430 | >0.33000 | wrong |
| ICPM | 0.80000 | >0.28000 | Right |

Table 2: Detail comparison of the three methods [7].

| | FAR | FFR | EER |
|---|---|---|---|
| P2PM | 1.885% | 3.473% | 2.679% |
| SSM | 0.607 | 0.673% | 0.639% |
| ICPM | 0.533% | 0.582% | 0.577% |

## 4.6 CONCLUSION

From the results of above experiments, we can see that ICPM is better than all the other methods. It comes from the fact that ICPM can effectively and accurately correct the rotation and shift variations between palm vein images, which consequently improves the accuracy of palm vein verification. So most of the Palm Secure devices use ICPM.

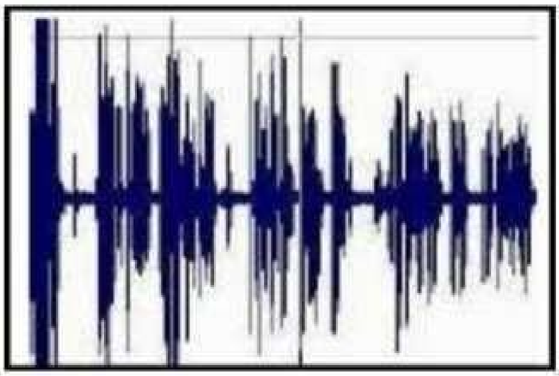
CHAPTER-5

# COMPARISON WITH OTHER BIOMETRIC TECHNOLOGIES

In this chapter we will compare the palm vein technology with biometric technologies. Also limitations and advantages of these biometric technologies are discussed in this chapter.

## 5.1 VOICE PRINT

Voice verification is a biometric authentication technology well suited for applications and systems in which other biometric technologies would be difficult or inconvenient to implement. This form of biometric is most often deployed in environments where the voice is already captured, such as telephony and call centers. Making use of distinctive qualities of a person's voice, some of which are behaviourally determined and others of which are physiologically determined; voice verification is typically deployed in such areas as home improvement and security, banking account access, home PC, network access, and many others [8]. Some of the key advantages and disadvantages for voice recognition technology are



listed below:

Fig-5.1 Voice print. [8]

**ADVANTAGES**

- Easy to use and requires no special training or equipment.
- Relatively inexpensive compared to other biometrics.
- Consumers prefer to use voiceprints over other biometric technology for identification according to a Chase bank’s research study.

**DISADVANTAGES**

- When processing a person’s voice over multiple channels such a microphone and then over a telephone reduces the recognition rate.
- Physical conditions of the voice, such as those due to sickness, affect the voice verification process.
- Environment noise reduces the overall accuracy and effectiveness of the recognition. • The storage requirement for voiceprint databases can be very large.
- A person’s voice changes over time.
- FRR is high because of that sometimes users are required to input the data or speak 2-3 times, hence speed is much slower.

## 5.2 FINGER/PALM PRINT

A fingerprint usually appears as a series of dark lines that represent the high, peaking portion of the friction ridge skin, while the valleys between these appear as white space and are the low, shallow portion of the friction ridge skin[9]. Fingerprint identification is based primarily on the minutiae, or the location and direction of the ridge endings and bifurcations along a ridge path. The images below present examples of the other detailed characteristics sometimes used during the automatic classification and minutiae extraction processes.

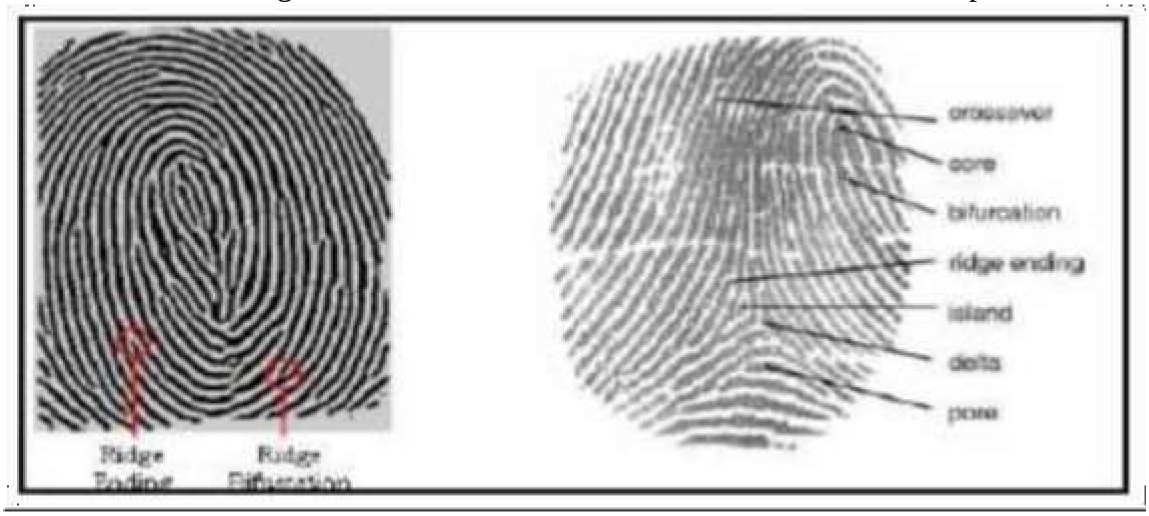



Fig-5.2 Finger prints. [9]

**ADVANTAGES**

- Since fingerprints are the composition of protruding sweat glands, everyone has unique fingerprints. They do not change naturally.

• Its reliability and stability is higher compared to the iris, voice, and face recognition method.

• Fingerprint recognition equipment is relatively low-priced compared to other biometric system and R&D investments are very robust in this field.

**DISADVANTAGES**

- Vulnerable to noise and distortion brought on by dirt and twists.
- Some people may feel offended about placing their fingers on the same place where many other people have continuously touched.
- Some people have damaged or eliminated fingerprints.
- Since users have to touch the sensing device, so it gets damaged on scratches on it and that's why the FFR increases with increased used of device.

## 5.3 FACE RECOGNITION

Every face has numerous, distinguishable landmarks, the different peaks and valleys that make up facial features. It defines these landmarks as nodal points. Each human face has approximately

80 nodal points. Some of these measured by the software are: • Distance between the eyes Width of the nose

•

- Depth of the eye sockets
- The shape of the cheekbones
- The length of the jaw line

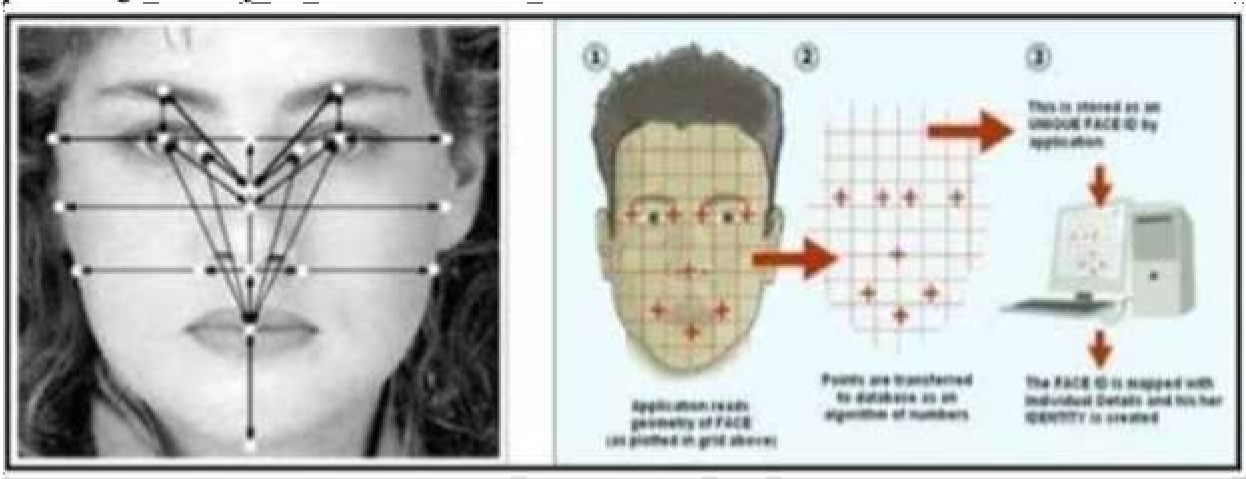


Fig-5.3 Nodal points and Face print. [10]

These nodal points are measured creating a numerical code, called a face print, representing the face in the database [10]. The face print obtained from scanning is then matched with existing database for authentication. This technology faces many problems but it is quite accurate.

**ADVANTAGES**

- Non intrusive, privacy cannot be invaded easily.
- Cheap technology.
- It requires a small database.

**DISADVANTAGES**

- 2D recognition is affected by changes in lighting, the person's hair, the age, and if the person wears glasses.
- It also depends on the orientation/angle of the user's face with the camera.
- Requires camera equipment for user identification; thus, it is not likely to become popular until most PCs include good resolution cameras as standard equipment
- Even the expressions on the face also affect the recognition process. For example: in Canada passport size photos with neutral face expressions are accepted.
- High FRR.

## 5.4 IRIS SCAN

Iris recognition is the process of recognizing a person by analyzing the random pattern of the iris. The iris muscle within the eye regulates the size of the pupil, controlling the amount of light that enters the eye [8]. It is the coloured portion of the eye with colouring based on the amount of melatonin pigment within the muscle. Although the colouration and structure of the iris is genetically linked, the details of the patterns are not. The iris develops during prenatal growth through a process of tight forming and folding of the tissue membrane. Prior to birth, degeneration occurs, resulting in the pupil opening and random, unique patterns of the iris.


**ADVANTAGES**

- Very high accuracy.

- Verification time is generally less than 5 seconds.
- The eye from a dead person would deteriorate too fast to be useful, so no extra precautions have to been taken with retinal scans to be sure the user is a living human being.

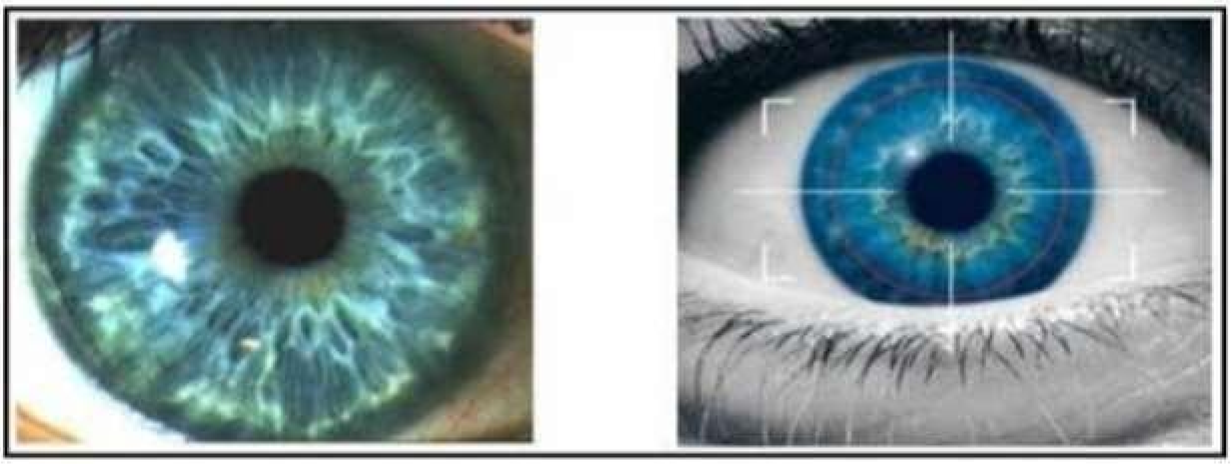


Fig-5.4 Iris and Iris pattern of human eye. [8]

**DISADVANTAGES**

• Intrusive.

• A lot of memory for the data to be stored.

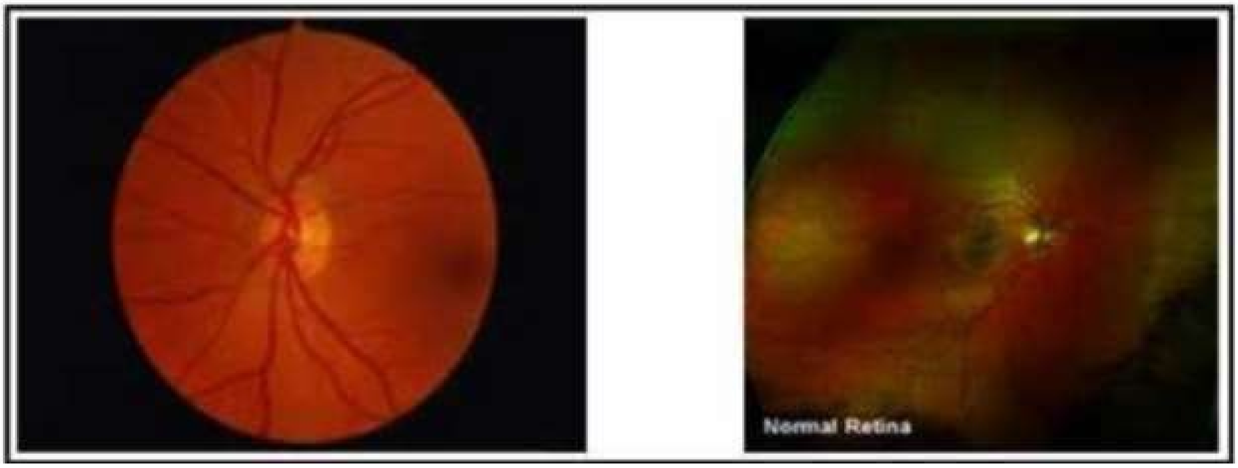
• Very expensive.

• Difficult to use because of positioning eye

• Requires more time for matching with database stored.

## 5.5 RETINA SCAN

The human retina is a thin tissue composed of neural cells that is located in the posterior of the complex structure of the capillaries that supply the retina with blood; each person's retina is unit ion of the eye. The network of blood vessels in the retina is so complex that even identical twins do not share a similar pattern [8]. A biometric identifier known as a retinal scan is used to map the unique patterns of a person's retina. The blood vessels within the retina absorb light more readily than the surrounding tissue and are easily identified with appropriate lighting. A retinal scan is performed by casting an unperceived beam of low-energy infrared light into a person’s eye as they look through the scanner's Palm Vein Technology ECED, SVNIT Page 29 eyepiece. This beam of light traces a standardized path on the retina. Because retinal blood vessels are more




absorbent of this light than the rest of the eye, the amount of reflection varies during the scan. The pattern of variations is converted to computer code and stored in a database.

Fig-5.5 Retina and its pattern. [8]

**ADVANTAGES**

• Very high accuracy.

• Low occurrence of false positives

• Extremely low (almost 0%) false negative rates

• Highly reliable because no two people have the same retinal pattern

• There is no known way to replicate a retina.

• The eye from a dead person would deteriorate too fast to be useful, so no extra precautions have to been taken with retinal scans to be sure the user is a living human being.

**DISADVANTAGES**

• It has the stigma of consumer's thinking it is potentially harmful to the eye.

• Comparisons of template records can take upwards of 10 seconds, depending on the size of the database.

• Measurement accuracy can be affected by a disease such as cataracts.

• Measurement accuracy can also be affected by severe astigmatism.

• Scanning procedure is perceived by some as invasive

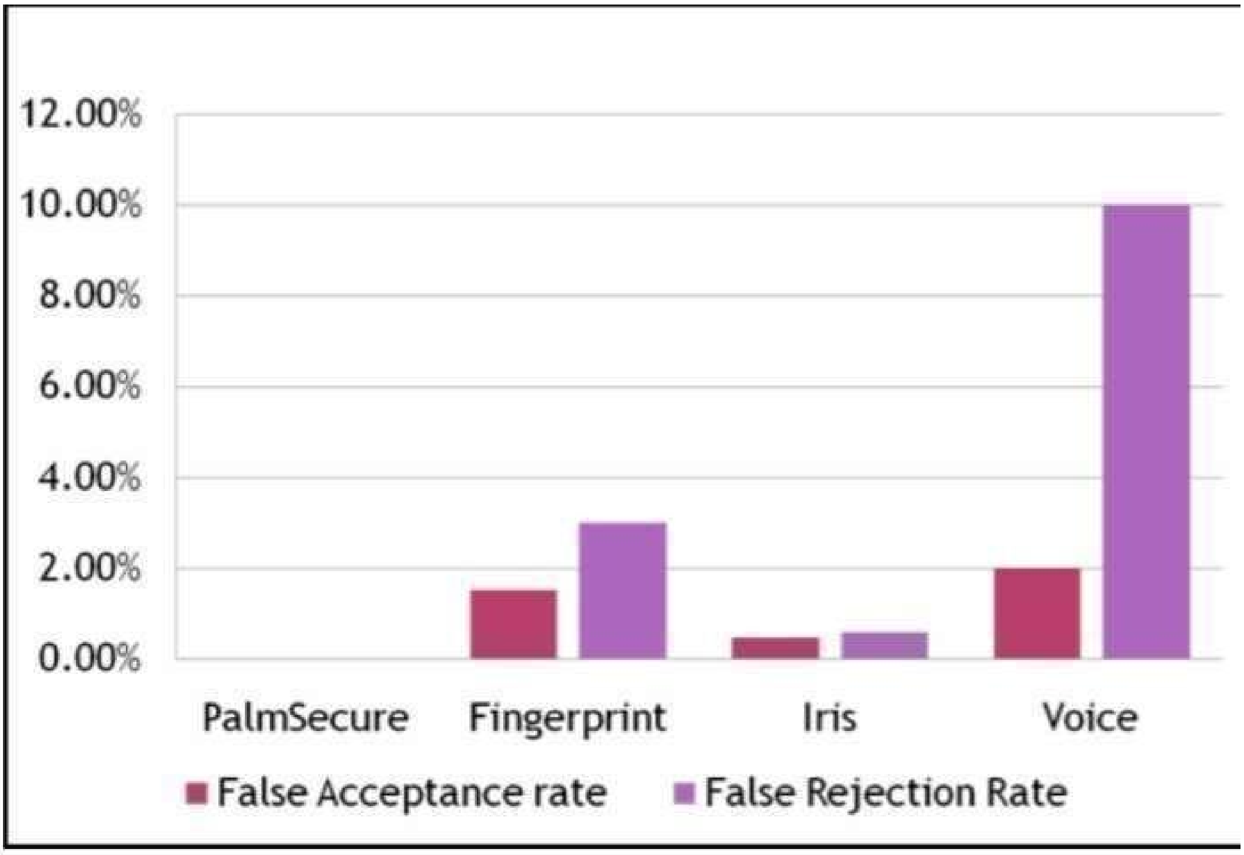
• Not very user friendly. 

• Subjects being scanned must be close to the camera optics.

• High equipment

Table-3: Comparison with other technologies based on FRR and FAR costs.

| Technology | FAR | FRR |
|---|---|---|
| Palm vein | 0.00008% | 0.01% |
| Finger print | 1-2% | 3% |
| Iris/Retina | 0.0001-0.94% | 0.99-0.% |
| Voice | 2% | 10% |




## 5.6 Ear shape

There are specified nodal points on the ear and relative position of these nodal points are identical for every individual. The ear biometric graph model is prepared. Also the convergence and force fields are defined [11]. On the basis of these field patterns and graphs, authentication is performed. If we use ICP algorithm in this technology, results will be far better because of 3D shape and orientation of ear. Left and right ears of most individuals are bilaterally symmetric, but a few have different shapes of right and left ear.

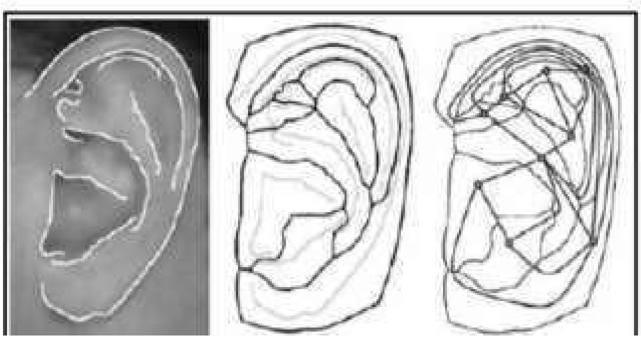


Fig-5.7 Stages in building the ear biometric graph model. A generalized Voronoi diagram (center) of the Canny extracted edge curves (left) is built and a neighborhood graph (right) is extracted. [11]

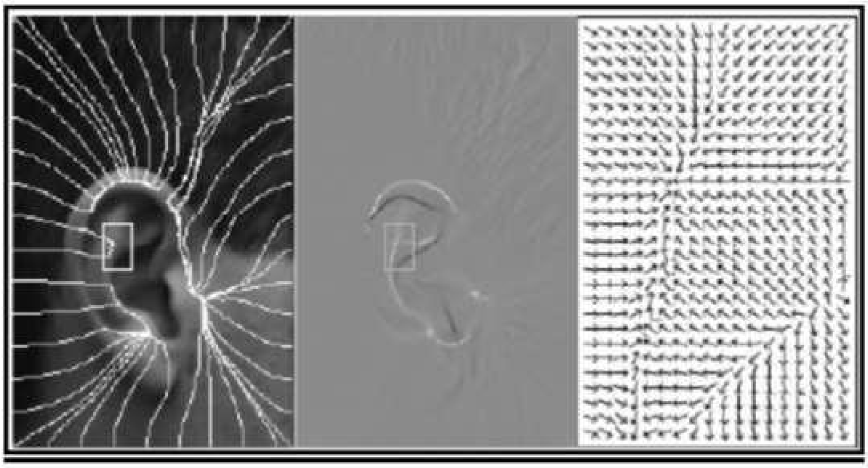


Fig-5.8 Force and convergence fields for an ear. The force field for an ear (left) and its corresponding convergence field (center). The force direction field (right) corresponds to the small rectangular inserts surrounding a potential well on the inner helix. [11]

**ADVANTAGES**

- Low occurrence of false positives.
- Relatively cheap technology.
- Requires small database.

**DISADVANTAGES**

- Ear shape changes slightly with weather and atmospheric conditions.
- High false rejection rate
- User faces difficulty to position his/her ear for using the device. It requires a little training.
- It can be invaded easily as the landmark lines and nodal point can be replicated and the liveliness of the user cannot be verified.
- Authentication time is comparatively higher.
- Not very user friendly.
- 2D recognition gives very low accuracy while using 3D recognition increases cost

## 5.7 DYNAMIC SIGNATURE RECOGNITION (DSR)

In this technology, a digital (touchpad) paper is used. Signature biometrics work by analyzing the stroke order, the pressure applied and the speed [8]. The signature image is also analyzed. A scanner is used to record the way a person writes on a tablet, and even with a sensored pen. Another way of capturing a signature biometric is by using ultrasonic sensing. Once the signature is captured, it is verified against the database.

**ADVANTAGES**

- Unique for every individual and user himself can decide the identity · Lesser false acceptance rate.
- Relatively cheap technology.
- No expert training required.

**DISADVANTAGES**

- Signature of a person may change after a long time, like if a user went through an accident and he cannot use his hand and then he signs after a long time, his sign and pressure points may change.
- High false rejection rate.
- Pressure points may change because of weather or some disease.
- System can be fooled by imitating.

## 5.8 TYPING PATTERN

This particular biometric identification analyses the way a person types. While the user is typing a phrase with the keyboard, the biometric system records the timing of the typing. This usually has to be done a number of times in order to verify that the keystrokes are distinctive. It is compared against the database to verify and identify the user.

**ADVANTAGES**

- Can be obtained from distance
- Can be used to determine medical illness
- Comparatively cheap technology

**DISADVANTAGES**

- Can be obtained from distance – invasion of privacy
- System can be fooled by imitating
- Time consuming

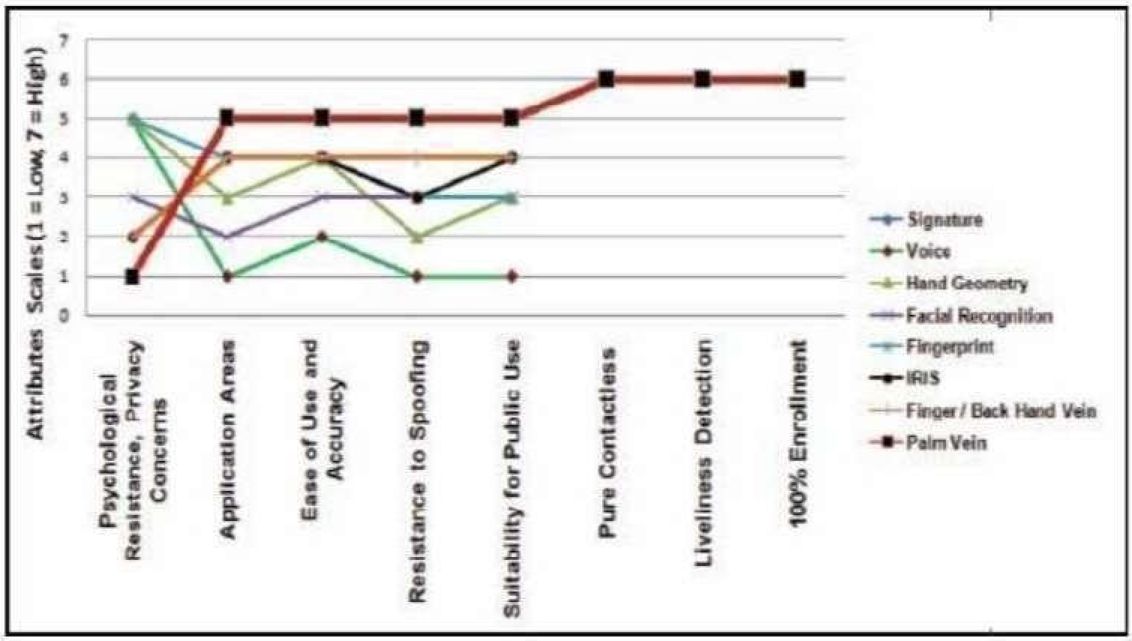



Fig-5.9 Comparison on the basis of some basic factors. [12]

## 5.9. PROPOSED SYSTEM

Vein pattern recognition has been selected as it is almost impossible to forge a fake vein pattern as the veins lie deep within the skin of the palm whereas, due to the long legacy of fingerprints, there are a number of methods that have been created to fool fingerprint systems. The proposed system has been implemented and tested with the Chinese Academy of Sciences 'Institute of Automation(CASIA). Database consists of 7200 palm images of 100 individuals using a specialized scanner. Out of which 30 samples were selected randomly in 2 different sessions. The time interval between both the sessions was approximately six months. Radon Transform and DCT were used to extract features and matching was done on the basis of Euclidean distance. The efficiency obtained was 93.2%. Results indicate that palm vein technology is one of the promising form of biometric identification.

# CHAPTER-6 DESIGN

## SYSTEM REQUIREMENTS

## 6.1 SOFTWARE REQUIREMENTS

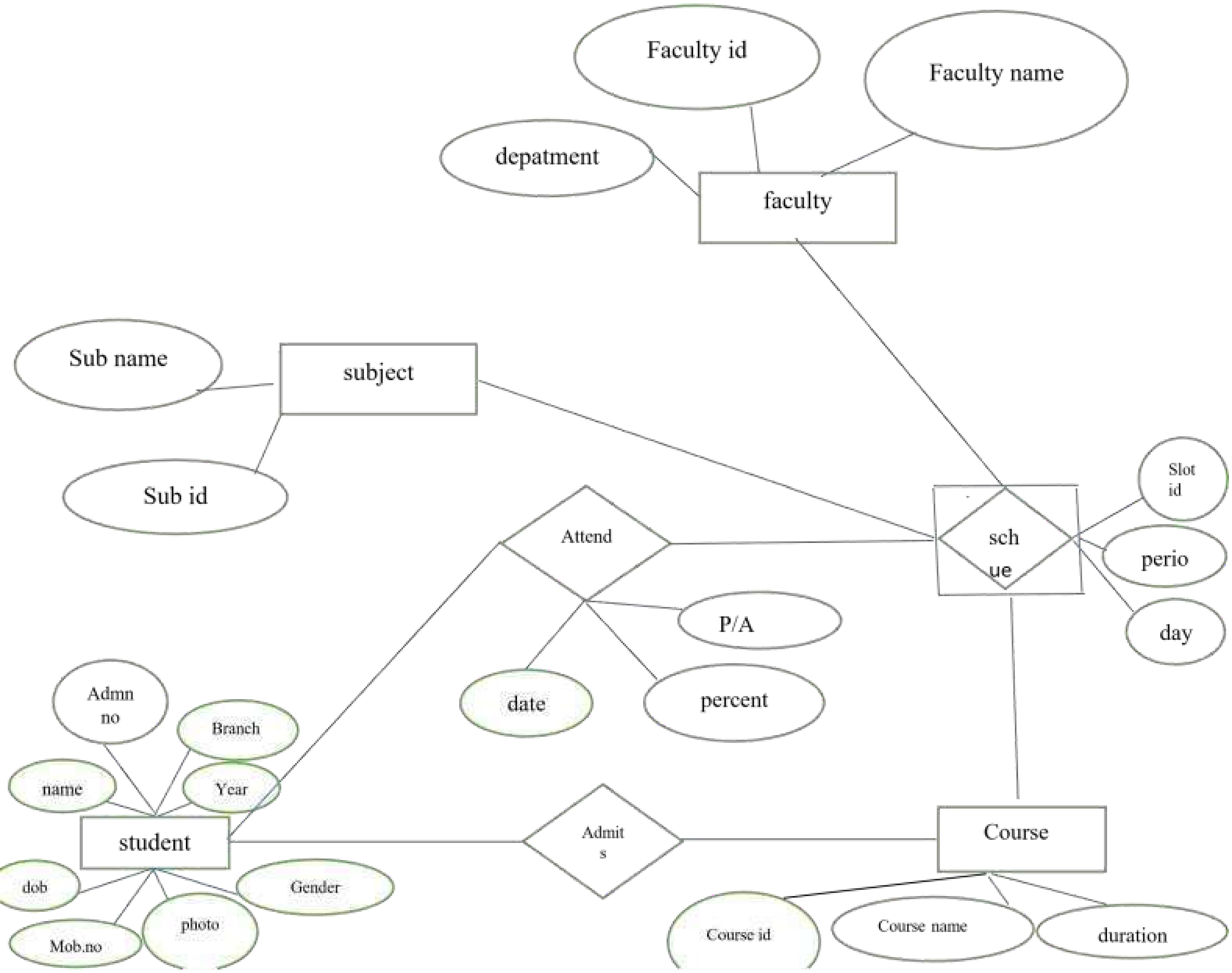
CLIENT SIDE :- HTML,CSS,JAVASCRIPT
SERVER SIDE:- Python , Django

BACKEND:- Mysql

## 6.2 HARDWARE REQUIREMENTS

RAM:-8GB Core i5-1135 G7 512GB SSD
OPERATING SYSTEM:- Windows11

## 6.3 UML DIAGRAMS



## 6.4. DATABASE

### STUDENT TABLE

| COLUMN NAME | DATA TYPE | SIZE | CONSTRAINTS |
|---|---|---|---|
| Admission number | Varchar 2 | 10 | Primary |
| Branch | Varchar | 100 | Not null |
| Name | Varchar 2 | 100 | Not null |
| Dob | Number | 8 | Not null |
| Year | Number | 4 | Not null |
| Mobile number | number | 10 | unique |
| Photo | varchar | 100 | unique |
| Gender | Char | 3 | Not null |
| Course id | Varchar | 10 | primary |

### COURSE TABLE

| COLUMN NAME | DATA TYPE | SIZE | CONSTRAINTS |
|---|---|---|---|
| Course id | Varchar | 10 | primary |
| Course name | Char | 100 | Unique |
| Duration | Num | 10 | Not null |

### FACULTY TABLE

| COLUMN NAME | DATA TYPE | SIZE | CONSTRAINTS |
|---|---|---|---|
| Faculty id | Varchar | 15 | Primary |
| Department | Char | 100 | Not null |
| Faculty name | Varchar 2 | 100 | Not null |

### SUBJECT TABLE

| COLUMN NAME | DATA TYPE | SIZE | CONSTRAINTS |
|---|---|---|---|
| Sub id | Varchar 10 | 10 | Primary |
| Subj name | Varchar 2 | 100 | Not null |

# SCHEDULE TABLE

| COLUMN NAME | DATA TYPE | SIZE | CONSTRAINTS |
|---|---|---|---|
| Slot id | Date-time | 15 | Primary |
| Period | Date-time/varchar | 100 | Not null |
| Day | Char | 7/10 | Not null |

# ATTENDANCE TABLE

| COLUMN NAME | DATA TYPE | SIZE | CONSTRAINTS |
|---|---|---|---|
| Present or absent | Varchar 2 | 10 | Not null |
| Admission number | Varchar 2 | 10 | Foreign key |
| Subject id | Varchar | 15 | Foreign key |
| Faculty id | Varchar | 15 | Foreign key |
| Slot id | Date-time | 15 | Foreign key |
| Date | Char | 7/10 | Not null |

# CHAPTER-7

# IMPLEMENTATION :

## 7.1 MODULES

The normalized and enhanced palm-vein images depict curved vascular network/patterns, and these vessels can be approximated by small line segments which are rather curved.
Therefore, in this project, we propose to use two new approaches to extract such line-like palm-vein features. In addition, a neighborhood matching scheme that can effectively account for more frequent rotational,translational variations, and also to some image deformations in the acquired image.In order to ascertain the effectiveness and robustness of the proposed approach for the palm-vein identification, we performed rigorous experiments on both contactless and contact- based databases systematically evaluated and compared all these methods together with our proposed ones, so that we can get more insights into the problem of palm-vein identification.

The software of the Performance Analysis on Palm-Vein based Authentication for Security Applications values are classified into 2 modules.

1. Juncture Point Algorithm
2. Hand Geometry

The database contains a set of hand vein images. A single hand vein image is given as input by mentioning the file name in the GUI. If the input image is present in the database then corresponding information is displayed. Else an error message is displayed. In-order to compare the input image and the images in the database the following four modules should be implemented. Initially the input image is binarized and converted into a matrix form.

### MODULE 1 :(Junction Point Algorithm)

Three vein intersecting points are considered. The coordinates of such three points are noted and the distance between the three points are noted. Fig 4.1 shows junction point in palm vein.These three points and the distances of the input image are compared for the images in the database. Centroid for the three points are also noted and compared with the image in the database.

### Line detection

We detected the lines and orientation on the image using edge finder .Morphological operation is used to remove isolated edge points. An edge link process is developed to least square fit the detected edges to a set of line segments. An example of the line detection of the region-of-interest (ROI) is shown. The ROI is the center part of the palm vein images. It is extracted based on the two webs of the hand image.In computer vision, a junction is defined as the point where two or more contours meet. The junctions can be used as salient features for object classification algorithms or to improve edge detection. Current junction analysis methods include convolution,which applies a mask over a sub-region of the image, and diffusion, which propagates gradient information from point-to-point based on a set of rules. In this paper, a Junction Point is defined as the intersection point of the three or more line segments and a Fast JP detector is proposed. The Junction Points of the palm vein line segments associated with their directions of palm vein are computed. Transition number is used to detect the junction function. The edge segments are thinned using a morphological operation. Then we test whether the center pixel within a 3x3 neigh-bourhood is a junction.

The orientation of a junction point is described as a code of the surrounding pixel of a junction point in the edge image. Pixels in the 5 u 5 regions of the junction point P in Table 1 are numbered as:

Table .1 Pixels in the 5 u 5 regions of the junction point P

| | | | | |
|---|---|---|---|---|
| P9 | P10 | P11 | P12 | P13 |
| P24 | P1 | P2 | P3 | P14 |
| P23 | P8 | P | P4 | P15 |
| P22 | P7 | P6 | P5 | P16 |
| P21 | P20 | P19 | P18 | P17 |

The orientation code of P is defined as a vector $f(P_1)f(P_2)f(P_3)f(P_4)f(P_5)f(P6)f(P_7)f(P_8)f(P_9)\ldots f(P_{24})$

The matching algorithm is as follows.
Step 1: Take an unchecked point b in Q
Step 2: Check for the presence of a point in a around b in P. If yes, add the point to a go Step 3. Else, goto step 1.
Step 3: Check for candidate points, a, with similar code with b. If yes, a and b are the c step 1.
Step 4: Repeat step 1-3 until all points in Q have been checked

## MODULE 2 : (Hand Geometry)

The length, width, perimeter and area of all 5 fingers are noted and the width of the palm for the input image is noted and compared with the images in the database.

### 3-D Hand Geometry

3-D features extracted from the cross-sectional finger segments have previously been shown to be highly discriminatory and useful for personal identification. For each of the four fingers (excluding thumb), 20 cross-sectional finger segments are extracted at uniformly spaced distances along the finger length. Curvature and orientation (in terms of unit normal vector) computed at every data point on these finger segments constitute the feature vectors.

### 2-D Hand Geometry

2-D hand geometry features are extracted from the binarized intensity images of the hand. The hand geometry features utilized in this work include finger lengths and widths, finger perimeter, finger area and palm width. Measurements taken from each of the four fingers are concatenated to form a feature vector. The computation of matching score between two feature vectors from a pair of hands being matched is based upon the Euclidean distance.

## 7.2 Source Code :

### Getting the image:

The first step is to get an image.. but how can we get an accurate picture of our veins? Turns out hemoglobin in our blood absorbs infrared light. So, if we take some infrared LEDs (mine were 940nm) and position them under one's hand, we should see veins!! Let's create a setup where we can get a consistent image every time.An ordinary shoebox with a palm-sized hole cut out above the camera worked perfectly for me.
The circuitry is very simple - we just need to power the IR LEDs. I used 5 LEDs connected in series with a 100 ohm resistor (you may need a different resistance depending on your LEDs) and 9V battery. The RaspberryPi is on top of the breadboard, with the camera resting on the battery facing up.

Let us set up auto-cropping, as we're only concerned with the palm. This is the command I used 600*600 images. raspistill -vf -w 600 -h 600 -roi 0.46,0.34,0.25,0.25 -o pic.jpg

Now we have this cropped image of our palm. We need to perform some image processing before we can actually make use of it.

### Image Processing:

**Load the 600x600 image and convert to grayscale** image

= cv2.imread("pic.jpg") gray

= cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

noiseReduced = cv2.fastNlMeansDenoising(gray) #
equalize hist kernel = np.ones((7,7),np.uint8) img =
cv2.morphologyEx(noiseReduced, cv2.MORPH_OPEN,
kernel) img_yuv = cv2.cvtColor(img,
cv2.COLOR_BGR2YUV) img_yuv[:,:,0] =
cv2.equalizeHist(img_yuv[:,:,0]) img_output =
cv2.cvtColor(img_yuv, cv2.COLOR_YUV2BGR) img =
gray.copy() skel = img.copy() skel[:,:] = 0 kernel =
cv2.getStructuringElement(cv2.MORPH_CROSS, (5,5))
while cv2.countNonZero(img) > 0:

eroded = cv2.morphologyEx(img, cv2.MORPH_ERODE, kernel) temp = cv2.morphologyEx(eroded, cv2.MORPH_DILATE, kernel) temp = cv2.subtract(img, temp) skel = cv2.bitwise_or(skel, temp) img[:,:] = eroded[:,:] ret, thr = cv2.threshold(skel, 5,255, cv2.THRESH_BINARY);

**CODE:** import cv2 import numpy as np import tensorflow as tf from tensorflow import keras from PIL import Image print

"training model" classes =

["left", "right"]

num_right_train = 20 num_left_train
= 20

pic = np.array(Image.open("train/right_thr" + str(0) + ".jpg"))
train_images = np.array([pic]) train_labels =
np.array([1]*num_right_train + [0]*num_left_train)

for i in range(1, num_right_train): pic =
np.array(Image.open("train/right_thr" + str(i) + ".jpg"))
train_images = np.vstack((train_images, np.array([pic])))

for i in range(num_left_train): pic =
np.array(Image.open("train/left_thr" + str(i) + ".jpg"))

train_images = np.vstack((train_images,

np.array([pic]))) train_images = train_images / 255.0

model =
keras.Sequential([ keras.layers.Flatten(input_shap
e=(600, 600)),

keras.layers.Dense(64, activation=tf.nn.relu),

keras.layers.Dense(2, activation=tf.nn.softmax) ])

model.compile(optimizer=tf.train.AdamOptimizer(),

loss='sparse_categorical_crossentropy',

metrics=['accuracy']) model.fit(train_images,

train_labels, epochs=5) while raw_input("took pic?

[y/n] ") == "y":

img = cv2.imread("pic.jpg") # noise grey = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY) noise = cv2.fastNlMeansDenoising(grey) noise = cv2.cvtColor(noise, cv2.COLOR_GRAY2BGR) print

```
"reduced noise"
# equalist hist kernel = np.ones((7,7),np.uint8) img =
cv2.morphologyEx(noise, cv2.MORPH_OPEN, kernel)
img_yuv = cv2.cvtColor(img, cv2.COLOR_BGR2YUV)
img_yuv[:,:,0] = cv2.equalizeHist(img_yuv[:,:,0])
img_output = cv2.cvtColor(img_yuv,
cv2.COLOR_YUV2BGR) print "equalized hist"

# invert inv = cv2.bitwise_not(img_output)
print "inverted"

# erode gray = cv2.cvtColor(inv,
cv2.COLOR_BGR2GRAY) erosion =
cv2.erode(gray,kernel,iterations = 1) print "eroded"

# skel img =
gray.copy() skel =
img.copy()
skel[:,:] = 0
kernel = cv2.getStructuringElement(cv2.MORPH_CROSS,
(5,5)) iterations = 0

while True: eroded = cv2.morphologyEx(img,
   cv2.MORPH_ERODE,
kernel) temp = cv2.morphologyEx(eroded,
cv2.MORPH_DILATE, kernel) temp = cv2.subtract(img,
temp) skel = cv2.bitwise_or(skel, temp) img[:,:] = eroded[:,:]
if cv2.countNonZero(img) == 0: break print "skeletonized"
ret, thr = cv2.threshold(skel, 5,255,
cv2.THRESH_BINARY); cv2.imwrite("thr.jpg", thr)

# predict pic =
np.array(Image.open("thr.jpg")) test_images
= np.array([pic]) print "predicting result"
predictions = model.predict(test_images)
print predictions print "final answer:" print
classes[np.argmax(predictions[0])]
```

## CHAPTER-8

## TESTING

Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design and coding. In fact, testing is the one step in the software engineering process that could be viewed as destructive rather than constructive. A strategy for software testing integrates software test case design methods into a well-planned series of steps that result in the successful construction of software. Testing is the set of activities that can be planned in advance and conducted systematically.

### 8.1 Testing Objectives

- Testing is a process of executing a program with the intent of finding an error.
- A good case is one that has a high probability of finding an error.
- A successful test is one that uncovers a yet undiscovered error. If testing is conducted successfully it will uncover errors in the software.
- Testing cannot show the absence of defects, it can only show the software defects are present.

### 8.2 Testing Principles

- Before applying methods to design effective test cases, a software engineer must understand the basic principles that guide software testing.
- All tests should be traceable to customer requirements.
- Tests should be planned long before testing begins.
- Testing should begin "in small" and progress towards testing "in large".
- Exhaustive testing is not possible.
- To be most effective. An independent third party should conduct testing.

### 8.3 Testing techniques

The primary objective for the test case is to drive a set of sets that has the highest likelihood for uncovering defects in the software. Testing is the process of executing a program with the intent of finding a yet discovered error. To accomplish this objective two different categories of test case techniques were used.

After the test plan and before going to test design, the test case is important. According to the project requirements we have to test some conditions to ensure the quality of software. For the purpose of testing these conditions we have to write test cases.

## 8.4 Testing Strategies

Testing is a set of activities that can be planned in advance and connected systematically, A strategy for software testing must accommodate low level tests that are necessary to verify a small source code segment has been correctly implemented as well as high level tests that validate system functions against customer requirements.

## 8.5 Test Case Preparation

**Blackbox testing**

The concept of the black box is used to represent a system whose inside workings are not available for inspection. In a black box, the test item is treated as a "black" since its logic is unknown: all that is known is what goes in and what comes out, or the input and output. Here, in this "Palm Vein Technology" the internal functionalities have been tested.

**Whitebox testing**

White box testing assumes that the specific logic is important and must be tested to guarantee the system's proper functioning. The main use of the white box testing is in error based testing.

It is predicted on close examination of procedural detail logic providing test cases that exercise specific sets of conditions and/or loops test path enough the software. Basis path testing is a white box testing technique. The basis path method enables the test case designer to derive a logical complexity of a procedural design and use this measure as a guide for defining a basis set of the execution path.

## 8.6 TestCase Verification

**Unit testing**

Unit testing focuses on verifying the effort on the smallest unit of software- module. The local data structure is examined to ensure that the date stored temporarily maintains its integrity during all steps in the algorithm's execution.

**Integration testing**

Data can be tested across an interface. One module can have an inadvertent, adverse effect on the other. Integration testing is a systematic technique for constructing a program structure while conducting tests to uncover errors associated with interring.

**Performance testing**

Performance testing is used to test runtime performance of software within the context of an integrated system. Performance test are often coupled with stress testing and require software instrumentation.

## Validation testing

After performing the validation testing, the next step is output testing of the proposed system since no system would be termed as useful until it does produce the required output in the specified format. Output format is considered in two ways, the screen format and the printer format.

## System testing

System Testing is nothing but testing the entire system. The following test cases are coming from the system testing.

# CHAPTER-9

## APPLICATIONS AND BUSINESS

This palm vein authentication technology is used in various areas for more security. The following are some of the important areas where it is used:

### 9.1 ATM AND BANKING

In July 2004, to ensure customer security, Suruga bank launched its “Bio Security Deposit '' the world’s first financial service to use Palm Secure . This service features high security for customers using vein authentication , does not require a bank card or pass book and prevents withdrawals from branches other than the registered branch and ATMs thereby minimizing the risk of fraudulent withdrawals. To open a Bio-Security Deposit account, customers go to a bank and have their palm veins photographed at the counter in order to guarantee secure data management, the palm vein data is stored only on the vein database server at the branch office where the account is opened.

In Oct 2004, The Bank of Tokyo launched its “Super –IC Card”. This card combines the functions of a bankcard, credit card, electronic money and palm vein authentication. This Super
–IC Card contains the customers palm Vein data and vein Authentication algorithms and reforms vein Authentication by itself. This system is advantageous because the customer’s information is not stored at the bank. When a customer applies for a Super –IC Card, the bank sends the card to the customer’s home. To activate the palm vein authentication function, the customer brings the card and his passbook and seal to the bank counter where the customers vein information is registered on the card . After registration the customer can make transactions at that branch counter and ATM using palm vein authentication and a matching PIN number.

PVT is used in 92% of all Japanese ATMs including 18,000+ ATM machines for Bank of Tokyo – Mitsubishi.

### 9.2 PERSONAL COMPUTERS

In personal computers palm vein technology can be applied by inserting the vein sensor inside mouse or on the keyboard. When power is supplied to system the mouse/keyboard also gets power and the sensor in the mouse/keyboard will be ready to sense palm veins. When one place his/her palm the sensor sense the veins and if they are matched with the registered ones the system allows the person to use it. One can use this technology even to lock folders , that should be maintained as private information. This technology will be very helpful in protecting data saved in computers and highly reducing the hacking of passwords. It can also be used in multi user computers where more than one person can use the computer. The users previously having an account or login account in particular can access the computer. Also this can be possible over a network like top secure sites of defense or other corporate sites or accounts where some of the officials can access the network.

(a) (b)

Fig-6.1 use of PVT (a) in ATM (b) in personal computers. [1]

## 9.3 HOSPITALS AND LIBRARIES

PalmSecure devices can also be used in hospitals for doctor and patient identification and where the high level of security is required. In libraries also Palmsecure devices may be used in place of ID cards. Some public libraries have started using this technology. For example, a public library in Japan is set to become the first in the world to use palm-vein biometrics as a substitute for conventional library cards. The University of Tokyo hospital has taken delivery of a contactless palm vein authentication system to secure physical access to its Department of Planning, Information and Management.

(a) (b)

Fig-6.2 PVT used in (a) Library (b) Hospitals for authentication. [13]

## 9.4 GENERAL AUTHENTICATION

- In front of our homes we can apply this Palm vein technology so that by registering the veins of our family members and relatives we can maintain high range security which is not possible through other technologies . Japanese recently used this technology before front doors and getting high range security.
- Nowadays credit and debit cards lose are very general cases and customers faces huge loose sometimes. So replacing credit card with palm vein will solve the all problems.

## 9.5 USE OF PVT IN OFFICES AND SCHOOLS

Palm vein sensing devices can be used in offices, schools, colleges, universities for attendance purposes. It also improves the security and prevents any sensitive case.

## 9.6 OTHER PRODUCT APPLICATIONS

- Management in healthcare
- Access control to medication dispensing
- Identification of doctors and nurses when accessing protected health records
- Patient identification management
- Operator authentication
- Settlement by credit card
- Obtaining various certificates using the Basic Resident Register Card
- Owner authentication
- Retrieval of checked luggage
- Driver authentication
- Attendance authentication
- Checking attendance in schools
- Clocking in and out of the workplace.

## 9.7 BUSINESS IMPACT

Although palm vein technology is quite new, it is creating an impact on the market and replacing the conventional biometric technologies. It can be seen from the fact that 92% of ATMs in JAPAN use this technology, including TOKYO NATIONAL BANK. Also some public libraries in JAPAN are using palm vein authentication in place of ID-cards. Even PVT is used at the front door of the home. Various administrative and customer impacts are specified below

## 9.8 ADMINISTRATIVE IMPACT

- Reduces, prevents sensitive financial information breach
- Prevents lawsuits
- Discourages workplace fraud
- Easy to implemented, fast to train
- Portability provide off-site access
- Without sacrifice security
- Increases Productivity by
- Reduces password loss
- Reduces the need of Technical Help Desk

## 9.9. CUSTOMER IMPACT

- Leading type of ID theft
- Credit cards
- Checking/savings accounts
- In 2007
- $45.3 Billion loss ( $5,592 per person)
- 8.1 Million victims (1 out of 8 American)
- Reduce company loss
- Give clients sense of security

## 9.10. FUTURE ASPECTS

Fujitsu is the first one to invent the technology. Nowadays only Japan and Korea are the leading manufacturers of Palm Secure devices. They supply the product mainly in Asia and America. But because the size of the device needed in various applications is different. For example, some companies want to incorporate this device in mobile phones and also in laptops and palmtops. So the size of the device needed for these applications is small. Hence research works are going on to reduce the size of the device.

Resolution of the image captured depends on ambient light intensity and temperature. Because these two factors strongly affect the resolution of captured images and hence the accuracy of the device, so still some improvements are required in the technology and some progress is going on. In near future these problems are expected to be solved and more enhanced, accurate and secure devices will be manufactured.

## MULTIMODAL BIOMETRIC

Error rates are high while using a single biometric, so the fusion of two or more biometrics are also used. Mostly palm vein and palm print technologies are used for fusion. This fused technology is also called multimodal biometric. The error rate decreases to a large extent. In this technology, separate templates of palm print and palm vein pattern are taken using sensors and camera and matched with a database.

# CHAPTER-10

# ADVANTAGES AND DISADVANTAGES

Palm vein technology has comparatively much more positives than negatives. Some of them are discussed earlier in the report and now we will discuss them all in detail.

## 10.1 ADVANTAGES

1. Palm vein authentication can be done using the vascular pattern on the back of a hand or a finger. However, the palm vein pattern is the most complex and covers the widest area, because the palm has no hair, it is easier to photograph its vascular pattern. The palm also has no significant variations in skin color compared with fingers or back of the hand, where the color can darken in certain areas. Also we can use fusion of two technologies, palm vein and palm print, which will be more complex and more reliable but costly.

2. Because the ICP method is used in this technology so there will be no false rejections or false acceptance cases because of orientation problems. So FRR and FAR are very low in comparison to other biometric technologies. So it is more secure and reliable.

3. The completely contactless feature of this device makes it suitable for use where high levels of hygiene are required. It also eliminates any hesitation people might have about coming into contact with something that other people have already touched.

4. The vascular pattern of our palm doesn't change with our growth or age, Even palm vein pattern is generated before birth. So once you register the palm vein pattern, you need not to re-register again anytime in your whole life except in any critical case of accident. Even in case of an accident if the palm is not injured critically, palm vein pattern can be extracted because veins are located deeper inside the hand. Also at the time of registration you have to register the vein pattern of both the palms, so if one gets injured other one can be used.

5. Palm vein pattern of any individual cannot be theft. Also since it is contactless, privacy cannot be invaded.

6. The average-selling price of the standard PalmSecure technology is between $300 and $350. While this is slightly higher than the average cost of fingerprint biometric technology solutions, customers are willing to pay the additional premium to receive the wide array of benefits associated with palm vein biometrics. Fujitsu recently

released a scaled-down version of this technology – Fujitsu PalmSecure LT for SSO,which will retain most of the benefits of the premium product and yet be priced below $200

## 10.2 DISADVANTAGES

The only weaknesses of the palm vein biometric system are the different factors that affect the quality of captured image. Such factors include body temperature, ambient temperature and humidity, uneven distribution of heat, heat radiation, and nearness of the vein to surface and camera calibration and focus. Most of these factors are natural causes which are difficult to overcome.

# CHAPTER-11

## CONCLUSION

After discussing all about the Palm Vein Technology, now we will talk about the technical specifications of the palm secure device, such as size of sensor used, verification time software used etc.

## 11.1 TECHNICAL SPECIFICATIONS OF DEVICE

Sensor size : 35x35x27 mm

Recording position : 4-6 cm over the Sensor; 0°, 90°, 180° ,270°, 360°

Verification time (1:1) : 1,5 sec

Identification time (1:n) : =/> 3 sec

Template size : 0,8 KB

Amount of templates / person : 2

FAR : 0,000 08%

FRR : 0,01%

Interface : USB 2

Encryption : AES

Software : Device driver for WIN 2000/XP und LINUX, PC Log in

SDK : Template Library SW, Tool & Adjustment, SW Demo SW

Power Supply : <2.5W for sensor, around 5W for CPU

Scan : Contactless, distance to sensor 5cm +/ 1cm, Scanning method directions life detection for free

Insensitive : Almost insensitive against ambient light (outdoor use possible, no direct sunlight or lamp)

Fast enrolment : 10s-20s

I/O interface : Wiegand I/O, system will easily fit in present installations; Seamless links to video management platform”Cware” and therefore interacts with CCTV and additional applications

Operating temperature : 0oC to 60oC

Certified : Components are certified by German Federal Office for Information Security (BSI)

Future proof : Solution can be easily adapted to diverse customer requirements.

## 11.2 PALMSECURE PRODUCT PORTFOLIO

Here are the details of availability of PalmSecure devices in various packages according to the various requirements. The device is available mainly in three packages as follows:

1. PalmSecure Developer Package (Part number FAT13S1A01)

    - 1x PalmSecure Sensor
    - 1x PS Hand guide
    - 1x PS Direct USB connector
    - 1x PS USB cable
    - 1x SDK

It is the hardware and software package for OEMs, system integrators and developers. This is the full package and each and every component required in the device is provided within this package.

2. PalmSecure Sensor GuideKit (Part number FAT13-SGK)

    - 1x PalmSecure Sensor
    - 1x PS Hand guide
    - 1x PS USB cable
    - 1x PC LOG IN SW

This package is for PC Login hardware and software packages for enterprises and end users. In this package SDK kit is not provided because for PC login users they can install software in their PC itself.

3. PalmSecure Sensor OEM Set (Part number FAT13M1S1)

    - 1x PalmSecure Sensor

It is available as a single sensor for integration i.e. for access control.

## 11.3 CONCLUSION

In this report we have discussed all about Palm Vein Technology. Palm vein technology is the new face of biometrics. It provides the maximum security as compared to other biometric technologies because it uses information contained within the body and is also highly accurate because the pattern of veins in the palm is complex and unique to each individual. It also gives the least FRR, FAR, EER among them. Also verification time is less as compared to other technologies. Since in this technology ICP method is used which is free from orientation and rotational problems of the image. Also there is no disadvantage. As discussed earlier, by using multimodal fusion of other technology with PVT will make it more secure. Moreover, its contactless feature gives it a hygienic advantage over other biometric authentication technologies. This paper also describes some examples of financial solutions and product applications for the general market that have been developed based on this technology. Many customers have favorably evaluated this technology and have experienced no psychological resistance to using it. This has encouraged manufacturers and developers to start development of new products for various applications, beginning with financial solutions and followed by access control units and login units.

Manufacturers and developers are working on reducing the size of the device in order to expand the range of application of the device. Fujitsu is continuing the work on reducing the size and improving the technology so that it can be more secure and have lesser FAR, FRR and EER.

## REFERENCES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