Development of Hand Vein Based Verification System Using LabVIEW

A dissertation submitted in partial fulfilment of the
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Submitted By

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CERTIFICATE

I hereby certify that the work which is being presented in the dissertation entitled, "Development of Hand Vein Based Verification System Using LabVEIW", in partial fulfillment of the requirements for the award of degree of Master of Engineering in Electronics Instrumentation and Control submitted in Electrical & Instrumentation Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of Dr. *Sunil K. Singla*, Assistant Professor. The matter presented in this thesis has not been submitted for the award of any other degree of this or any other university.

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ABSTRACT

With advent of technology biometric person identification emerged as a common technological tool for identity verification and carries significant importance for national or international security. Development of accurate and reliable security system is a prime concern in an automated world where machines are replacing the human beings in every aspect of life. Many biometric traits like face, fingerprint, palm print, iris, retina, hand veins, ears can be used to develop such biometric authentication systems. Many researches have been done and are being done on these biometric systems to improve their accuracy and reliability. Some of the unique features in human being like fingerprint, palm print, face, iris, ear etc. are used for automate identity and authentication. Hand vein is a new class of relatively stable biometric. In the present work, an image based hand vein recognition system has been developed. The proposed method is reliable and user friendly as it is developed in Laboratory Virtual Instrument Engineering Workbench (LabVIEW). The experiments have been conducted using the template size of 100 × 100, 200 × 200 and 300 × 300. Template 100 × 100 and 200 × 200 showed smaller template size is better for better results. Template size of 200 × 200 showed best results. Larger size of templates as in case 300 × 300 shows more False Rejection Rate. Moreover increase in threshold value increases False Rejection Rate. 0 % error was obtained with threshold value 700 for all templates sizes under experiment. For threshold value 750 maximum error obtained was 1.1% i.e. for 300 × 300 template size. While 100 × 100 and 200 × 200 template size showed error of 0.3 % for 750 threshold value. With threshold value of 800 maximum error was obtained to be 10.9% i.e. for template size of 300 × 300. With further increase of threshold value the error kept increasing.

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CHAPTER1

INTRODUCTION

1.1 Biometrics

Earlier pins and passwords were supposed to be safest thing to secure your data/ privacy. As the time passed with advent of hacking passwords are now no more secure. Now these hackers can back trace your pin and passwords resulting in insecurity of the data. This created demand for more secure authentication techniques, solution to this is provided by Biometrics. In future, biometrics will replace these concepts as it is more convenient and reliable. Biometric systems acquire two type of traits those are physical and behavioral characteristics of an individual and recognize them on basis of these traits in combination or individually. Biometric cannot be stolen, or forgotten, and forgoing one is practically impossible[1]

Biometrics uses physical characteristics, defined as the things we are and personal traits, defined as the things we do, some of the physical biometric authentication systems use following traits [1].

- Chemical composition of body odor.
- Facial features and thermal emissions.
- Features of the eye retina and iris.
- Fingerprints.
- Hand geometry.
- Skin pores.
- Wrist/ hand veins.
- D.N.A.

Behavioral based methods does authentication by analyzing behavior patterns, such authentication systems use some of the following traits [1].

- Handwritten signatures.
- Keystrokes or typing.
- Voiceprint.

Major problem faced by behavioral characters is high variations. If at all you cope with variations next problem with them is problem of measuring because of influences such as stress, fatigue or illness. Social acceptance to behavioral methods is not an issue. Among physical and behavioral, physical are more stable because altering them is difficult.

Biometrics can automatically authenticate individuals by verifying their traits with increased accuracy as we can recognize our acquaintance face from crowd similarly biometrics does it for us. Enhanced security as compared to passwords and pins system would make medical information, banking data, credit card numbers or any personal data transactions on web more secure

1.2 Biometric Functionality

Many different aspects of human physiology, chemistry or behavior can be used for biometric authentication. The selection of a particular biometric for use in a specific application involves a weighting of several factors. Jain et al. (1999) [2] identified seven such factors to be used when assessing the suitability of any trait for use in biometric authentication.
Universality means that every person using a system should possess the trait[2].

Uniqueness means the trait should be sufficiently different for individuals in the relevant population such that they can be distinguished from one another

Permanence relates to the manner in which a trait varies over time. More specifically, a trait with 'good' permanence will be reasonably invariant over time with respect to the specific matching algorithm.

Measurability (collectability) relates to the ease of acquisition or measurement of the trait. In addition, acquired data should be in a form that permits subsequent processing and extraction of the relevant feature sets.

Performance relates to the accuracy, speed, and robustness of technology used.

Acceptability relates to how well individuals in the relevant population accept the technology such that they are willing to have their biometric trait captured and assessed.

Circumvention relates to the ease with which a trait might be imitated using an artifact or substitute.

1.2.1 Block Diagram of a Biometric System

In verification mode the system performs a one to one comparison between captured biometric and a specific template stored in a biometric database in the system order to verify the individual is the person they claim to be. There are three steps involved in person verification.
In the *first* step, reference model database is generated by generating reference models for all users.

In the *second* step, some samples are matched with reference models so as to generate the authentic and impostor scores and threshold is computed.

Third step is the testing step. This process may use a username or ID number to indicate which template should be used for comparison. 'Positive recognition' is a common use of verification mode, "where we prevent multiple people from using same identity"[2].

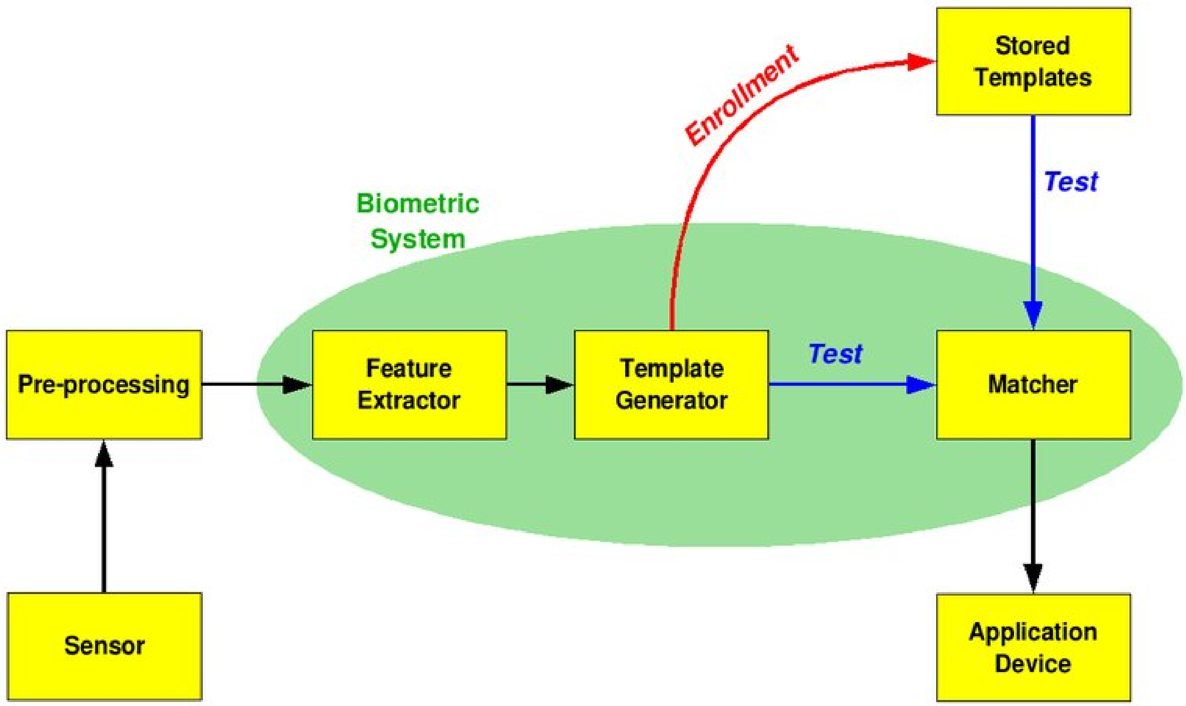


Figure 1.1: Block diagram of biometric system [3].

In *Identification* mode the system performs a one to many comparison against a biometric database in attempt to create the identity of an unknown individual. The system will flourish in identifying the individual if the comparison of the biometric sample to a template in the database falls within a already set threshold. In identification mode two types either for 'positive recognition' (no user need to provide any information about the template to be used) or for 'negative recognition' of the person "where the system establishes whether the person is who she denies to be" [3]. The latter function can only be attained through biometrics since other methods of personal recognition such as passwords, PINs or keys are ineffective.

Very first step to entire process of biometric system is enrollment. During the enrollment, biometric information from an individual is captured and stored in the system. In following uses, biometric information is detected and compared with the information stored at the time of enrollment. Note that it is vital that first the storage and second the retrieval of such systems themselves be secure if the biometric system is to be robust. The sensor does the work of relating between the real world and the system, it has to acquire all the necessary data. Generally it is an image acquisition system, but it can change according to the requirements of the system. The second block performs all the necessary pre-processing: it has to remove artifacts from the sensor, to exaggerate the input (e.g. eliminating background noise), to use some kind of normalization, etc. In the third block necessary features are extracted. This step is an important step as in this system the correct features need to be extracted in the optimally. A vector of an image or number with particular properties is used to create a template. A template is a synthesis of the relevant traits extracted from the source. Elements of the biometric measurement that are the byproducts of comparison algorithm are scrapped in the template to reduce the file size and to protect the identity of the enrollee.

If enrollment is being performed, the template is simply stored somewhere. If a matching phase is being performed, the obtained template is fetched and matched by a matcher that compares it with other existing templates in database, estimating the distance between them using any of the algorithm . The matching algorithm will evaluate the template with the input. This will then be output for any specified use or purpose. Selection of biometrics in any practical application depending upon the trait measurements and requirements of users. Performance, acceptability, circumvention, robustness, population coverage, Size, identity theft deterrence should be considered in selecting a particular biometric. Biometric selection based on user requirement considers device availability, sensor availability, reliability and computational time , cost, sensor area and power consumption.

1.3 Performance Metrics

The following are used as performance metrics for biometric systems [4]:

1) **False accept rate or false match rate (FAR or FMR)**: the probability of incorrectly matching the input pattern to a non matching template in the database. It measures the percentage of untrue inputs which are incorrectly accepted. Where as in case of similarity scale, if the person is imposter in real, but anyhow the matching score comes out to be higher than the threshold, then he is treated as genuine that increase the FAR and from this we can conclude performance is dependent upon the threshold value taken into consideration.

2) **False reject rate or false non-match rate (FRR or FNMR):** Its reverse of the above case, the probability of failing to detect a match between the input pattern and a matching template in the database by the system. It measures the percent of valid inputs which are incorrectly rejected.

3) **Receiver operating characteristic or relative operating characteristic (ROC):** The ROC plot is a graphical representation of the tradeoff between the FAR and the FRR. Generally, the matching algorithm makes a decision according to a threshold which determines how near to a template the input needs to be for it to be considered a match. If the threshold is decreased, there will be less false non matches but hiked false accepts. Correspondingly, a hiked threshold will decrease the FAR but raise the FRR. A common variation is the detection error tradeoff (DET), this is obtained using normal deviate scales on both axes. This more linear graph enlightens the differences for higher performances.

4) **Equal error rate or crossover error rate (EER or CER):** the rate at which both accept and reject errors are same. The value of the EER can be easily fetched from the ROC curve. The EER is a faster way to compare the accuracy of devices with diverse ROC curves. In general, the device with the lowest EER is most accurate.

5) **Failure to enroll rate (FTE or FER):** the rate of unsuccessful attempts to create a template from an input. This is most commonly caused by low quality inputs, input with noise.

6) **Failure to capture rate (FTC)**: In case of automatic systems, the probability that the system fails to detect a biometric input when presented correctly. Which results in failure to capture.

7) **Template capacity**: It's the maximum number of sets of data which can be stored in the system.

1.4 Biometric Technologies

Many of the traits can be used in biometrics systems. Some of the following are some of the biometric traits which can be used in biometric systems [5][1]

- Fingerprint Recognition
- Voice Recognition
- Face Recognition
- Iris Recognition
- Hand Vascular Pattern Recognition

- Retina Recognition
- Keystroke Recognition
- D.N.A. Recognition
- Gait Recognition

1.4.1 Fingerprint Recognition

In fingerprint recognition, we capture image of a person's fingertips and look for characteristics like furrows, whorls and loops along with the patterns of ridges, arches, and minutiae[4]. Fingerprint matching can be achieved in three ways:

• *Minutae* based matching stores minutiae as a set of points in a plane and the points are matched of the stored template and the input minutiae.

• *Correlation* based matching superimposes two fingerprint images and degree of correlation between corresponding pixels is computed. 1 represents the full matching whereas 0 shows no match.

• Ridge feature based matching is an advanced method that picks ridges, problem with minutiae capturing are difficult in low quality fingerprint images. Capturing the fingerprints, current techniques employ optical sensors that use a CCD or CMOS image sensor; solid state sensors that work on the transducer technology using capacitive, thermal, electric field or piezoelectric sensors; or ultrasound sensors that work on echography in which the sensor sends acoustic signals by the transmitter on to the finger and captures the echo signals with the receiver.

Fingerprint scanning is very stable and trust worthy [4]. It secures entry devices for building door locks and computer network access is becoming more common. Recently many banks have begun using fingerprint readers for authorization of their staff to operate computer fingerprint is very oftenly used for attendance. Hopefully, these civilian identification systems can be implemented sensitively but liability on user is to use wisely. If so, they may prove to be a positive force for privacy and a strong economic enabler in the next millennium [6].

1.4.2 Voice Recognition

Voice recognition blends physiological and behavioral factors and produce speech patterns that are captured by technology of speech processing. Inherent properties of the speaker like fundamental frequency, nasal tone, cadence, inflection, etc. are used for speech authentication.[9]

Voice recognition techniques can be divided into categories depending on the type of authentication domain.

• Fixed text method is a technique where the speaker is required to say a predetermined word that is recorded during registration on the system.

• In the text dependent method the system prompts the user to say a specific word or phrase, which is then computed on the basis of the user's fundamental voice pattern.

• The text independent method is an advanced technique where the user need not articulate any specific word or phrase. The matching is done by the system on the basis of the fundamental voice patterns irrespective of the language and the text used.

• Conversational technique verifies identity of the speaker by inquiring about the knowledge that is secret or unlikely to be known or guessed.

This interactive authentication protocol is more accurate as the FAR are claimed to be below 10-12

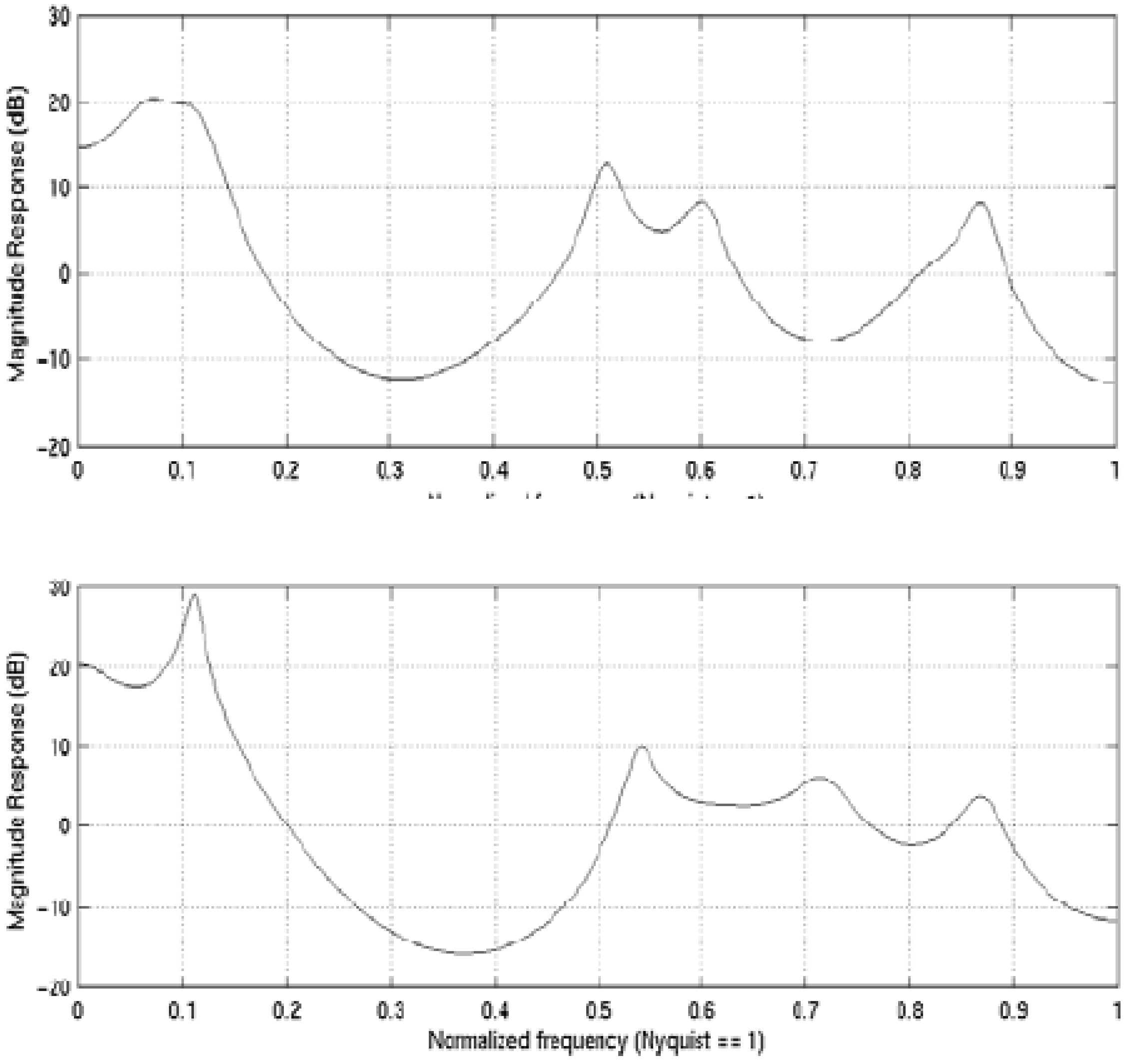


Figure 1.2: Illustrates the differences in the models for two speakers saying the same vowel [15].

The vocal tract is represented in a parametric form as the transfer function H(z). Ideally, the transfer function composed of poles as well as zeros. However, all pole model for H(z) is sufficient if only the voiced regions of speech are used then an. Furthermore, to efficiently estimate the parameters of an all pole model linear prediction analysis can be used. The all pole model is the minimum phase part of the true model and has an identical magnitude spectrum, which contains the bulk of the speaker dependent information (Illustrated in Fig. 2).

This technique is inexpensive but is sensitive to background noise can prove troublesome and it can be reproduced. Also, it is not always fool proof as voice is subject to change during period of illness, hoarseness, or other common throat problems. To apply this technique we need to include voice controlled computer system, telephone banking and audio and video indexing.

1.4.3 Face Recognition

In more than twenty years of research, many methods have been tested with the aim of recognizing people from the image of their face. Some of these methods are deals with facial features by extracting landmarks from the subject face. Such features can be position, size, and/or shape of the eyes, nose, cheekbones, and jaw, while others consider the appearance of a face (Eigen face and Fisher face methods)[11] but no method up to now performs sufficiently well, which means that a lot of research is still going on and a lot more to come.
For face recognition algorithms two main approaches can be implied [13] ,

photometric, In this method we use statistical techniques to do the recognition that picks an image as an set of values and compares the values with templates to eradicate variances.

geometric, as name suggests we look for distinctive geometric features of the face like size, shape , geometry for facial parts like nose, eyes , etc.

Some of the popular recognition algorithms are principal component analysis using eigen faces, elastic bunch graph matching using the fisher face algorithm, linear discriminate analysis, the hidden markov model, the multilinear subspace learning using tensor representation, and the neuronal motivated dynamic link matching.

Advantage of this system is that it does not require the cooperation of the subject. Properly designed systems installed in airports, multiplexes, and other public places can identify individuals among the crowd, without subject passing by even being aware off. Other biometrics such as fingerprints, iris scans, and hand vein cannot perform this kind of mass identification.

Disadvantages of this system as it is not perfect and struggles to perform under certain conditions. One among the obstacle is related to the viewing angle of the face. Another conditions where face recognition does not work in cases of poor lighting, sunglasses, long hair, or other objects partially covering the subject’s face, and low resolution images. Facial expressions also affect the accuracy of the system. Even a big smile can make the system less effective.

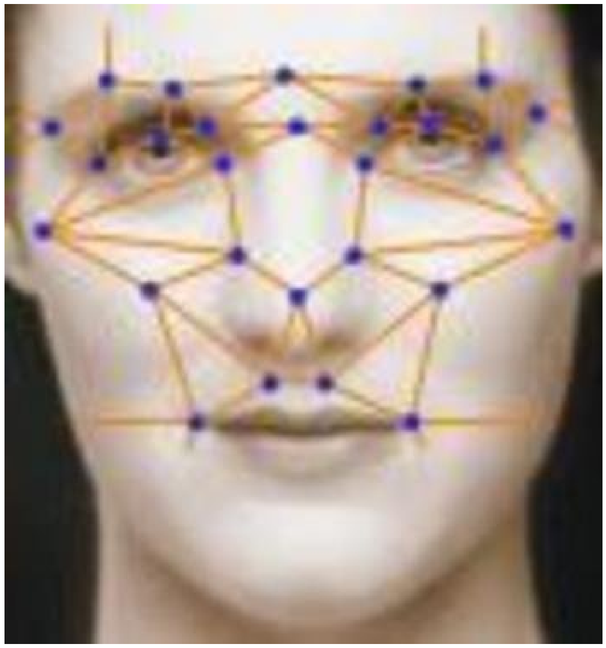


Figure1.3: Image showing face features [28].

1.4.4 Iris Recognition

Iris Recognition analyzes features like furrows, rings, and freckles existing in the colored tissue around the pupil [16]. The image acquisition done with a regular video camera and works through glasses and contact lenses. The image of the iris is taken directly by positioning user's eye within the field of a single narrow angle camera. This process of positioning is done by observing a visual feedback via a mirror. The isolated iris pattern obtained is then demodulated so as to extract its phase information.

Image acquisition of Iris can be done in two ways:

• Daugman System uses an LED based point light source in accompanied by a standard video camera. Their arrangement captures images with the iris diameter typically around 100-200 pixels from a distance around 15-46 cm with help of 330mm lens[19].

• Wildes System in comparison results in an illumination rig that is more complex. This arrangement images the iris with around 256 pixels across the diameter from 20 cm using an 80mm lens[20].

Iris recognition was piloted in India under Aadhar card scheme with a motive of as keeping identity of its citizens[17].

1.4.5 DNA Recognition

Deoxyribonucleic acid (DNA) can be considered to be the most reliable biometrics. It is in fact a one dimensional code unique for every person. Exception in this case are identical twins. This method has some drawbacks[26]:

1) Contamination and sensitivity, as it’s easy to steal a piece of DNA from an individual and use it for an ulterior purpose.

2) No real time application is possible because DNA matching needs complex chemical technique involving expert's skills.

3) Privacy issues

All of these limit the use of DNA matching in the forensic applications

1.4.6 Retina Recognition

Infrared scanning is used in retina recognition technology which compares images of the blood vessels that are present in the back of the eye, the choroidal vasculature. The eye’s inherent isolation and protection from the external environment as an internal organ of the body is a benefit[26]. High end security applications like military installations and power plants uses retina scan.

1.4.7 Signature Recognition

Signature Recognition is an instance of writer recognition, which has been accepted as irrefutable evidence in courts of laws. Every person has his own way of doing signatures. Signature verification Approach utilizes features like number of vertical slope components and number of interior contours [26]. Signatures are behavioral biometric, problem with this biometrics is that it can change with time, influenced by physical and emotional conditions of the signatories. Furthermore, professional forgers can reproduce signatures to fool an unskilled eye and hence is not the preferred choice.

1.4.8 Hand Vascular Pattern Identification

One's vein pattern is relatively stable through one's life [24]. In this method we use a non harmful near infrared light (NIR) to produce an image of one's vein pattern in their hand, wrist, or fingers. It is a non invasive, automated comparison of shape and size of subcutaneous blood vessel structures in the back of a hand. A video camera picks up the vein tree pattern which is sufficiently characterized to function as a personal code and that is extremely difficult to replicate or discover. Sensor is not essentially required to have physical contact. This provides excellent convenience and no performance degradation even with scars or hand contamination. Verification speed of the system is fast while maintaining the false acceptance rate is FAR and false rejection rate (FRR) [25] . Though minimally used at the moment, vascular pattern scanners can be found in testing at major military installations and is being considered by some established companies in the security industry and multi outlet retailers

1.4.9 Keystroke

Keystroke dynamics is a data processing technique by analyzing the way a user types by monitoring the keyboard inputs it attempt to identify them via their habitual typing rhythm. As compared with other physical and behavioral biometrics, keystroke dynamics is not capable to be used as uni model biometric system. Again by integrating keystroke dynamics with the existing password authentication system, even if the impostor is able to present the login credentials, either by hacking, shoulder spoofing or key logger, without the correct typing pattern, they will be denied access. In contrast, mere password authentication will guarantee access to any user as long as the login credential is matched not considering if the user is legitimate. Description and procedure of calculation for each of these keystroke features based on example are given as follow.

Dwell Time (D1): The time interval between a key pressed until the key is released.

$D = R - P$

Flight Time (D2): The time interval between a key press and the next key press.

D = P − P

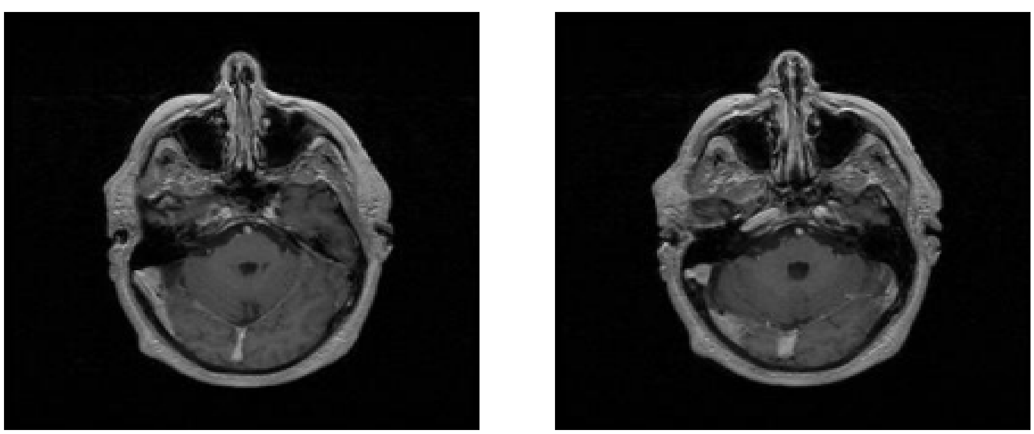
At this stage we propose two methods: (1) Direction Similarity Measure (DSM) and (2) Gaussian Probability Density Function (GPD). The output of both methods is a similarity score value, S, where $0 \leq S \leq 1$. The score is then compared against a predefined threshold, If the score is larger than the threshold, then we declare the user as a genuine user, and vice versa [27].

1.5 Beyond Classical Biometrics: Hidden Biometrics

Visible biometrics traits are more prone to get forged. With everyday increasing requirement of privacy researchers are now going for hidden biometrics like hand vein, MRI, X-RAY

1.5.1 MRI

Magnetic resonance imaging of brain can be used for identification of individual. Since one can easily distinguish between them visually as shown in figure 4. An automatic system for recognition through MR images can be made by using proper texture analyzing algorithm. To normalize the MR brain images elliptical band, which is a technique based on Daugman's rubber sheet model[29]. The concept behind MR imaging of brain recognition can be generalized by processing the whole volume , numerous parameters can be analyzed for instance geometrical and texture parameters. When it comes to geometrical parameters shape of the brain is modeled while in case of texture analysis we analyze brain convolution. Problem with this biometrics are possibly a) cost b) social acceptance.



(a) (b)

Figure 1.4: MR images of two individuals even visibly differentiable [29]

1.5.2. X-RAY

Concept of hidden biometrics can also be taken to X-ray images, especially when low radiations are used. For an example, we can also even consider lung X-ray images, hand bone structure using X ray as shown in figure 4 corresponding to two individuals. Variations with respect to texture and morphology can be pinpointed easily. Feature extraction can be done using some appropriate image processing methodology can be deployed to identify individuals with efficacy.

(a) (b)

Figure 1.5: Hand X-ray of two different individuals even visually distinguishable [29].

1.6 Comparison

Each and every method discussed above have its own pro and cons which plays vital role in the success or failure of the method. Like in case of fingerprint recognition rubber stamp can befool the system which ante the jeopardy of failure. To prevent it, it's suggested to incorporate pulse detector or such technology to avoid such failure and detecting liveliness.

Following table makes comparison between various types of the methods of biometrics

Table 1.1 Comparison of various biometric technologies based on the perception [3].

Biometric Identifier	Universality	Distinctiveness	Permanence	Collectability	Performance	Acceptability	Circumvention
DNA	H	H	H	L	H	L	L
Ear	M	M	H	M	M	H	M
Face	H	L	M	H	L	H	H
Facial thermogram	H	H	L	H	M	H	L
Fingerprint	M	H	H	M	H	M	M
Gait	M	L	L	H	L	H	M
Hand geometry	M	M	M	H	M	M	M
Hand vein	M	M	M	M	M	M	L
Iris	H	H	H	M	H	L	L
Keystroke	L	L	L	M	L	M	M
Odor	H	H	H	L	L	M	L
Palmprint	M	H	H	M	H	M	M
Retina	H	H	M	L	H	L	L
Signature	L	L	L	H	L	H	H
Voice	M	L	L	M	L	H	H

Where as

H = High.

M = Medium.

L = Low.

1.7 Problem Formulation

Hand vein recognition has some advantages over the other biometric traits which make it better then other biometric systems [24]

1. Live body identification.
2. Internal feature.
3. Non contact.
4. Difficult to forge.
5. Social acceptance.

Hand vein is considered as a good biometric feature that can offer better reliability and security for identity verification due to the above advantages. The aim of this dissertation is to:

i. Study the various biometric systems.
ii. Study the literature of various techniques of hand vein as biometric.
iii. Develop a flexible, cost effective, hand vein biometric system using LabVEIW.

CHAPTER2

LITERATURE REVIEW

Hand vein is one of the latest techniques of biometrics as before 1990 it was undiscovered. Many techniques are now available for hand vein recognition. Vein pattern is comparative recent as an biometric trait. *MacGregor* and *Welford* were first to came up with their system namely"vein check" for person identification [30]. Since then a lot of research have been done and still going on upon hand veins. With some advantages like social acceptance, lesser consumption of time, better accuracy its becoming more popular these days. More over these comes under category of hidden biometrics which makes it more secure and difficult to invade.

Choi et al. stated that the hand vein patterns have the distinctiveness property. The entire network of blood vessels beneath hand skin comprising of veins and capillaries is considered to be all together different for every individual [31].

Mehnert et al. [1993] did a research relating to segmentation of the subcutaneous vascular network of the backside of hand [32].

Im et al. [2001] presented an ASP (application specific processor) for vein pattern extraction and its application to a biometric identification system. In the case of conventional algorithms relating to vein pattern extraction, it is vital to use a costly DSP processor suitable for a floating point operation and a real time process. The ASP adopts shift and add architecture for filters, sobthe preprocessing algorithm can be implemented using fixed point operation, and the filter coefficients are designed with 7 tap CSD codes. The implementation of processor was done using a FPGA (field programmable gate array) device [33].

Im et al. [2003] proposed an improved vascular pattern extraction algorithm for person verification applications. Proposed algorithm is direction based vascular pattern extraction (DBVPE). Algorithm implement two different filters on input images: First is row vascular pattern extraction filter (RVPEF) so as to effectively extract the abscissa vascular patterns and second is column vascular pattern extraction filter (CVPEF) so as to effectively extract the ordinate vascular patterns. A final hand vascular pattern is obtained by combination of both the filters. Compared to the conventional hand vascular pattern extraction algorithm, the directional extraction approach is advantageous as this approach prevents loss of the vascular pattern connectivity. In order to validate the DBVPE algorithm, a prototype system with a DSP processor was used. The prototype system showed approximately a three times better false acceptance rate (FAR) than the conventional single filter algorithm [34].

Bouzida *et al.* [2008] proposed an imaging technique of the hand vein tree, with the help of natural human circulatory system and a controlled arm band pressure around the arm, a lock in thermography technique with an internal excitation is done. As the stimulation frequency and the inspection depth are inversely proportional to each other, thus needs the use of a very slow frequency. In order to minimize the duration of the pressure applied to the armband, a saw tooth waveform is preferred. A frequency of approximately 0.03 Hz and a pressure range between 100 and 140 mmHg, according to the diastolic and systolic blood pressure, are used as stimulation. Followed by dorsal hand amplitude and phase images are acquisition with IR_view (Klein, 1999).Thermally mapping of hand vein structure is performed by an IR camera working in the middle wavelength infrared range (MWIR) at room temperature. Frequencies creating artifacts are avoided by keeping the hand fixed. Resultant images show a temperature gradient among surrounding tissues and the back of hand veins. Fast fourier transform (FFT) image processing technique is used for vascular signature segmentation extraction from the amplitude and phase images [35].

Wang et al. proposed a methodology of partition local binary pattern (LBP) for hand dorsa vein recognition. Under this methodology the image is divided into sub images after preprocessing is done. Then the LBP features are extracted from all those sub images, minimum distance classifier is used for the purpose of identification. Algorithm is tested on a database having 2040 images from 102 individuals built up by a custom made acquisition device. The experimental results show that PLBP performs better than other features [36].

Wang et al. also proposed the feature code for hand vein recognition. The output of partitioned LBP is extracted and served as the input to back propagation encoder. The orthogonal gold code is taken as the output code for back propagation. The classifier called correlation classifier is used as the final classifier [31].

Wang et al. proposed feature descriptor methodology in which partition LBP is blended with feature weighting and error correction code. The feature weighting lessens the effect of insignificant local binary patterns and error correction code hike the distances between feature classes. Implementing on a large database with over two thousand hand dorsa vein images, the resulting new feature descriptor, named Weighted and Coded PLBP (WCPLBP), came out to be more efficient as that to the original PLBP without feature weighting and error correction code, as it gives a better performance in recognition of hand dorsa vein images with a right recognition rate reaching approximately 99% with help of a simple nearest neighbor classifier [37].

Wang et al. suggested local Scale Invariant Feature Transform (SIFT) which has practical importance because of its translation and rotation invariance. The hand vein image is preprocessed to eradicate the background and minimize image noises and the SIFT features are obtained to describe the gradient information of hand vein. Minimum distance is used as classifier [31].

Kumar et al. proposed an methodology of authenticating user by knuckle shape of information palm dorsa hand vein images and triangulation of hand vein images. Tips of knuckle are utilized for extraction of region of interest ROI. The resultant matching scores are computed by the four topologies of triangulation of binarized vein structures and from the geometrical features which comprises of knuckle point perimeter distances in the captured images. The combination of these two matching scores on weighted score level are deployed to authenticate the individuals [38].

Tanaka et al. proposed the certification system which compares vein images with high speed , low cost and high precision certification. Equipment used comprises of a near infrared light source (NIR) and a monochrome CCD to produce contrast enhanced images of the subcutaneous veins. Recognition algorithm comprises phase only correlation and template matching. In this purposed algorithm sharpness filters, several noise reduction filters and histogram manipulations were tested for best effort. As an outcome of this, high certification ratio in this system was obtained [39].

Ojala et al. came up with Local Binary Patterns (LBP) is a straightforward but efficient texture operator utilized in different tasks, like texture segmentation, texture classification, face recognition, etc. One of its extensions is uniform LBP. Although, uniform LBP has two big glitches. One of them is, this only covers a small neighborhood area and as a result gives very limited local information. The other drawback is that some of vital non uniform information will be gone for one scale [40].

Rothaus et al. proposed a few methods of vessel segmentation which is utilized in separation of retinal vascular graph in veins and arteries. Generally most of the methods make use of either the palmar hand vein image or the dorsal hand vein image [41].

Ojala et al. continued this operator to use neighborhoods of various sizes. Deploying circular neighborhoods along with bilinear interpolating the pixel values takes into account any radius and number of pixels in the neighborhood. Uniform patterns is one of the another extension to the default method. A local binary pattern is considered to be uniform if that comprises of at most two bitwise transitions from 1 to 0, or alternatively, when the binary string is assumed circular. The local primitives such as corners and edges are represented by uniform patterns. It is to be noticed that most of the texture information lies in the uniform patterns. A single fixed pattern replaces all of non uniform patterns. This in result decreases the number of patterns greatly. The Local binary pattern (LBP) operator is one of the texture descriptor which was originally proposed in 1994. LBP operator has foundation on the gray level comparison of a neighborhood of pixels. Later LBP operator was reconstructed to be sensitive to certain types of spatial patterns. Specifically the "uniform" LBP emphasis on patterns accounting for most two bitwise transitions. Other adaptations comprises of gray level invariance and rotation invariance. The size of the operator is said as the number of neighboring pixels P at radius from center point R

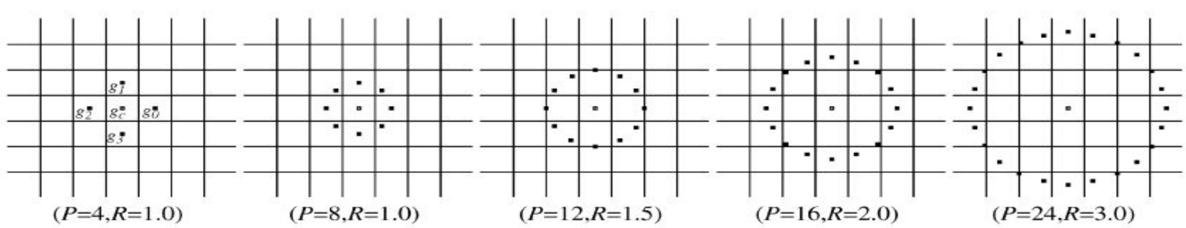


Figure 2.1: Circularly symmetric neighbor sets [42].

Palm veins are line structures with variable width, gray level values of whom vary from the background. The LBP operator is established on gray level variations in local neighborhoods. Hence it has the potential to fetch distinctive features from palm vein images. The size of the information to be extracted determines the size of the operator. In the case of a neighborhood comprising a vein region, the vein will either end inside or cross the local neighborhood. Thus, the out came patterns of interest will not comprise of many discriminative bitwise transitions indicating gray level transitions. It is hence logical to consider "uniform" patterns. The direction of veins presents a differentiative feature, hence it’s not essential to consider rotation invariant patterns. In the need of preserving local spatial information, the LBP operator is applied on segments of an image and not on the entire image . A few numbers of neighboring points is worthwhile in reducing noise feature extraction [42].

Shahin et al. proposed fast spatial correlation of hand vein patterns images for authentication. Upon done with segmentation and pattern post processing, correlation is deployed to measure the identity [43].

Zhang et al. The LDP operator is a high order texture descriptor. This was introduced as an encoding scheme for local patterns. Originally to implement face recognition in comparison using the LBP method, and was proved to be more effective. First order non directional patterns fetched be the LBP operator. On the contrary to LBP, the LDP operator fetches the information based on derivative direction variation which is deemed as second order pattern information. Every neighboring pixel adds to the pattern code with the direction of its derivative in reference to the derivative of the center point. The derivatives are taken in various directions, in the default case, the directions 0, 45, 90 and 135 degrees were taken into consideration. Image derivatives in all direction are attained by subtracting neighboring pixels in accordance with the direction. In the study of fitting the LBP operator to efficiently extract veins patterns, the LDP operator required to be implemented with parameters best fit for the task of the vein extraction . The order of an operator n, the directions of derivative, the range (radius from center) applied to the neighborhood size and the number as well as size of the sub image blocks upon which the LDP operator is directly executed, are varied [44].

Yuhang et al. showed that best segmentation effects can’t be achieved through single threshold (fixed threshold, total OSTU, total mean and so on) and multi thresholds segmentation methods (local mean, local OSTU). But the effect of segmentation has been enhanced from the one threshold to multi thresholds. That is to hike the number of the thresholds against the number of the image pixels. The recognition effect provided by the vein recognition algorithm they introduced are comparatively good. There is a possibility of issues like speed in the part of threshold segmentation which makes it necessary to improve the algorithm further .The step of feature extracting and matching, feature points comprising the cyclic structures can be extracted. But where as in the process of matching algorithm, the matching algorithm is relatively simple [43].

Kejun Wang implemented *NiBlack's* method to vein image recognition and analogize the effect of *NiBlack's* method coupled with the effect of his boundary characteristic based method and came up with the results that the gradient based method has a better performance in case of the vein image [45].

Khan et al. [2009] Purposed principle component analysis (PCA), that's a successful method, which was originally applied on face biometric have been modified using Cholesky decomposition and Lanczos algorithm so as to fetch the dorsal hand vein features. This modified technique decreases the processing time by reducing the number of computation. The eigen veins were successfully computed and projected onto the vein space. The experimentation of system was done on a database of 200 images and using a threshold value of 0.9 to obtain the false acceptance rate (FAR) and false rejection rate (FRR) [46].

R.Raghavendra [2012] gave algorithm which utilizes sparse representation of Gabor features for hand vein biometric, the outcomes of the algorithm have legitimize that, the proposed method had out came as an powerful tool for accurate hand vein recognition on both clean and noisy samples [47].

Sheng et al. [2011] introduced an method which is based on two important spatial indicators, i.e. gray variance and mean gray these are studied carefully. As a result the law between the derived current by near infrared light source and the vein image scores is attained [48].

Michael et al. [2010] proposed a technique of local ridge enhancement. This technique is helpful in eliminating illumination errors while keeping good contrast between vein pattern and background image [49].

Meng *et al.*[2013] applied Fisher‘s linear discriminant method on vein patterns, which was earlier proposed by Xie *et al.* for face recognition [50].

Lakshmi Deepika [2009] Accuracy is the prime concern in a biometric identification system.Despite of the advancements in image acquisition and image processing techniques, the extent of research still being carried out in person verification and identification show that a recognition system which can offer 0% FAR and FRR is yet not a reality. Multi biometric systems are those which combine two different biometric modalities of the same biometric, to verify a person's identity are a ways of improving the accuracy of biometric system. The earlier case however requires the user to give his biometric identity two times to two different sensors. The image processing and pattern matching activities also increase nearly two fold in comparison to unimodal systems. Proposed a fusion of two different feature sets, one which extracted from the statistical features and the other from morphological features, of the same biometric template, namely the hand vein biometric. The proposed system offers the accuracy of a multimodal system but at the speed and cost of a uni modal system [51].

Rothaus [2009] purposed vascular structure of the retina comprises of two kinds of vessels: arteries and veins. Collectively these vessels make the vascular graph. This approach aims to separate arteries and veins based upon pre segmentation and a few hand labeled vessel segments. Algorithm use a rule based method to propagate the vessel labels through the vascular graph. The anatomical characteristics of the vessels on the retina are modeled as a dual constraint graph. In this algorithm embed the task as double layered constrained search problem driven by a heuristical AC-3 algorithm to overcome the NP hard computational complexity. Outcomes are represented on vascular graphs generated from automatic as well as manual segmentation [52].

CHAPTER 3

PROPOSED APPROACH

3.1 Methodology

Vein patterns have fascinated researcher's community recently, as a new way of biometric recognition. It appeared in 1990's [30] and became popular from 2000 because of some advantages over others like vascular structure is unique even identical twins don't have same pattern, vast vascular pattern underneath the person's skin, this make it difficult to get damaged and forged. Hand veins have desirable properties such as universality, uniqueness and permanence. Most important aspect of vein pattern is its social acceptance as being non invasive, contactless ease to capture trait infrared thermal imaging takes whole credit for it. There exists an increasing amount of work in the past decade, using hand vein patterns of palm part, dorsal part or finger part.[30]. Vein pattern can only be acquired from a live body. This in turn is natural and convincing proof that the person whose hand vein is eventually captured alive. Hairs present on skin don't pose a great hurdle to this technology. To acquire image we need a CCD sensor coupled with NIR imaging capabilities and its performance significantly affects the overall quality of the system. Hand vein recognition can be installed where priorities are accuracy, non contact and subject's liveliness is required. Basic methodology of hand vein recognition is shown in Fig 3.1

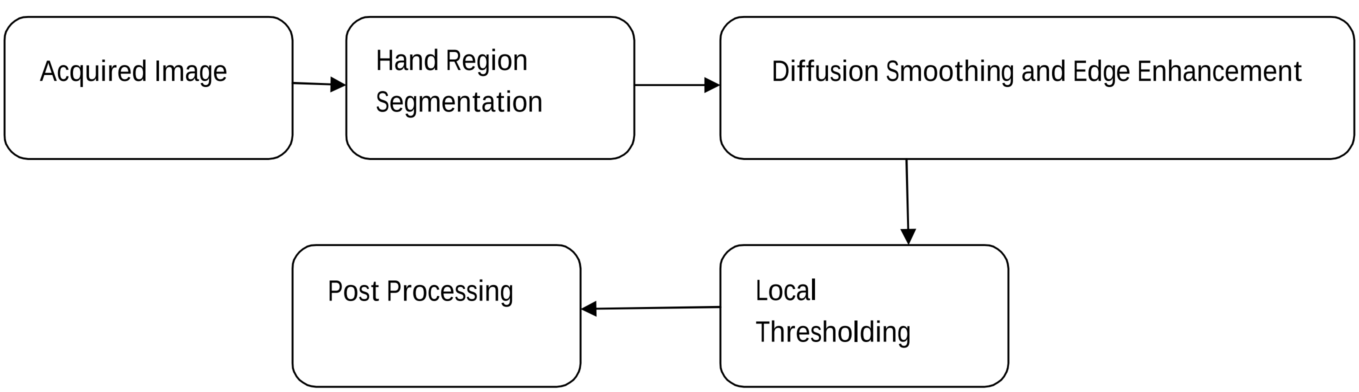


Figure 3.1: Block diagram of hand vein processing stages [25]

3.2 Hardware Requirements

The various hardware requirements for development of a hand vein based personal authentication system are as follows.

- Digital camera with NIR capabilities.
- Computer system

3.2.1 Digital Camera with NIR capabilities.

The vein image acquisition devices, shown in Fig.3.1, consist of the following parts: near infrared light source, near infrared cameras, and filters [53]. Near infrared light source is comprises of matrix of near infrared LEDs with wavelength around 760mm. CCD sensor based camera is used which is sensitive to near infrared light. The camera is also sensitive to lights with spectra outside of near-infrared. In order to obtain a high quality vein image, camera is confronted with a special infrared filter to remove the influence of other spectral light on the image details. In our work we use the PUT database by CIE available at http://biometrics.put.poznan.pl/vein-dataset

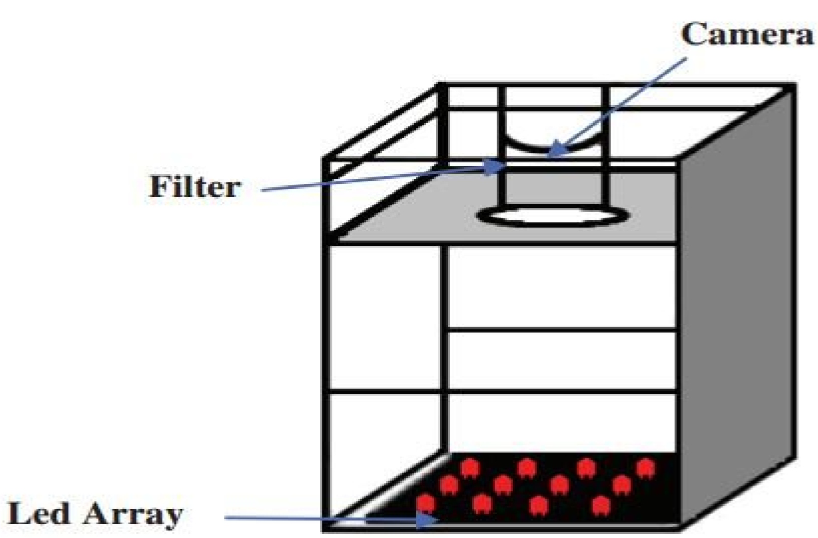


Figure 3.2: Hand vein acquisition device [53].

3.2.2 P.C

The speed of execution of verification system relies upon the computer system in which the software is to be executed. The minimum required clock frequency and RAM for the system is that enables LabVIEW to run easily. Specification of the used computer system are Intel core(TM) 2 duo 2.0 GHz clock frequency with 3 GB RAM.

3.3 LabVIEW

LabVIEW stands for Laboratory Virtual Instrument Engineering Workbench which is a system-design platform and development of virtual environment for a visual programming language from National Instruments. LabVIEW is a program generally used to automate processes and data gathering. It is basically a graphical programming language in which the user can have access to the program to manipulate and store data. Programming languages such as C and BASIC use functions and subroutines as programming elements. The advantage that LabVEIW have over its counter software's is that it uses data flow programming while others use sequential programming. It doesn't mean if it follows data flow programming it misses the advantages of sequential programming, LabVEIW have the provisions for sequential programming in its structures like sequence structure which follows the frame sequence. The IMAQ and Vision Asistant of LabVIEW software is used for hand vein recognition.

LabVIEW has two main parts : a **front panel** ,a **block diagram**.[54]

Front Panel It enables LabVEIW to interact with external and real time environments as it deals with the inputs and outputs. It enables all the controls and indicators. It contains a knob for selecting the required number of measurements, a control for selecting the measurement type, a digital indicator to display the output value, and a stop button. An elaborate front panel can be created without much effort to serve as the user interface for an application. The front panel of a VI handles the functions inputs and outputs and the code diagram performs the work of the VI. Multiple VIs can be used to create large scale applications in a single VI, in fact large scale applications may have several hundred sub VI's. A VI may be compared to the user interface or as a subroutine in an application. User interface elements are user friendly such as graphs are drag and drop easy in LabVIEW.

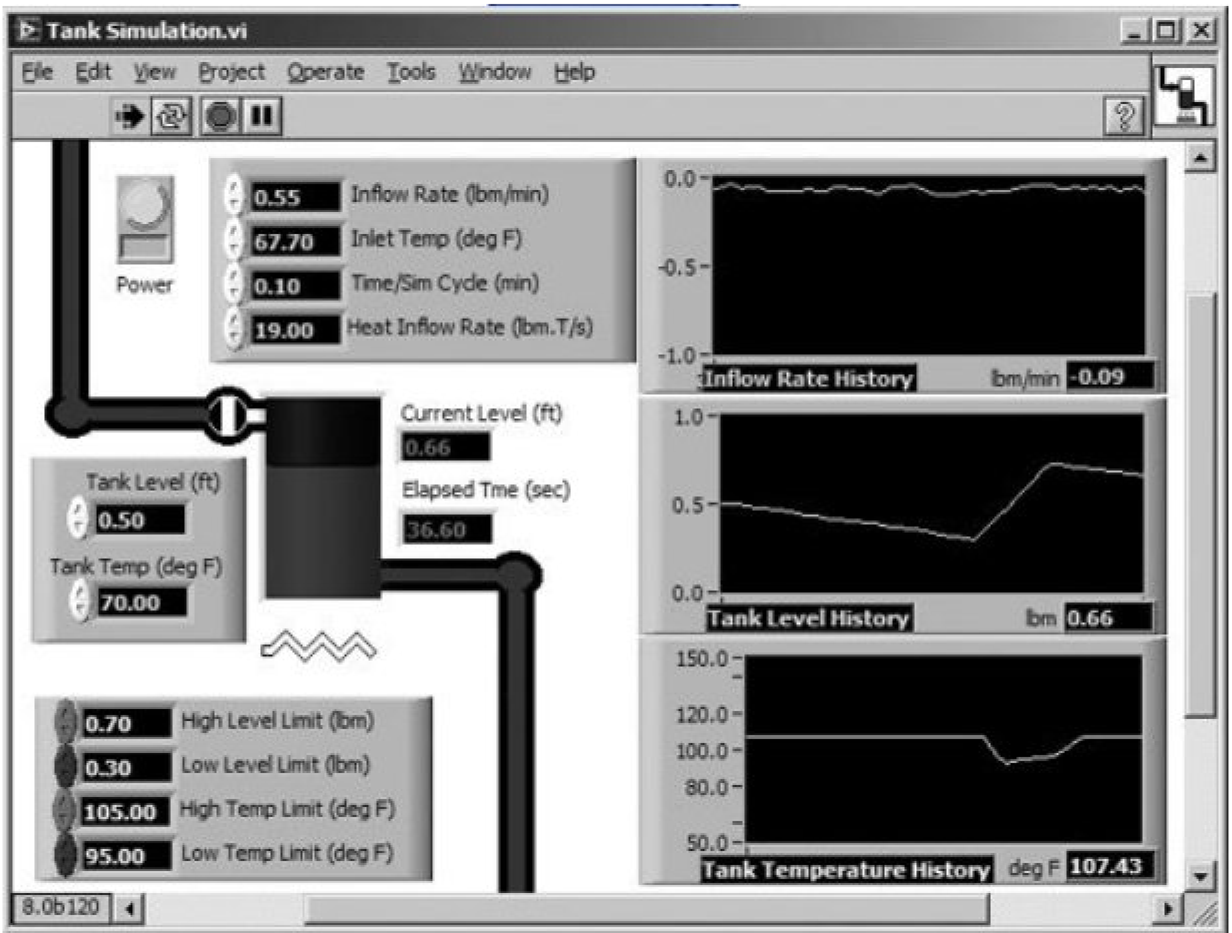


Figure 3.3: Sample front panel [54].

Block Diagram window is the used where you create the underlying code for your program. You will create the program graphically using the inputs and outputs which are already created in the front panel and objects from the functions window. All coding in LabVIEW is done on the block diagram. Various functions are inherent to aid in the development of various applications. The functions palette is there, when the block diagram window is active. LabVIEW is a programming language and uses the typical programming constructs such as loops, other structures which follows data flow programming. Block diagram is called the brain of an VI because all the coding, implementation of the algorithms is done the block diagram.

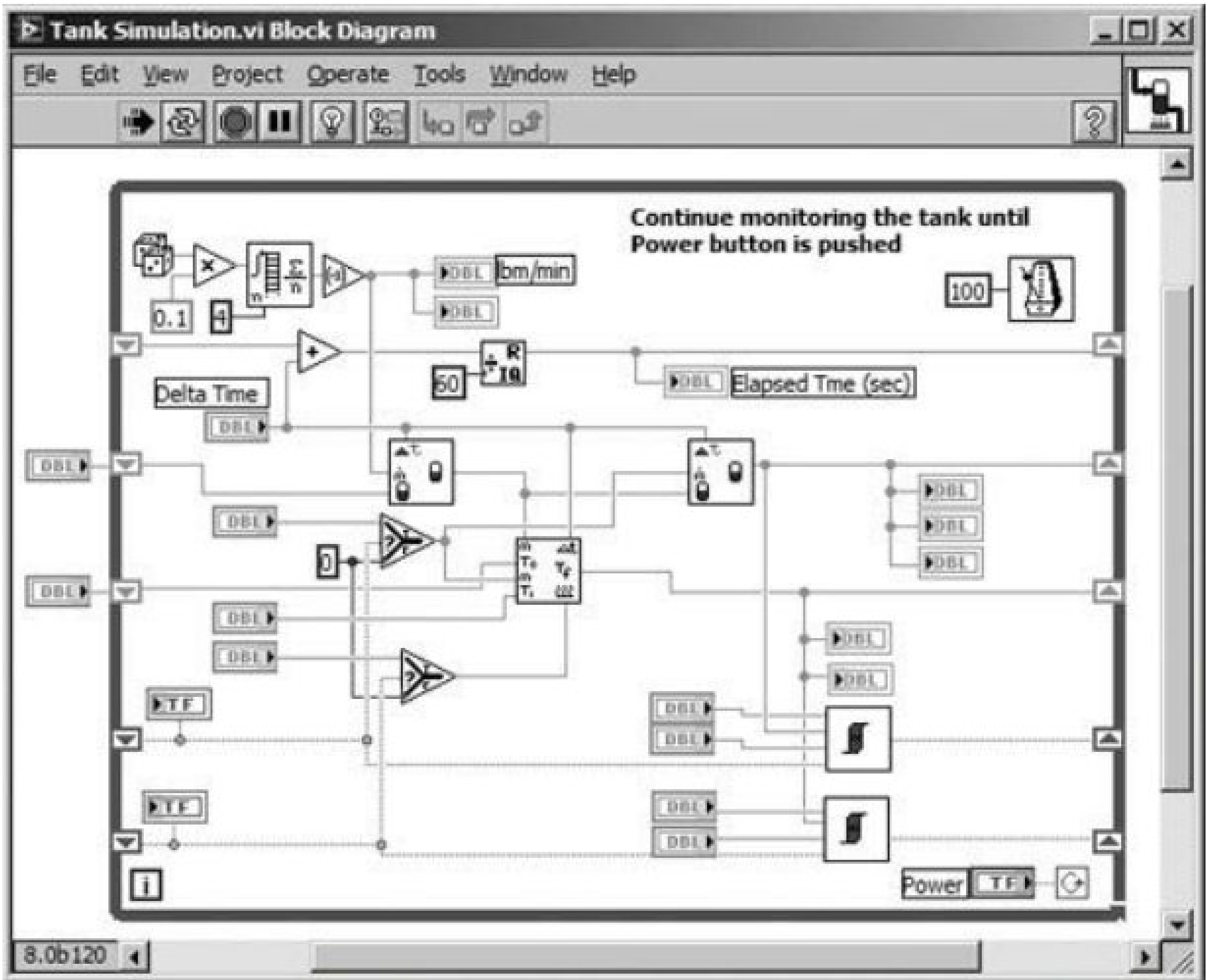


Figure 3.4: Sample block diagram [54].

3.4 Enrollment

Enrollment is the process by which new subjects are subscribed to the system. Each enrollee have to enter his/her name and password accompanied by the biometric trait, i.e. hand veins. Flow chart for the enrollment process is given in fig 3.3. Clusters are used to store the database of the users. Datalog files are faster to read and write. While designing the system care should be taken multiple users are not under a single name. If at all this occurs the system should not enroll the second time on same name and should demand for new name.

There are few steps involved in process of enrollment which are stated in the following flow chart.

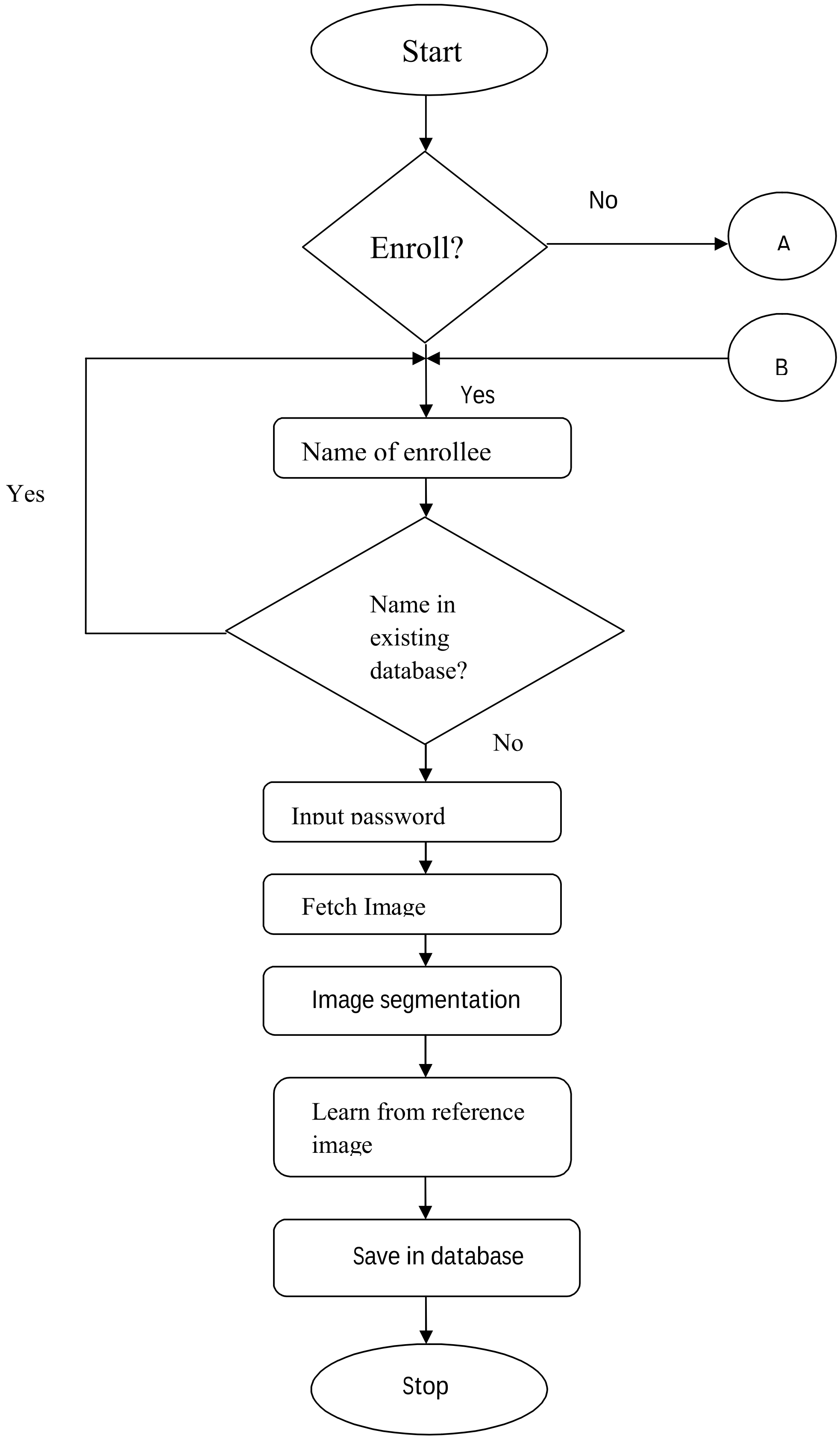


Figure 3.5: Flow chart of enrollment process [55].

3.4.1 Name and Password

When we start the enrollment process system first asks for name of the person. If the name enters is there in system, then the system asks for password else stops.

3.4.2 Image Acquisition

Thermographic camera is a device responds to the infrared radiations same as common digital camera responds to normal visible light. Thermographic cameras absorbs and process the radiations emmited by the object, called the black body radiation . Stefan boltzmann states , total energy emmited per unit area by a black body is direactly proportional to the fourth power of its thermodynamic temprature.

$E= \sigma *E*T^4$

E = Emissivity value for perfect body is 1.

T = surface temprature of object.

σ = Boltzmann constant [56].

The value of E is approximated to be 0.98 to 0.99 for human skin. [paper 7] Infrared energy operates around range of 3-14 micro meter for the human body in place of 450-750 nm range of visible light. Infrared light can impinge into tissue while venous blood absorbs more infrared light than the adjoining tissue, in result to this veins appear darker than the adjoining tissue in the captured NIR image. Vein patterns are caused due to tempature gradient in the flow of the blood under vascular arrangment. Temparture gradient is sensed by infrared thermal camera to capture underlying patterns. Nevertheless temprature gradient is largely affected by relative humidity and ambient temprature of the surrounding enviornment while capturing.

There are two types of hand veins found on the dorsum part of the hand, which are cephalic and basilic. Cluster of veins attached with surface of hand are called basilic veins and generally comprises of upper limb of the back of hand. Cluster of veins attached with the elbow of the hand are called cephalic veins . Above stated two types of hand veins and the palmar hand veins disperced in various layers of the hand and comprises of rich depth information. The spatial structure of hand veins doesnot change when the hand is rotated.

A set of 850nm NIR light source is put under the hand to illuminate both dorsal and palmar hand veins. Two near infrared sensitive CCD cameras whose optical axes tilt with a small angle are located above the hand to capture the transmission stereoscopic images of hand veins simultaneously. The small angle of two camera's optical axes is designed to get a larger optical parallax. In front of the cameras, there are two NIR bandpass filters with the center wavelength 850nm and bandwidth of 50nm. This setup is proposed by zhang et al [57] figure 3.4 illustrates this setup. Although CCD camera works in NIR light, but the visible light will pose artifacts in image capturing by attenuating the contrast ratio between hand skin and hand veins. So, the filters are used to make sure that only the NIR light which varies drastically between human tissues and blood in their absorption and reflection properties reaches the cameras.

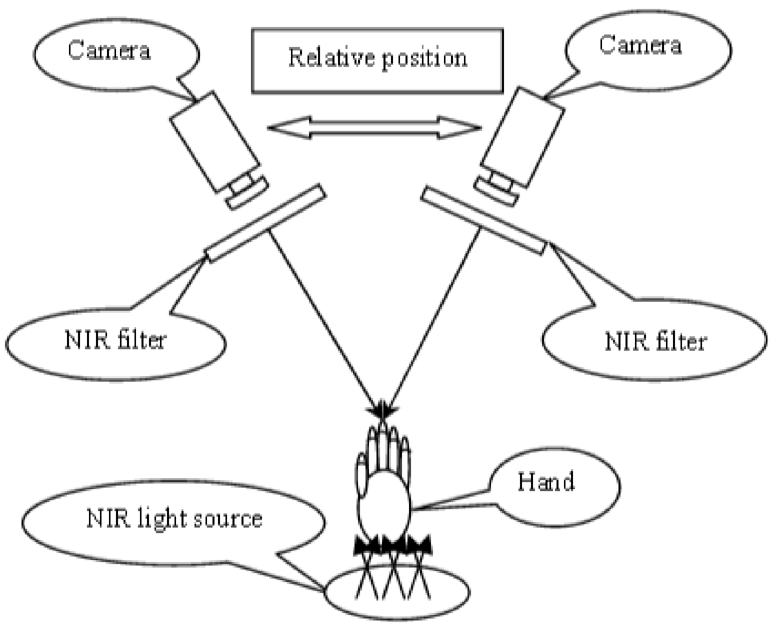


Figure 3.6: Hand vein capturing system [57].

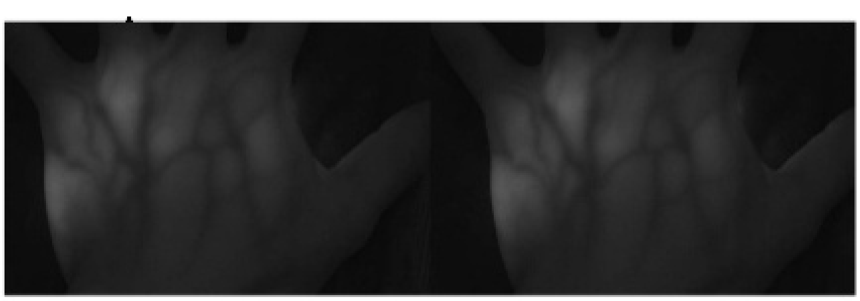


Figure 3.7: Sample of image capture by the stated system[57].

3.4.3. Image Segmentation

Images aquired are also prone artifacts . This part is also responsible for image enhancement , image segmentation, thresholding, etc . This part makes our captured image ready for feature extraction .

- Gray scale image conversion
- Image segmentation
- Image croping

Image segmentation As earlier stated there is possiblities for artifacts In order to eliminate such undesirable artifacts, a preprocessing step is performed, i.e. segmentation. Segmentation is the way to separate the foreground region (region of interest) in the image from the background image. The foreground region of an image relates to the clear biometric trait information such area containing the edges, end points, ridges, etc , which is the area of interest. The background relates to the region outside the border of the hand vein area which does not contain any valid hand vein information. So, this area can be even discarded. The segmentation is performed by calculating the variance [55]. A foreground region has a high variance value while a background region has a low one [55]. The image is fragmented into an 8 × 8 window and its variance calculated. If the variance comes out to be below a particular value then that is a background. While if that variance comes out to be above a particular value then it contains the valid biometric information. The variance k of the window of size L × K is given by :

$$\sigma^2(n) = \frac{1}{LK}\sum_{i=0}^{L-1}\sum_{j=0}^{K-1}\left(I(i,j) - M(n)\right)^2$$

Image thresholding: Thresholding is one of the easiest method of image segmentation from a grayscale image. Thresholding in can be used to create binary images. Step before doing thresholding is to transform the RGB image into a grayscale image. A red, green and blue (RGB) value of each pixel is extracted. Since a monochromatic image is required for the threshold to be determined. All pixels values in grayscale image which are above the threshold are considered white pixels and all other pixels values which are below the threshold are considered black pixels. This method gives an output as thresholding image T(x,y) which is of the same dimensions as to that of the original image I(x,y), and then does the segmentation of the original image by the thresholding image. Given N points around every pixel (x,y), the thresholding image T(x,y) is decided by the mean of N gray scale values among the center of pixel (x,y)[Y 23 grad].

$$\begin{cases} I(x,y) = 0, I(x,y) \geq T(x,y) \\ I(x,y) = 255, I(x,y) < T(x,y) \end{cases}$$

This method is takes lesser time but the threshold is the local mean, which cannot seprate the vein image and dark background effectively. Moreover, this method must carry on the specific regions wise of hand dorsa vein image, otherwise the edges can cause failure of segmentation. The figure below depicts the failue by simple thresholding image.

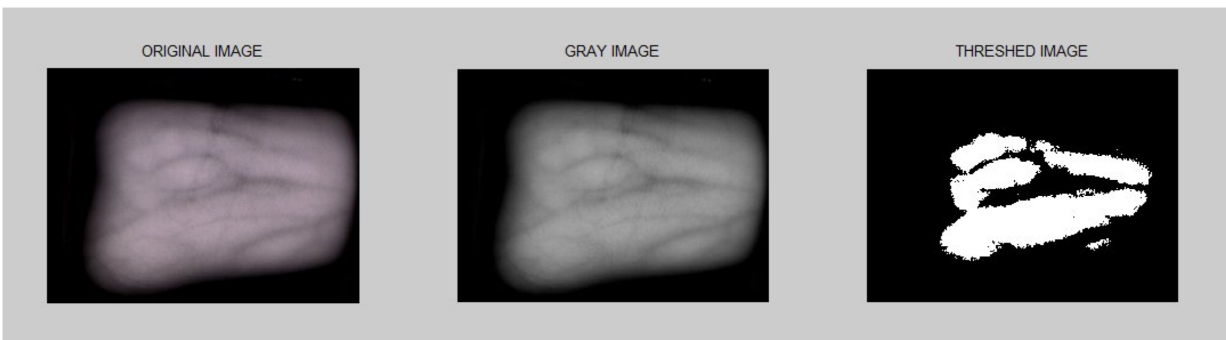


Figure 3.8: Failure of conventional thresholding.

As its very clear from image veins in lower part of image are totally missed. While whatever the part it catches of veins is not perfect. Irresptive of depicting veins shows clumps. To overcome this problem we should do thresholding regionwise with different value of thresholding in every region. Still its not effective because threshold values of every region for different images will be different to get proper results. We also deduced a method to over come this problem. In that approach we used canny edge detector to get edges. Results of canny edge detector were points depecting edges , number of these points vary by varying parameters of canny edge detector. Next step to this is we did dilation to get the perfect edges. Figure below depicts our results.

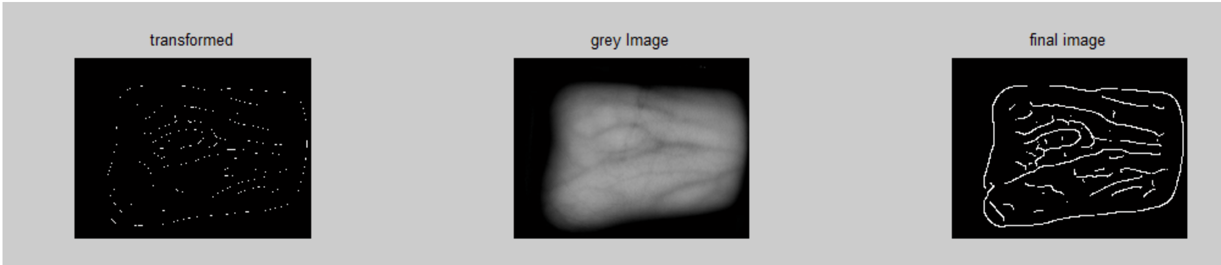


Figure 3.9 Results with canny edge detector.

3.4.4 Hand Vein Feature Extraction

Now from earlier segmented image a biometric template is extracted. The accuracy of the system relies upon the size of the extracted template . If the size of the template beeing too small then the template may not provide enough dissimmilarity on the other side if the entire hand vein image is taken as a template then the elastic deformation of the that image may cause serious errors. Our experiments have been conducted by considering the template sizes of 50 by 50, 100 by 100 and 200 by 200 pixels taken from the centre of the image. The extracted template is input to the image acquisition (IMAQ) learn pattern virtual instrument (VI). This VI generates a description of the template of the reference image that is to be compared with the data of the query image during the matching stage. In the learning phase a pseudo random sub sampling is performed in which pixels are analysed by checking their surrounding neighborhood for uniformity and each pixel is classified according to how large the uniformity of its surrounding neighborhood is (e.g. 3 by 3, 5 by 5 and so on)[sir paper]. With this step amount of calculations will be reduced at the matching stage. The extraction of features of the reference image is done using the edge detection operation and the resultant outcome is stored in a file as information along with the circular intensity profile of the reference image used in finding the rotated version of the image in the query image. In need to extract geometric features of the hand vein it is required that the image contains only edges. Edges stands for the points where there is a boundary (or an edge) between two image regions . Generally, there is possibility that an edge can be of almost arbitrary shape, and can even comprises of junctions. Edges can be described as sets of points in the image which have a strong gradient magnitude. Edge detection is the process of localizing pixel intensity transitions. At an edge there is a sharp change in intensity of an image. The process of edge detection of an image considerably bring reduction in the amount of data and also filters out useless information, without compromising on important structural properties in an image. This makes edge detection is one of the vital part of image preprocessing. Some of the edge detection methods like canny,prewitt, roberts and sobel, laplacian, log [59]. The connected source image must have been created with a border capable of supporting the size of the processing matrix. To make sure whether a variation in the pixel values is eligible to be considered as an edge or not threshold parameters are used. Threshold level around 100 to 255 is chosen. This threshold value relies upon the pixel grayscale intensity. It is capable of computing the location of the edges with accuracy in sub pixel.

3.4.5. Matching

Identity of a user is established in matching stage. Features extracted in the above stated stages are compared with the feature set already stored in the database in need of establish the identity of the hand vein. Matching process involves the generation of a match score by comparing the feature sets concerned to two hand vein images. In simple words matching score indicative of the degree of similarity between two hand vein images. In one to many identification it is done against the entire database but in one to one verification, comparison is done only against the template of the person calimimg the identity.

As the case of verification is just a subset of the identification case, so we get concerned to verification only. The computed match score(s) in the matching module ensures the decision. In the verification mode , the output is simply a “yes” or a “no”, whereas “yes” implies a genuine match and “no” indicating an imposter[3]. In the identification mode of operation, the output is a catalogue of potential matching identities sorted according to their matching scores.

3.4.6 Decision

When results of matching algorithm are available , a recognition decision is made whether to accept or reject the best match found. If in case matching score exceeds value of a predefined threshold, then that attempt of recognition is considered as an impostor access, else the attempt of recognition is considered a valid access and the system assumes the user has been rightly identified.

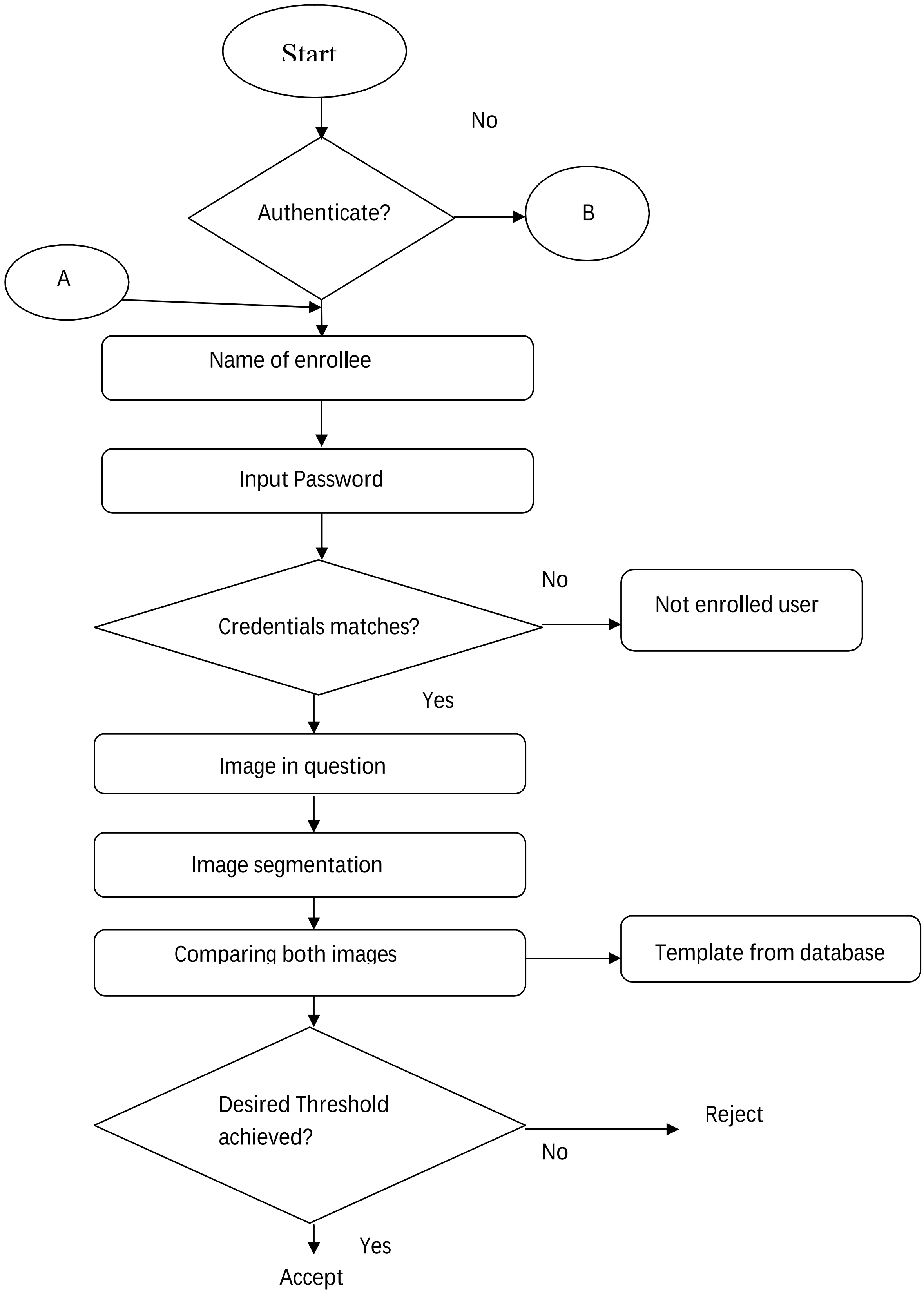


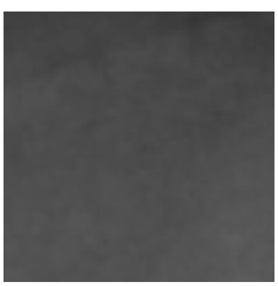
Figure 3.10: Flow chart of verification mode [55].

CHAPTER 4

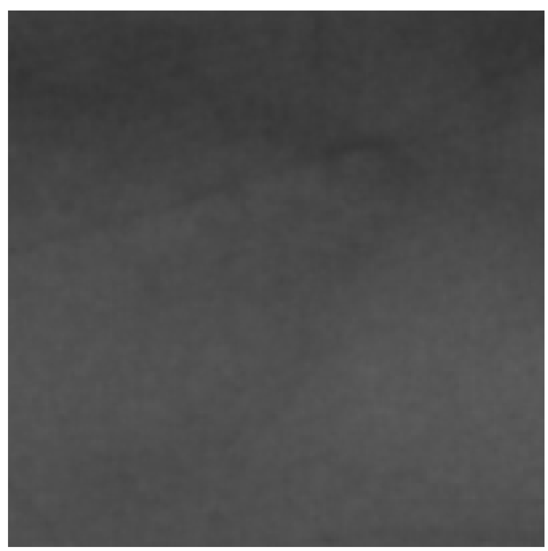
RESULTS AND DISCUSSIONS

4.1 Results

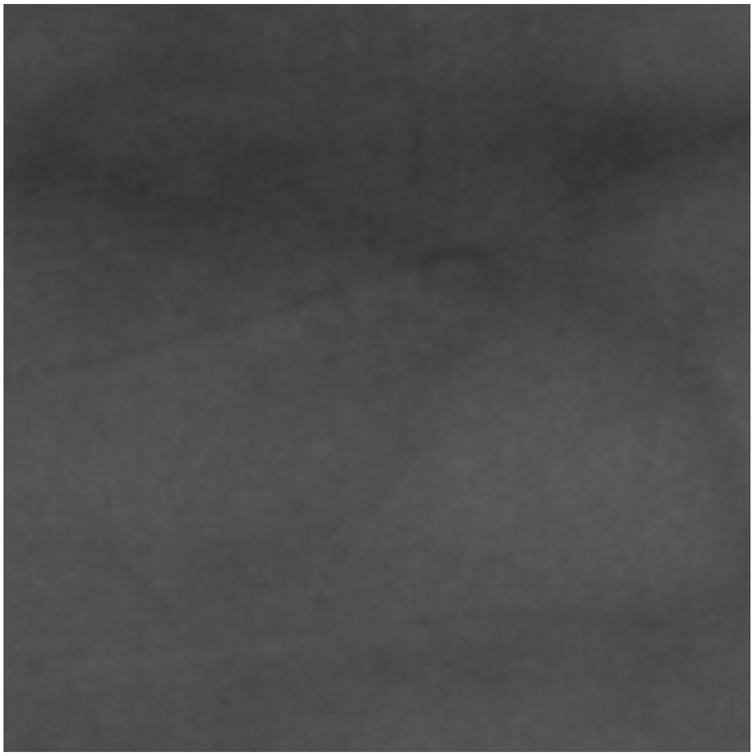
In the present work an image based algorithm for hand vein verification has been discussed. The proposed algorithm has been implemented using LabVIEW (Laboratory Virtual Instrument Engineering Workbench) 6i software. In the present work the hand vein images from PUT database by CIE available at http://biometrics.put.poznan.pl/vein-dataset has been used to obtain the results. False rejection rate (FRR) and false acceptance rate (FAR) have been computed so as to inspect the performance parameters for various images under comparison with different thresholds values and window sizes. Experiments were carried out taking into consideration template size of 100 × 100, 200 × 200 and 300 × 300 pixels which were extracted with respect to the centre of the image. Figure 4.1 shows the extracted images of template size 100 × 100, 200 × 200 and 300 × 300 pixels respectively.



a



b



c

Figure 4.1: Template size of (a) 100 × 100 pixels,(b) 200 × 200 pixels, and (c) 300 × 300 pixels

System presented here asks for demonstration image from which ROI is taken for reference. As shown in figure 4.2 which shows front panel of the system.

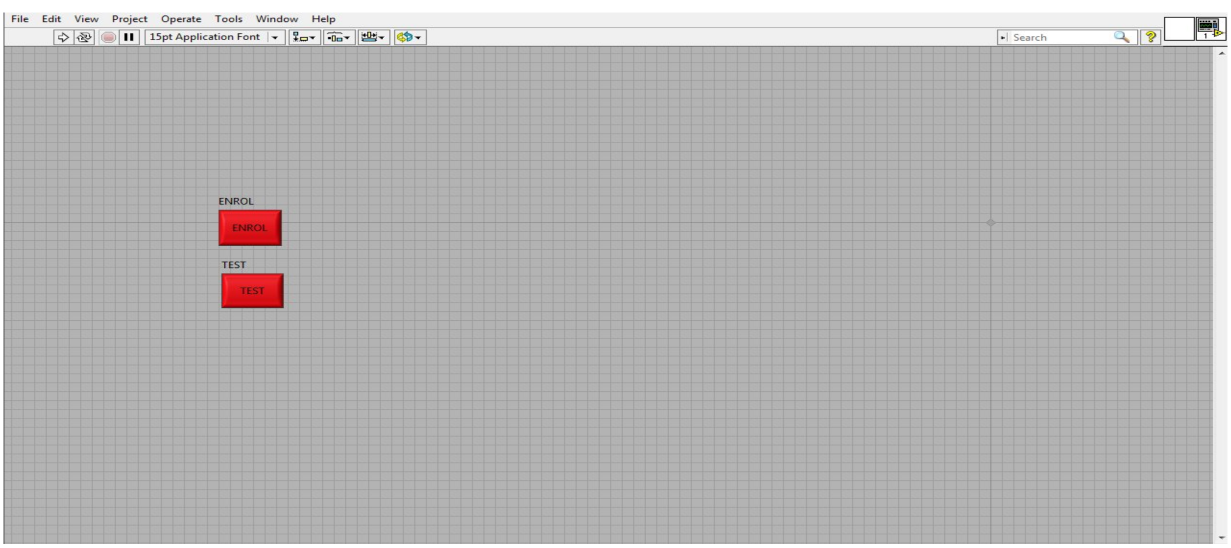


Figure 4.2: Front panel of the system.

System firstly asks for enrollment or test and does the necessary action accordingly. Given below is figure depicting part of block diagram enabling this feature.

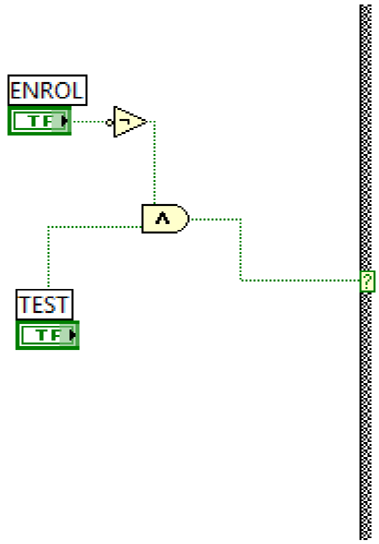


Figure 4.3: Block diagram enabling enroll or test.

Now two cases arises either to enroll or to test. Figures below depicts the block diagrams in parts depicting the entire enrollment process. Firstly, system asks for name as shown by its block diagram.

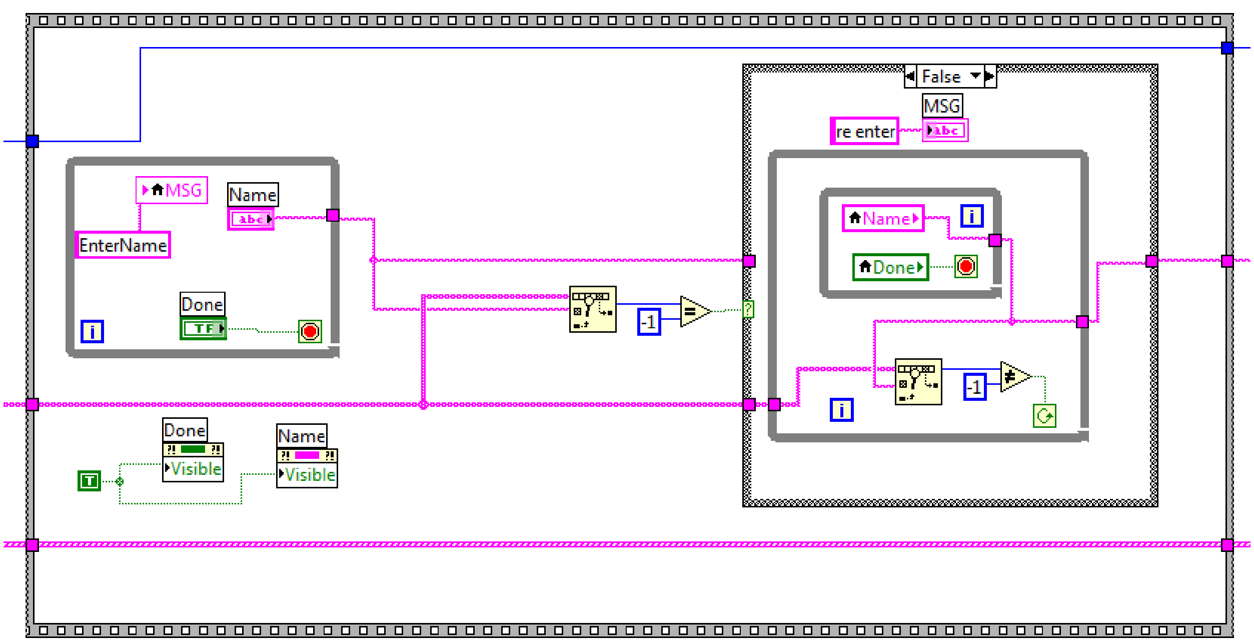


Figure 4.4: Saving enrollee's name.

After saving name it asks for password and saves it. Figure below depicts block diagram

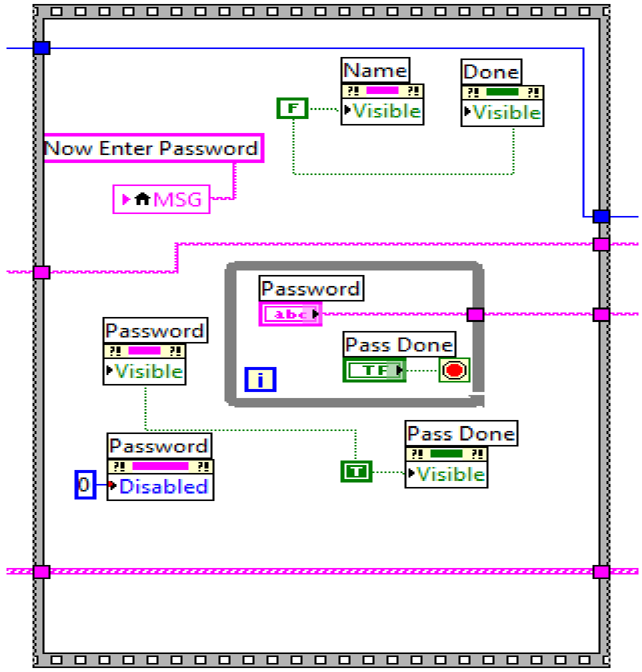


Figure 4.5: Saving enrollee's password.

Now system asks for the reference image and saves it to database . Figure below depicts its block diagram

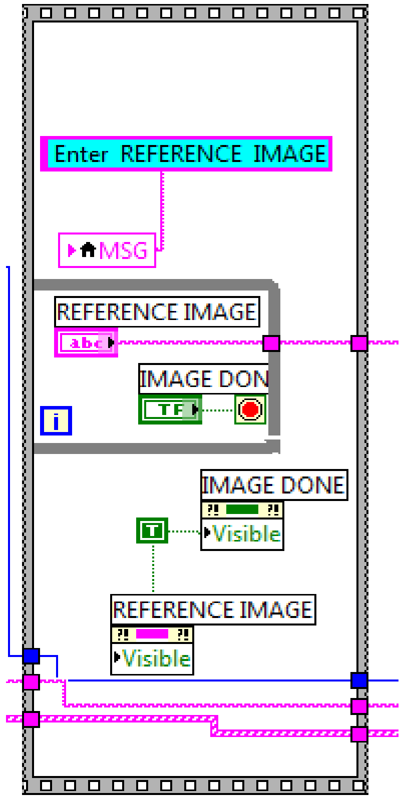


Figure 4.6: Saving reference image.

After saving the reference image system learns from the image. Biometric template is created and its saved so that it can be used in part where system is used in test mode. Figure below depicts the block diagram of learning process.

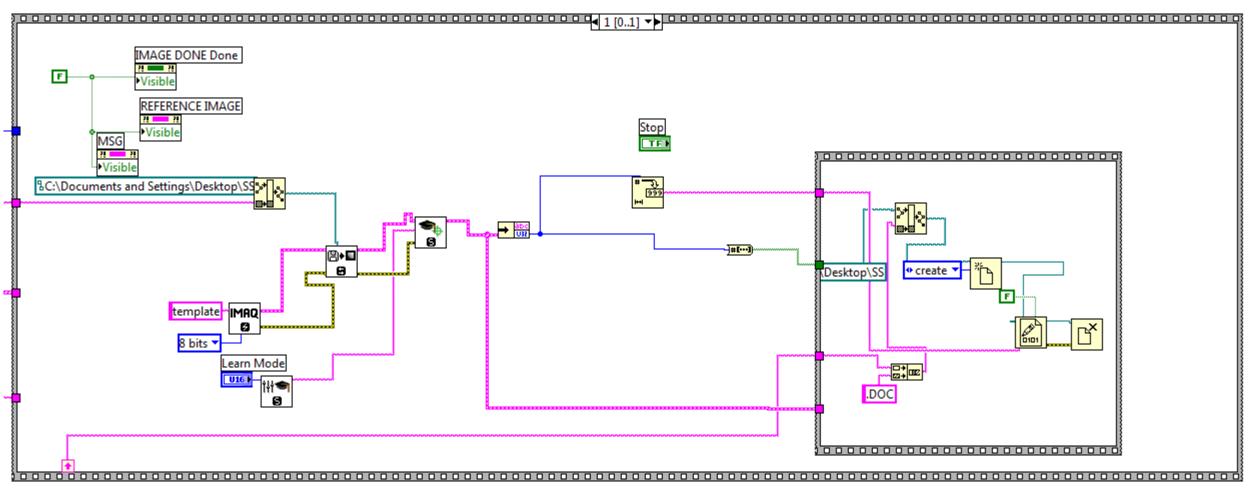


Figure 4.7: Learning process block diagram.

When the system is used in test mode. System does ask for name and password. After verifying name and passwords system asks for test image. Then the matching process is done to give scores.

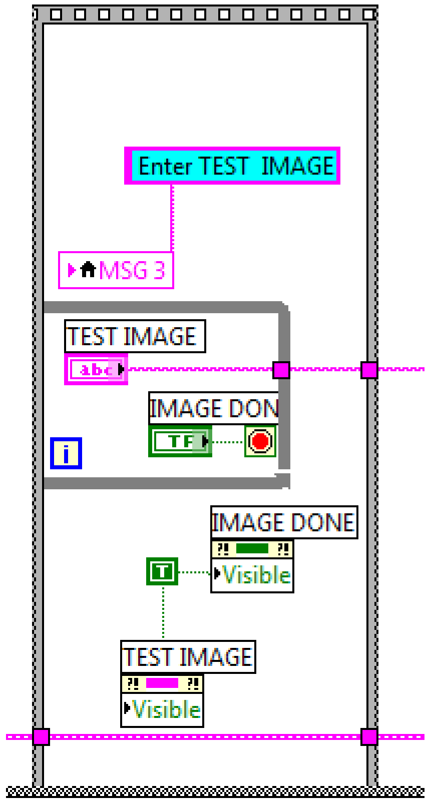


Figure 4.8: System reading test image.

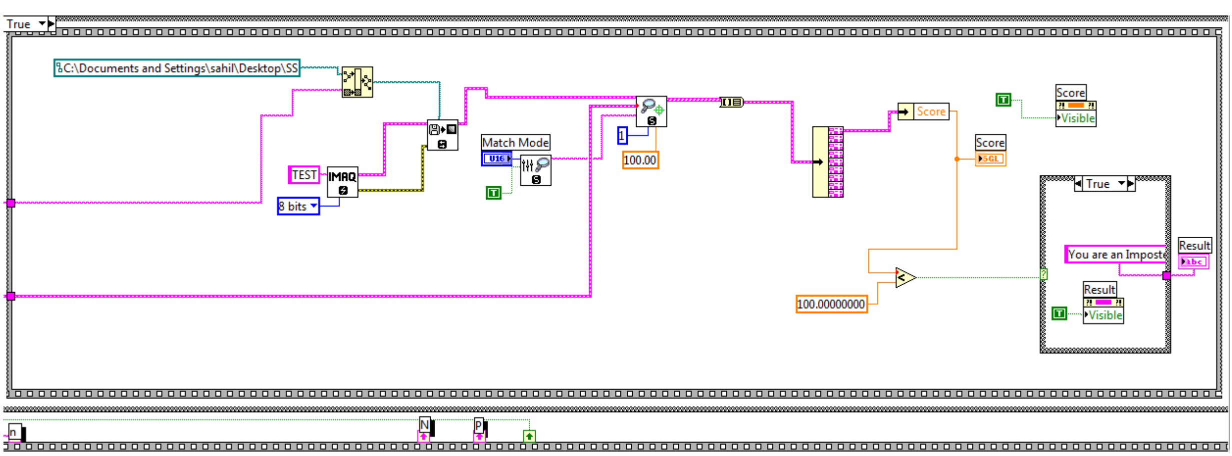


Figure 4.9 Matching process.

False rejection rate (FRR)

In this work 24 subjects are considered from PUT database by CIE available at http://biometrics.put.poznan.pl/vein-dataset, each subject having 12 images sample.FRR is computed for this database with different templates of size 100 × 100, 200 ×200, 300 × 300. Following results are obtained

Table 4.1: FRR for learning images, size 100 × 100 pixels.

Threshold	Image No.									
	A1-1	A2-2	A3-3	A4-4	A5-5	A6_6	A7-7	A8-8	A9-9	A10-10	A11-11
700	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
750	0%	0%	0%	0%	9.09%	0%	0%	0%	0%	0%	0%
800	0%	0%	0%	0%	18.1%	0%	0%	0%	0%	0%	0%
850	0%	0%	72.7%	0%	36.6%	0%	0%	0%	100%	54.5%	18.18%
900	0%	0%	81.8%	18.1%	72.2%	63.6%	100%	0%	100%	100%	100%
950	90.9%	63.6%	100%	72.7%	100%	100%	100%	81.8%	100%	100%	100%

Table 4.2: FRR for learning images size 100 × 100pixels.

Threshold	Image No.												
	A12-12	A13-13	A14-14	A15-15	A16-16	A17-17	A18-18	A19-19	A20-20	A21-21	A22-22	A23-23	A24-24
700	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
750	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
800	0%	0%	0%	0%	9.09%	0%	27.2%	0%	0%	0%	45.4%	0%	0%
850	27.2%	0%	0%	0%	27.2%	54.5%	54.5%	0%	0%	0%	100%	90.9%	27.2%
900	100%	0%	0%	0%	36.3%	100%	90.9%	0%	0%	0%	100%	100%	36.3%
950	100%	0%	0%	0%	54.5%	100%	100%	100%	0%	45.4%	100%	100%	100%

Table 4.3: FRR for learning image size 200 × 200 pixels.

Threshold	Image No.											
	A1-1	A2-2	A3-3	A4-4	A5-5	A6-6	A7-7	A8-8	A9-9	A10-10	A11-11	A12-12
700	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
750	0%	0%	0%	0%	9.09%	0%	0%	0%	0%	0%	0%	0%
800	0%	0%	0%	0%	18.1%	0%	36.3%	0%	18.1%	0%	18.1%	27.2%
850	0%	0%	0%	0%	36.3%	0%	54.5%	0%	63.6%	0%	27.2%	45.4%
900	0%	0%	72.7%	27.2%	72.7%	0%	72.7%	0%	100%	18.1%	63.6%	90.9%
950	90.9%	72.7%	90.9%	72.7%	100%	100%	100%	0%	100%	27.2%	100%	100%

Table 4.4: FRR for learning images size 200 × 200 pixels.

Threshold	Image No.											
	A13-13	A14-14	A15-15	A16-16	A17-17	A18-18	A19-19	A20-20	A21-21	A22-22	A23-23	A24-24
700	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
750	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
800	0%	0%	0%	0%	0%	0%	0%	0%	0%	54.5%	27.2%	0%
850	0%	0%	0%	0%	63.6%	0%	0%	0%	0%	100%	90.9%	36.3%
900	0%	0%	0%	27.2%	100%	9.09%	54.5%	0%	0%	100%	100%	54.5%
950	36.3%	0%	0%	36.3%	100%	45.4%	72.7%	36.3%	36.3%	100%	100%	100%

Table 4.5: FRR for learning images size 300 × 300 pixels.

Threshold	Image No.											
	A1-1	A2-2	A3-3	A4-4	A5-5	A6-6	A7-7	A8-8	A9-9	A10-10	A11-11	A12-12
700	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
750	0%	0%	0%	0%	0%	0%	18.1%	0%	0%	0%	0%	0%
800	0%	0%	0%	0%	9.09%	0%	36.3%	0%	27.2%	0%	0%	27.2%
850	0%	0%	9.09%	0%	9.09%	18.1%	36.3%	27.2%	63.6%	18.1%	18.1%	36.3%
900	36.3%	0%	36.3%	54.5%	27.2%	72.7%	63.6%	72.7%	100%	27.27%	36.3%	54.5%
950	100%	72.7%	90.9%	90.9%	72.7%	90.9%	90.9%	72.7%	100%	63.6%	72.7%	90.9%

Table 4.6: FRR for learning images size 300 × 300 pixels.

Threshold	Image No.											
	A13-13	A14-14	A15-15	A16-16	A17-17	A18-18	A19-19	A20-20	A21-21	A22-22	A23-23	A24-24
700	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
750	0%	0%	0%	0%	0%	0%	0%	0%	0%	9.09%	0%	0%
800	18.1%	0%	0%	0%	9.09%	0%	9.09%	9.09%	0%	54.5%	54.5%	9.09%
850	27.2%	0%	0%	0%	63.6%	0%	36.3%	36.3%	27.2%	100%	90.9%	36.3%
900	27.2%	0%	0%	36.3%	100%	36.3%	63.6%	63.6%	45.4%	100%	100%	54.5%
950	90.9%	27	0%	54.5%	100%	90.9%	72.7%	72.7%	72.7%	100%	100%	100%

Table 4.7: Consolidated table for FRR.

Threshold	Learning image		
	100 × 100	200 × 200	300 × 300
700	0%	0%	0%
750	0.3%	0.3%	1.1%
800	4.1%	8.3%	10.9%
850	27.6%	21.5%	27.2%
900	50%	39.7%	50.3%
950	75.3%	67.4%	82.5%

False acceptance rate(FAR)

In this we took images of 25 subjects from PUT database by CIE available at http://biometrics.put.poznan.pl/vein-dataset. Now new set of images is formed to do computations, like set one contains first image sample out of 12 image sample per subject, second contains second image sample of every subject and so on. Template size is taken as 300 × 300 in this case and the following results are obtained.

Table 4.8: FAR for learning images, size 300 × 300 pixels.

Threshold	Image No.											
	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12
700	24%	16%	20%	24%	40%	32%	28%	28%	32%	48%	36%	40%
750	4%	8%	8%	4%	16%	16%	12%	12%	0%	0%	4%	28%
800	0%	0%	0%	0%	4%	4%	0%	4%	0%	0%	0%	0%
850	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
900	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
950	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

From tables 4.7 we can say that when the template size was smaller the errors were also small, but it got increased with increase in the template size. Same is the case with thresholding value as it increases it brings the increase in the error. Maximum error was obtained when template size was 300 × 300 pixels and threshold value is 950. Template with 200 × 200 showed best results. Template 100 × 100 and 200 × 200 showed smaller template size is better for better results. Larger size of templates as in case 300 × 300 shows more errors. Zero error was obtained with threshold value 700 for all templates sizes under experiment. For threshold value 750 maximum error obtained was 1.1% i.e. for 300 × 300 template size. While 100 × 100 and 200 × 200 template size showed error of 0.3 % for 750 threshold value. With threshold value of 800 maximum error was obtained to be 10.9% i.e. for template size of 300 × 300. With further increase of threshold value the error kept increasing.

5.2 Future Scope

Although this system works fine but problems can be there when rotation, translation, etc is there. This can cause serious errors thus future improvements proposed are:

- Translating the images in both X and Y direction.
- Rotating the fingerprint images.
- Both translating and rotating the images.
- Template image in this case is taken directly from centre of image. It's proposed that from image, area containing biometric information should be extracted by removing background. Now from obtained image template should be taken from centre.

References

1. Woodward J.D.," Biometrics: privacy's foe or privacy's friend?", Proceedings of the IEEE (Volume:85 , Issue: 9), Sep 1997, 1480-1492

2. Anil K. Jain, Arun Ross and Salil Prabhakar**,** "An Introduction to Biometric Recognition", Appeared in IEEE Transactions on Circuits and Systems for Video Technology, Special Issue on Image- and Video-Based Biometrics, Vol. 14, No. 1, January 2004

3. Block diagram of biometrics available at http://commons.wikimedia.org/wiki/File:Biometric_system_diagram.png

4. Necla Ozkaya, Seref Sagiroglu, Arif Wani, "An Intelligent Automatic Fingerprint Recognition System Design," icmla, pp.231-238, Fifth International Conference on Machine Learning and Applications (ICMLA'06), 2006.

5. Anil K. Jain, Sharath Pankanti, Salil Prabhakar, Lin Hong, Arun Ross, James L. Wayman, "Biometrics: A Grand Challenge". Pattern Recognition, 2004. ICPR 2004. Proceedings of the 17th International Conference on (Volume:2) 23-26 Aug. 2004,935 - 942 Vol.

6. Anil Jain, Lin Hong, and Sharath Pankanti, "Biometric Identification"**.** Magazine Communications of the ACM CACM Homepage archive Volume 43 Issue 2, Feb. 2000, 90-98.

7. Anil Jain, Lin Hong, and Sharath Pankanti, "Biometric Identification**".** February 2000/Vol. 43, No. 2 Communications of the ACM , 91-98.

8. Norman Poha, Ajita Rattani and Fabio Roli, "Critical Analysis of Adaptive Biometric Systems". December 18, 2012.

9. Radu Leca, Voicu Groza , "Online personal identification Agent**".** Measurement Systems for Homeland Security, Contraband Detection and Personal Safety Workshop, 2005. (IMS 2005) Proceedings of the 2005 IEEE International Workshop on 29-30 March 2005, 17-20.

10. Kresimir Delac , Mislav Grgic, "A survey of biometrics recognition methods" Electronics in Marine, 2004. Proceedings Elmar 2004. 46th International

Symposium 18-18 June 2004, 184 - 193

11. Face recognition available at: http://en.wikipedia.org/wiki/Facial_recognition_system

12. Pin Shen Teh, Shigang Yue and Andrew B.J. Teoh, “Improving Keystroke Dynamics Authentication System Via Multiple Feature Fusion Scheme”. Cyber Security, Cyber Warfare and Digital Forensic (CyberSec), 2012 International Conference on 26-28 June 2012, 277 - 282.

13. Face feature image available at: http://www.ubuntubuzz.com/2011/05/face-authentication-face-recognition.html

14. Siddhesh Angle, Reema Bhagtani, Hemali Chheda, ”Biometrics : A further echelon of security” available at http://researchweb.iiit.ac.in/~vandana/PAPERS/BASIC/types_biometric.pdf.

15. Adler, F.H., Physiology of the Eye (Chapter VI, page 143), Mosby (1953)

16. https://portal.uidai.gov.in/

17. Richard P. Wildes, Jane C. Asmuth, Keith J. Hanna, Stephen C. Hsu, Raymond J. Kolczynski, James R. Matey, Sterling E. McBride “Automated, non-invasive iris recognition system and method” U.S. Patent 5572596, 1996.

18. Wildes, R.P, “Iris recognition: an emerging biometric technology”, Proceedings of the IEEE Volume: 85, Issue: 9 Digital Object Identifier: 10.1109/5.628669 (1997).

19. John G. Daugman, “Biometric personal identification system based on iris analysis”, US 5291560 A, 1994.

20. S.sanderson and J.H. Erbetta, “Authentication for secure environments based on Iris scan technology” Visual Biometrics (Ref.No. 2000/018), IEE Colloquium on 2000,8/1 - 8/7

21. J. P. Holmes, L. J. Wright, and R. L. Maxwell, “A performance evaluation of biometric identification devices” Sandia National Laboratories, Albuquerque, NM, Tech. Rep. SAND91-0276,1991

22. L. Flom and A. Safir, “Iris recognition system”,U.S. Patent, 4 641 349, 1987.

23. Xu JIA, Jianjiang CUI, Dingyu XUE, Feng PAN, “A Adaptive Dorsal Hand Vein Recognition Algorithm Based on Optimized HMM”. Journal of

Computational Information Systems 8: 1 (2012) 313–322.

24. Ishani Sarkar, Farkhod Alisherov, Tai hoon Kim and Debnath Bhattacharyya,"Palm Vein Authentication System: A Review". International Journal of Control and Automation Vol. 3, No. 1, March, 2010, 27-34.

25. Peter N. Belhumeur, Joao,P. Hespanha, and David J. Kriegman. Eigenfaces vs Fisherfaces: Recognition Using Class Specific Linear Projection.

26. Nishant Singh, Kamlesh Tiwari, Aditya Nigam and Phalguni gupta, "Fusion of 4-Slap Fingerprint Images with Their Qualities for Human Recognition". Information and Communication Technologies (WICT), 2012 World Congress on Oct. 30 2012-Nov. 2 2012, 925-930

27. Sahoo, SoyujKumar, Mahadeva Prasanna, SR, Choubisa, Tarun, "Multimodal Biometric Person Authentication : A Review". IETE Technical Review (Impact Factor: 0.71). 02/2012; 29(1):54-75

28. Amine nait ali, "Beyond classical biometrics: When using hidden biometrics to identify individuals". Euvip 2011 IEEE, 241-246.

29. Yinhang Tang, Di Huang, Yunhong Wang,"Hand dorsa vein recognition based on multi level keypoint detection and local feature matching". 21st international conference on pattern recognition (ICPR 2012) november 11-15, 2012. Tsukuba, Japan, 2837-2840.

30. K. Premalatha, T. Anantha kumar, and A.M. Natarajan "A dorsal hand vein recognition based on local gabor phase quantization with whitening transformation", Defence Science Journal, Vol. 64, No. 2, March 2014, pp. 159-167, DOI 10.14429/dsj.64.4659 2014, DESIDOC.

31. J.M. cross, J.L. smith,"Thermographic imaging of the subcutaneous vascular network of the back of the hand for biometric identification". 0-7803-2627-X/95 $4.00, 20-35.

32. Sang kyun Im, Hyung man park, Young woo kim, Sang chan han, Soo won kim and Chul hee kang,"An biometric identification system by extracting hand vein patterns". Journal of the Korean Physical Society, Vol. 38, No. 3, March 2001, pp. 268-272.

33. Sang Kyun Im, Hwan Soo Choi, and Soo-Won Kim," A direction based

vascular pattern extraction algorithm for hand vascular pattern verification". ETRI Journal, Volume 25, Number 2, April 2003, 101-108

34. Nabila Bouzida, Abdel Hakim Bendada, Jean Marc Piau, Moulay Akhloufi, Xavier Maldague, Mathieu Raymond," Using lock in infrared thermography for the visualization of the hand vascular tree" Proc. of SPIE Vol. 6939 69390O-1.

35. Yiding Wang, Kefeng Li, Jiali Cui," Hand dorsa vein recognition based on partition local binary pattern". ICSP 2010 proceedings,1671-1674.

36. Yiding Wang, Kefeng Li, Lik Kwan Shark, Martin R Varley," Hand dorsa Vein Recognition Based on Coded and Weighted Partition Local Binary Patterns". 978-1-4577-0490-1/11/$26.00 ©2011 IEEE.

37. Ajay Kumar and K. Venkata Prathyusha," Personal authentication using hand vein triangulation and knuckle shape". IEEE Transactions on image processing, vol. 18, No. 9, SEPTEMBER 2009, 2127-2136.

38. Toshiyuki Tanaka, Naohiko Kubo," Biometric Authentication by Hand Vein Patterns". SICE Annual Conference in Sapporo, August 4-6,2004 Hokkaido Institute of Tecnology, Japan.

39. Tim Ojala, Matti Pietikhen, and David Harwood," Performance evaluation of texture measures with classification based on kullback discrimination of distributions". 1051-4651/94 $04.00 1994 IEEE, 582-585.

40. Qishen Zhang, Ya Zhou, Danting Wang Xiaoming Hu," Personal authentication using hand vein and knuckle shape point cloud matching". Biometrics: Theory, Applications and Systems (BTAS), 2013 IEEE Sixth International Conference on Sept. 29 2013-Oct. 2 2013, 1 – 6.

41. Timo Ojala, Matti PietikaÈinen and Topi Ma ÈenpaÈa," Multiresolution gray scale and rotation invariant texture classification with local binary patterns". IEEE Transaction on pattern analysis and machine intelligence, vol. 24, No. 7, july 2002, 971-987.

42. Mohamed Shahin, Ahmed Badawi, and Mohamed Kamel," Biometric authentication using fast correlation of near infrared hand vein patterns". World academy of science, engineering and technology Vol:2 2008-01-

26,756-763.

43. B. Zhang, Y. Gao, S. Zhao, and J. Liu. Local derivative pattern versus local binary pattern: Face recognition with high order local pattern descriptor. IEEE transactions on image processing, 19(2):533 -544, 2010.

44. Yiding Wang Hai Wang," Gradient based image segmentation for vein pattern". 2009 fourth international conference on computer sciences and convergence information technology,1614-1618.

45. Maleika Heenaye Mamode Khan , Naushad Mamode Khan and Raja K.Subramanian," Feature extraction of dorsal hand vein pattern using a fast modified PCA algorithm based on cholesky decomposition and lanczos technique". World academy of science, engineering and technology Vol:4 2010-01-22, 235-238.

46. R.Raghavendra," Sparse representation for accurate person recognition using hand vein biometrics". 2012 Eighth International Conference on intelligent information hiding and multimedia signal processing, 41 – 44.

47. Ming Yu Sheng , Yuan Zhao, Da Wei Zhang, Song Lin Zhuang," Quantitative assessment of hand vein image quality with double spatial indicators". Multimedia Technology (ICMT), 2011 International Conference on 26-28 July 2011, 642 - 645.

48. Goh Kah Ong Michael, Tee Connie, Andrew Teoh Beng Jin," design and implementation of a contactless palm print and palm vein sensor ". 2010 11th Int. conf. control automation, robotics and vision singapore, 7-10th December 2010.1268-1273.

49. Zhaohui Meng, Xiaodong Gu," Hand vein recognition using local block pattern". Electronics letters (Volume:49 , Issue: 25) December 5 2013. 1614 – 1615.

50. C.Lakshmi Deepika, A.Kandaswamy," An algorithm for improved accuracy in unimodal biometric systems through fusion of multiple feature sets". ICGST-GVIP Journal, ISSN 1687-398X, volume (9), issue (III), June 2009. 33-40.

51. Kai Rothaus, Xiaoyi Jiang, Paul Rhiem," Separation of the retinal vascular

graph in arteries and veins based upon structural knowledge". Image and vision computing 27 (2009) 864–875.

52. Yuan Zhao, Ming Yu Sheng," Acquisition and preprocessing of hand vein image". Multimedia Technology (ICMT), 2011 International Conference on 26-28 July 2011, 5727 – 5729.

53. Jeffrey Travis, Jim Kring," LabVIEW for Everyone: Graphical Programming Made Easy and Fun" , Third Edition, Prentice Hall,2006.

54. Ajat S.Arora and Sunil K. Singla**.**Image based fingerprint verification system using LabVEIW. Mj. Int. J. Sci. Tech. 2008, 2(03), 498-501**.**

55. Kumar A., Hanmandlu,and Gupta H.M," Online biometric authentication using hand vein patterns". Computational intelligence for security and defense applications, 2009. CISDA 2009. IEEE Symposium on 8-10 July 2009, 1-7.

56. Qishen Zhang, Ya Zhou, Danting Wang, Xiaoming Hu," Personal authentication using hand vein and knuckle shape point cloud matching". Biometrics: Theory, Applications and Systems (BTAS), 2013 IEEE Sixth International Conference on Sept. 29 2013-Oct. 2 2013, 1-6.

57. Kabaciński [illegible]

RUK [illegible]