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ALTINBASUNIVERSITY
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Information Technologies

**HUMAN IDENTIFICATION USING PALM PRINT
IMAGES BASED ON COMBINED LOCAL
BINARY PATTERN AND GRAY LEVEL CO-
OCCURRENCE MATRIX**

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by

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Aysha Ahmed Otman Tayeb

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ABSTRACT

HUMAN IDENTIFICATION USING PALM PRINT IMAGES BASED ON COMBINED LOCAL BINARY PATTERN AND GRAY LEVEL CO- OCCURRENCE MATRIX

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In this thesis, for the complete extraction of useful features from an appearance, a simple but powerful method an uniform local binary pattern to identification of palms are expressed because this method can pull out all the useful information of an appearance. The gray level co-occurrence matrix and combined gray level co-occurrence matrix and local binary pattern feature extraction are tested. The best result reached from local binary pattern method.

Keywords:Human Identification, Image Processing, Palm Print Recognition

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LIST OF ABBREVIATIONS

LBP : Local Binary Pattern

GLCM : Gray Level Co-Occurrence Matrix



1. INTRODUCTION

1.1 PALMPRINT IMAGES

The palm print is the famous method for the human recognition in the world. The first category's aim is recognizing the identification of the individual among the others in the database. In such systems, to the question "who am I?" will answer. In the second, the person offers his identity and the aim of the system is the confirming this identification and in the systems, to the question "do what I say I am?" will answer. It is clear that any biometric identification system is not the absolutely best solution for identification. By international biometric group, an interesting comparison is done between different systems based on four parametric, distinctiveness, and cost of identification system, time and spending effort by the user in the identification and the rate of user's comfort during identification. An ideal biometric system is a system in which contains all four enumerated parameters in the farthest place according to the center of the diagram [1].

A sample of the palmprint image is shown in figure 1.1.

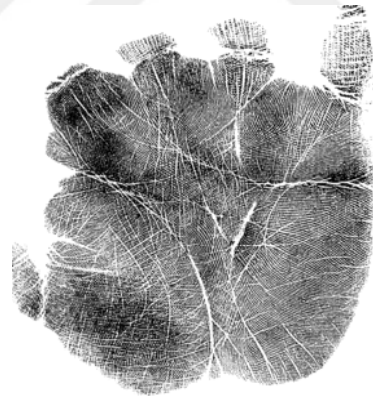


Figure 1. 1: A sample of the palmprint image

There are prominent lines on the palmprint, wrinkles and epidermal ridges that are analyzed with the help of feature in palmprint images. The impressions of the palmprint are the same as the finger, but their texture, indent and marks are different from the fingerprint.

The palmprint impressions help in catching the culprit. Palm prints are also used in commercial applications. In biometrics, palm marks are also used. Palm marks are found at the criminal place, when the offender accidentally slipped his hand or hit his hand somewhere [2].

Palm recognition system is a biometric system using intelligent automatic methods to identify or verify the identification of a person based on physiological characteristics. In the past two decades, the matter of identifying of palms is the extensive research field of machine's vision and pattern recognition. One of the extensive applications for recognition of palm lines is the field of security and verification. In controlling the high population areas, such as airports, railway stations, and subway and ..., this method is more effective than other methods of surveillance. So several photographs have taken from the lines in the palms of people and the device must be able to identify these people at different times, in different orientations of light [3][1][4].

1.2 A BRIEF HISTORY OF THE PALM PRINT IMAGES

William James Herschel, the son of John Herschel, was an astronomer. His father asked him to choose a career different than astronomy, so he began the East India Company, and in 1853 was posted to Bengal. Following the Indian Mutiny of 1858, Herschel became a member of the ICS (Indian Civil Service), and was posted to Jungipoor.

In 1858 he made a contract with Mr. Konai, he was a domiciled man, for the construction of road building materials. To prevent Konai from rejecting his signature later, Herschel suppressed his handprint in his documentary figure 1.2 shows that Mr. Konai's palmprints. Herschel continued to experiment with hand prints, soon he realized that it was necessary to use fingers. He collected prints from his friends and family, and the result was that one's fingerprints did not change over time. The Governor of Bengal suggested that fingerprints should be used on legal documents to prevent impersonation and refusal of contracts, but this proposal was not addressed[5].

Now people are using palm prints and fingerprints to investigate the criminal cases, for example in a crime scene when they found some palmprints and fingerprints on a subject in the crime scene then they collect this print after that they compare the prints with the people who committed crime before. Also in government's documents people use it like a sign of a person, and in health applications, so as we see there are many areas to use the palm print images.



Figure 1. 2:Mr. Konai's palm and finger prints[5].

1.3 PALMPRINT IDENTIFICATION USING AREAS

Banking Sector; authentication, internet banking, ATMs (Automated Teller Machine) and credit card applications. In figure 1.3 there is an example of palm print authentication device on an ATM. Health Sector; patient authentication, polyclinic patient follow-up, medical examination procedures.

- Aviation Sector; Banking, ticket sales, airline entry / exit operations.
- Insurance Sector; Identification, service description.
- Information Sector; Network and Data Security, user authentication.
- Education Sector; Student Tracking, information sharing.
- Construction Sector; Intelligent Buildings, security.
- Public Applications; Criminal, Tax.
- Special Education Practices; Authentication, service security, payment planning.

- Safety; Public safety, safety follow-up.
- Every sector where staff follow-up and door entry.

The usage areas of the palmprint recognition system are quite broad as mentioned above.

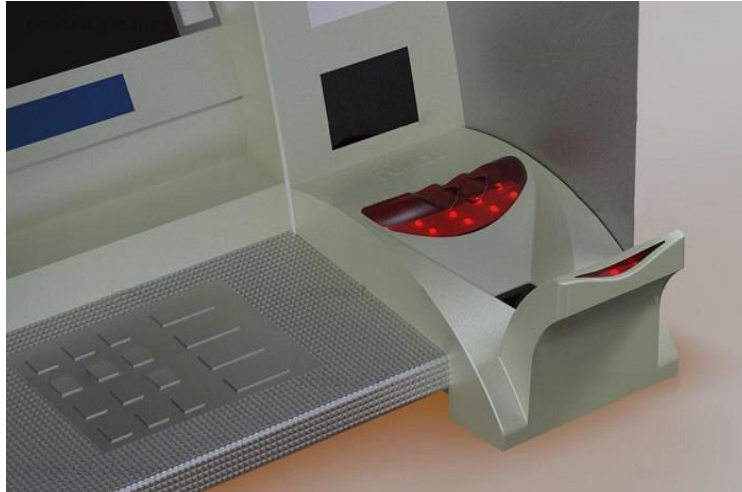


Figure 1. 3: An ATM application of palm print authentication

1.4 ADVANTAGES OF PALM PRINT IDENTIFICATION

- Every person's palm print is unique, so palm print identification is a perfect form of authentication.
- The palm print recognition system has a high level of security because it is impossible to steal.
- Palm print is used in many industries such as healthcare, aviation, education, construction and banking. Thus, palm print identification is a user-friendly system.
- The size of the palm print recognition system is small and portable.
- Palm print recognition system is hygienic due to contactless use.

1.5 PALM PRINT FEATURES

The palm print is stable and has rich line attributes; Three types of line patterns appear on the palm. These are the basic lines, wrinkles and bulges. The basic lines are the longest and widest lines on the palm trail. The basic lines determine the most distinctive directional features on the palm. Most

people have three basic lines on the palm, and these lines are often called the heart line, head line, and lifeline. Wrinkles are considered thinner and more irregular line patterns. Wrinkles, especially wrinkles that are obvious around the baseline, can also contribute to the discrimination of the palm print. On the other hand, the ridges are fine line texture scattered across the palm surface. The bubble attribute is less useful to distinguish the individual because they cannot be detected by the poor imaging source. Figure 1.4 shows the lines on the palm print[6].

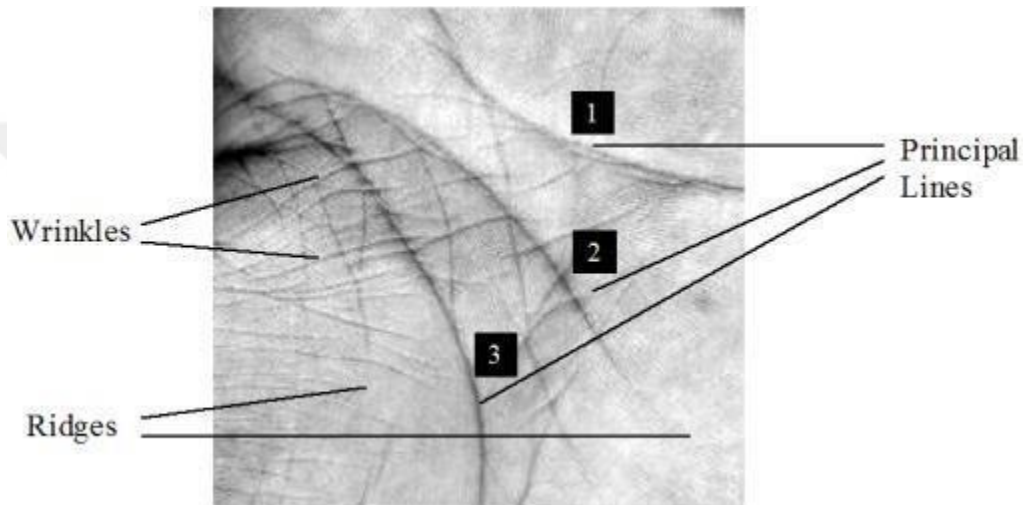


Figure 1. 4: The line patterns on the palm print[6]

2. LITERATURE REVIEW

2.1 BACKGROUND

In this thesis we will look deep inside the image processing, and the developed methods before. We will compare these methods and we will give a conclusion about these methods.

2.2 PREVIOUS WORKS

Identification and verification using palm print features are still pending problems today. Researches have been developed in various ways. The methods such as fingerprints are usually performed using Gabor filter, wavelet transforms, Fourier transform methods. Compared to the fingerprint, the palm prints have a lot of lines and high performance in recognition of the fingerprint shows. Even when fingerprints require high resolution, palindromic traces do not, and low-resolution recognition is easy. In the literature, people used orientation methods, wavelet transforms to extract features and artificial neural networks to classify.

Fei et al in 2016 [7], they worked on Half Orientation Code. There are many "line" curves in Palmprint. The point on these curves usually has two dominant directions. Furthermore, it appears that there are numerous cross wrinkles in palmprint. There are clearly two dominant directions at the crossing point of both cross wrinkles. A simple and effective double half-orientation-based method has been proposed for identification and extraction of palmprints. In the method, a bank consisting of "half Gabor" filters is defined for Palmprint's -directional extraction. Compared to a single dominant orientation, the dual half-orientations can more clearly characterize palmprints global orientation. Comprehensive experiments have been conducted in three different palmprint databases and the results show that the proposed method achieves promising performance in fingerprint verification and identification and performs better than methods based on other orientation properties.

Wei Jia et al in 2014 worked on Histogram of Oriented Lines for Palmprint Recognition. They succeed in sensitive with illumination changes, and this method is stable to slight translations and rotations [8].

In 2008 Yu, he used the Modified Discrete Cosine Transform based feature extraction method for the palm recognition approach in his work. Uses radial based artificial neural networks in classification. Radial-based neural networks have also been used to reduce excess data to a reasonable size in order to facilitate training [9].

In Yang's proposed system in 2008, palm geometric features and texture properties were obtained by core-based component analysis (CBPA). Apply a self-organizing artificial neural network (ANN) to select a small dataset among the excess data to select hand geometry properties. Uses a radial-based artificial neural network in the identification phase [10].

2.2.1 Pattern Recognition

In recent years, many people have been able to distinguish amount of work has been done. Some of the patterns studied are characters, symbols, pictures, sound waves, electrocardiograms. Usually complex difficult to interpret due to calculations or human evaluations of overload problems are used in computerized identification. The path maps to the pattern. In this case, a pattern for each pattern class the set of patterns is stored in memory in the form of a database. Unknown class of each class pattern. The classification is based on a previously determined mapping criterion or similarity criteria. Compare the pattern with the complete pattern it is faster to compare some features rather than the more accurate result most of the time. For this reason, pattern recognition process, feature extraction and classification examined in two separate phases [11].

In figure 2.1 future extraction, makes some measurements on the pattern and turns the results into a feature vector.

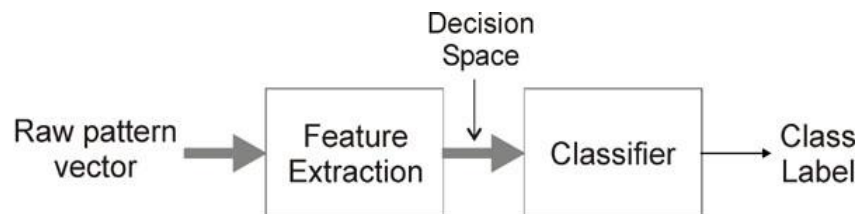


Figure 2. 1: Future Extraction and Classifier[12].

This feature may vary considerably depending on the nature of the problem. Also, the importance ratings and costs of the features may be different. For this reason, properties should be selected to distinguish the classes from each other and to achieve lower costs.

Features are different for every pattern recognition problem. Based on the properties extracted in the classification stage, it is decided to which class the given object belongs to. Although the feature extraction does not differ according to the pattern recognition problem, the classifiers are collected in specific categories [13].

Pattern mapping is the most common classification method. In this method, each pixel of the view is used as a feature. The classification is done by comparing the input image to all the class patterns. The comparison results in a similarity measure between the input information and the pattern, with the pattern, the pixel-based equivalence of the input image increases the degree of similarity, while the corresponding pixels reduces the similarity. After all the patterns are compared, the class of the pattern giving the most similarity grade is selected. Structural classification techniques use structural features and decision rules to classify patterns. For example; line types in characters, holes and slopes are structural properties. Rule-based classification is performed by using these extracted features. Many pattern recognition systems are based on mathematical bases to reduce misclassification. These systems are pixel-based and use structural features. Examples include Gabor features, contour properties, gradient properties, and histograms. As a classifier, classifiers including discriminant function classifiers, Bayesian classifiers and artificial neural networks can be used[14].

2.2.2 Fundamentals of Image Processing

In its simplest terms, it is a necessary tool to process darkness, manipulate images, and two important input-output niches are demanded image digitization and imaging devices. Due to the inherent nature of these devices, images do not create a direct source for computer analysis. Since computers work with numeric values rather than with image data, the image is transformed into a numeric format before processing begins. Figure 2.2 shows how a numbered array of numbers can represent a material image. The material image is divided into small regions called "shape elements" or "pixels". The rectangular mesh cage device, which is the most comprehensive subdivision scheme, is also shown in figure 2.2 In the digital image, the value placed on each pixel is given the brightness of that spot.

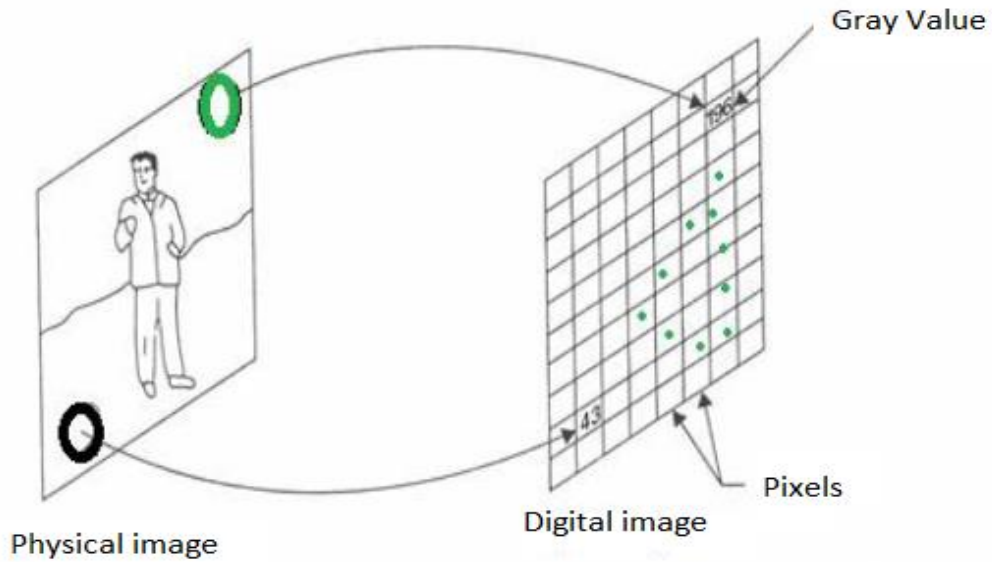


Figure 2. 2: A material image and a numerical figure [15].

The conversion process is called numerical conversion. This situation is completely transferred to a diagram in figure 2.3 the brightness of each pixel is used as examples and numerically. This part of the operation shows the brightness or darkness of each pixel in that place. When this process is applied to all pixels, the image is displayed in a rectangular shape. Each pixel has a full place or a trace (number of lines and columns), and at the same time has a full value called gray level. This sequence of numeric data is now available for processing on a computer. Figure 2.4 shows the numerical state of a continuous view[15].

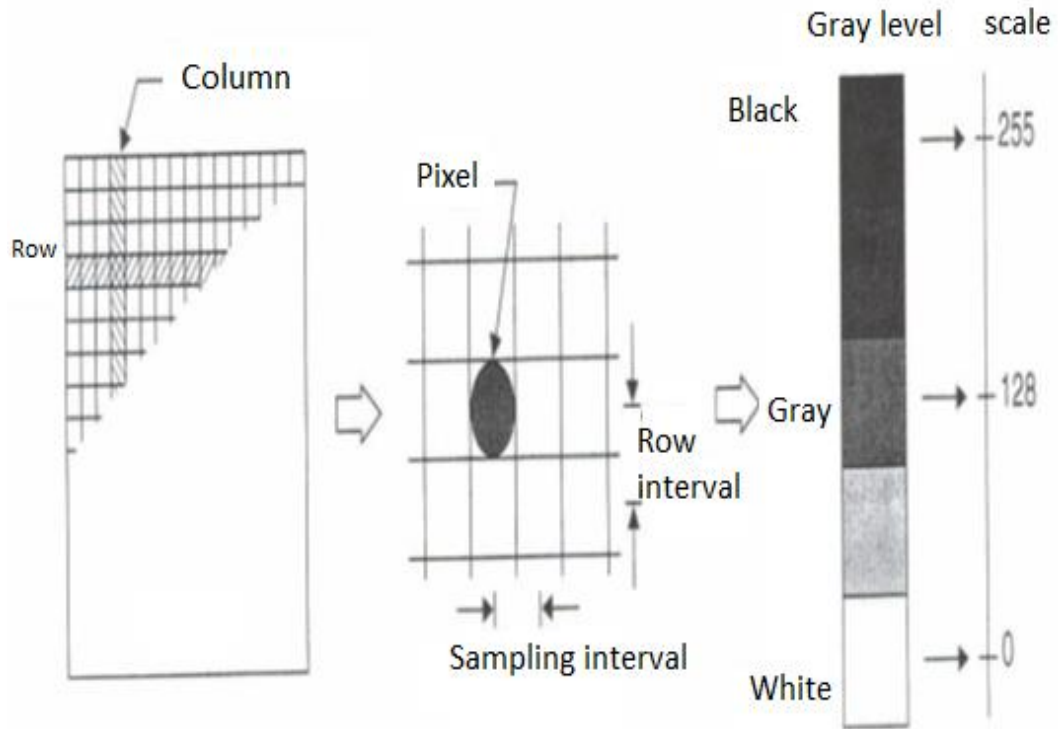


Figure 2. 3: Digitizing a scene[15].

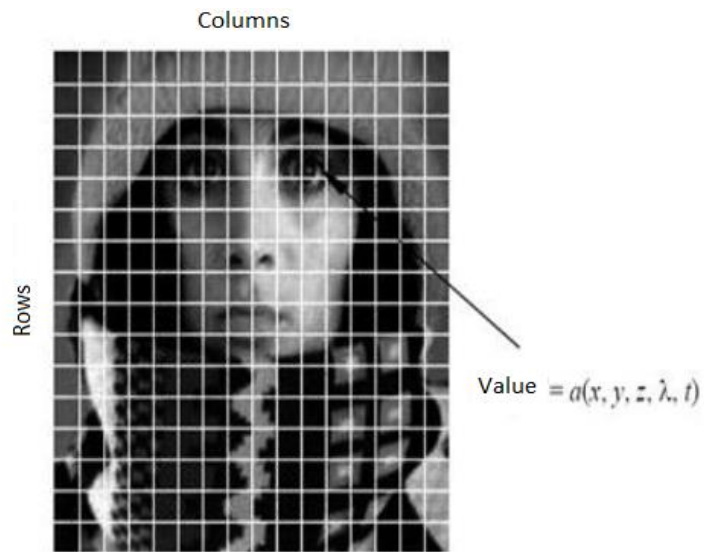


Figure 2. 4: It has the form of a continuous image counting. $[m, n]$ is like a single point numerically in place, brightness, etc. values [15].

Digital image studies can be divided into two main groups; input and output are the images, and the second group is the methods in which entries can be images, but stamps are stamps extracted from images. This organization is shown in Figure 2.5.

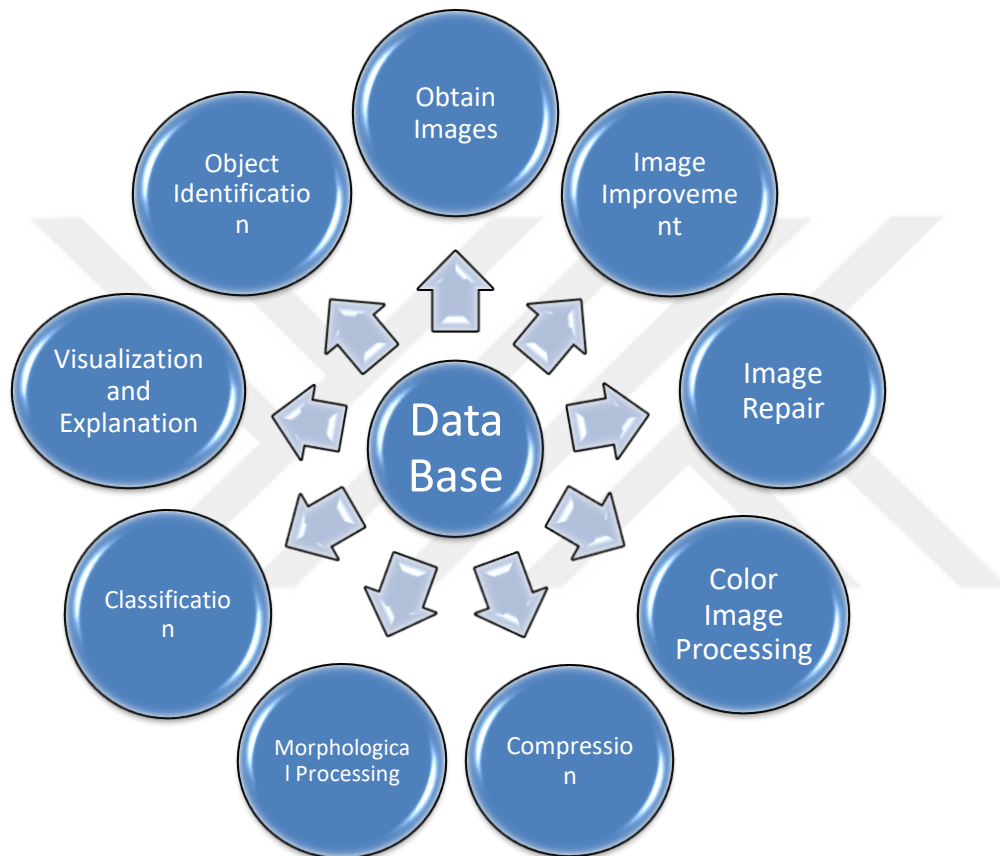


Figure 2. 5: Digital processing images

2.2.3 Obtain Images

The first thing shown in figure 2.5, the image header, is generally called the pre-processing process, such as prototyping, as can be given using a substantially numeric data.

2.2.4 Image Improvement

It is one of the most practical image processing departments. Basically, the main idea behind the image enhancement methods is to show off-the-spot details or to show some fixed properties. The first thing to do is to increase the contrast of the view.

2.2.5 Image Repair

Image repairs make the picture better. Image enhancement is a subjective concept, image repair is an objective concept. Mathematical and predictive forms are used in the renewal of image losses. Image enhancement is a matter that varies according to the person, the result can be changed depending on the preference of the person.

2.2.6 Colored Image Processing

Color is the perception that occurs when light of different wavelengths reaches the retina of the eye. People's perception of color is created by objects reflecting light and transmitting it to the brain through the eyes. This perception is called tint or color only because the light hitting any object is partially absorbed and partially reflected. If the entire wavelength is visible at the same time, the object is perceived as white, and if no light is reflected, the object is perceived as black [15].

Color images are projected onto the computer screen as 24-bit data. The image on the screen is obtained by projecting three different levels of the same object - red, green and blue - to the screen in a row. 0.4-0.5 mm wavelength in the electromagnetic spectrum to blue color; 0.5-0.6 mm wavelength green color; 0.6-0.7 mm wavelength corresponds to red color. If three 8-bit images in the range of these wavelengths, that is, a combination of red-green-blue, are projected onto the computer screen, a colored image is obtained [16].

In grayscale images, the image contains different grayscale-tone values. Gray level values are expressed as: $G = [0, 1, \dots, 255]$. This means that a total of 256 different shades of gray or different gray values are possible. Here, 256 different gray values can be expressed as 1 byte, 1 byte = 8 bits, and $2^8 = 256$. The value of 0-gray corresponds to black as a rule, and value 255-gray to white. Shades of gray lie between these two values.

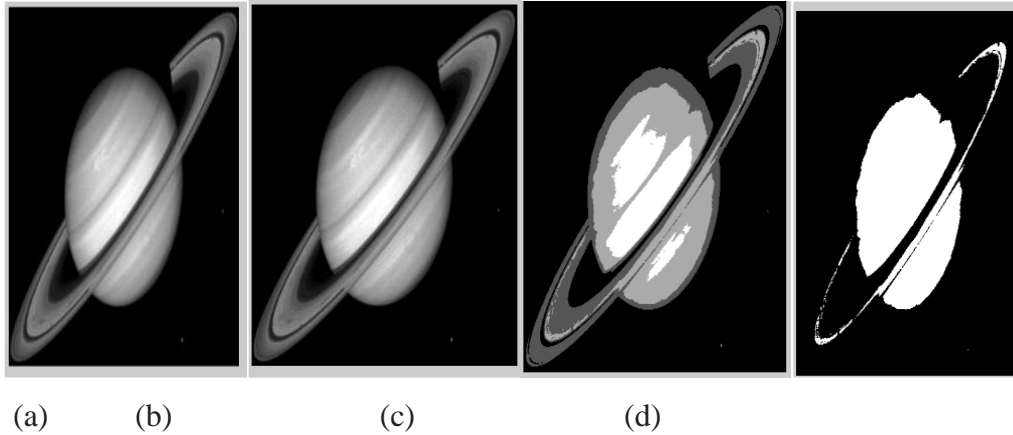


Figure 2. 6: Different Gray Level Views

In figure 2.6 (a) 8-bits grey view, (b) 5-bits grey view, (c) 2-bits grey view, (d) 1-bit grey view.

2.2.7 Compression

It is about reducing the specific image size that a picture needs to be stored. Covering technologies have been over-developed in recent times, but the same can not be said for dimensional transfer technologies. This has become especially important in the use of the internet, which has picture content. JPEG (Joint Photographic Experts Group) is an image compression standard known from computer users' document extensions [17].

2.2.8 Morphological Processing

Biology is the morphology of the branch of living things that deals with form is called the cognition. Mathematical morphology is an essential tool for applications such as defining boundaries, skeletal structures and extracting, noise reduction, segmentation based on basic set operations. Image processed usually as pre-or post-processing, such as morphological filtering, thinning, pruning are often used.

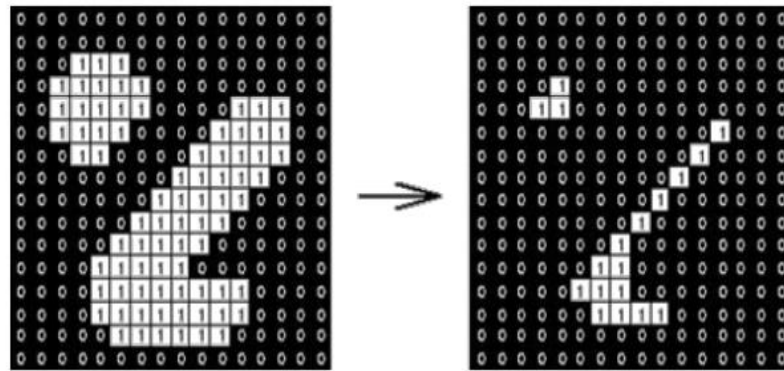
Mathematical morphology is an approach based on the theory of sets based on the formal structure of image. At the base of this method are two morphological operators, erosion and dilation. For digital signals

erosion operation, a Minkowski cluster removal operation, and the dilation operation is performed by Minkowski cluster aggregation. The erosion process is the intersection process in the cluster algebra, the dilation process corresponds to the joining process in the cluster algebra.

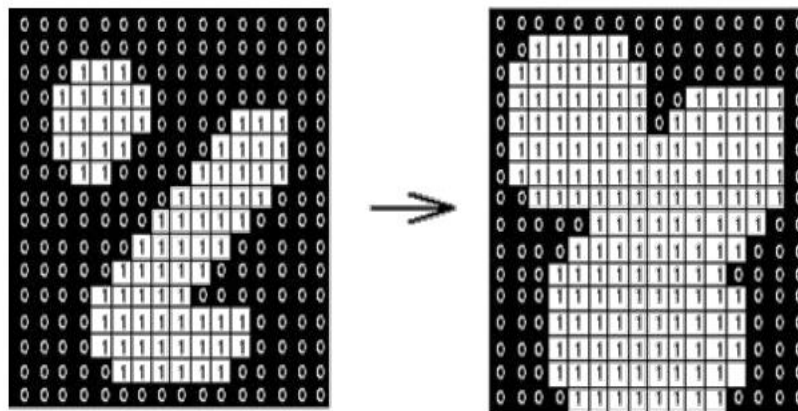
The dilation Process can be used to enlarge or thicken an object morphological process. To expand a numeric image, to enlarge as much as the intersections. Each pixel of the image to be processed is placed at the center point of the structural element and is expanded.

The structural element determines how to perform the thickening process. An image that has undergone the dilation process is observed to fill the holes and gaps in the image and to soften the corner point.

Erosion is a morphological process that helps to shrink or thin an object in a binary image. The erosion process is not exactly the case, but it is the opposite of a reciprocal dilation process. Objects in the image are scaled down, holes are wider, bound objects tend to separate [18].



(a)



(b)

Figure 2. 7: Morphological erosion and dilation

In figure 2.7 A black-and-white image of the top image was eroded in the form of a matrix (a). Images are displayed after dilation in black and white matrix form in the bottom image (b) [18].

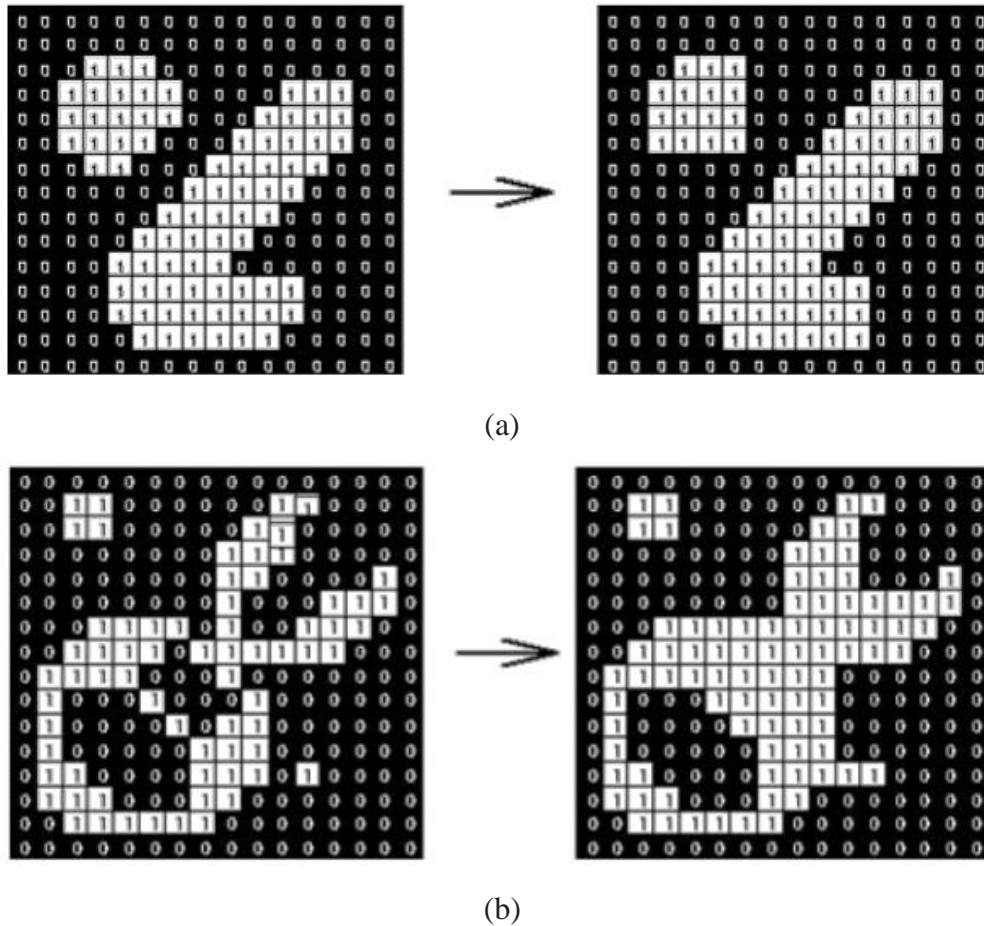


Figure 2. 8: Morphological opening and closing

In figure 2.8 morphological opening process of a black-and-white image in top image (a). Morphological closing process of a black-and-white image in the bottom image (b) [18].

Morphological operations can be applied to binary images, as well as to gray-scale images. The grayscale image spreading process opens the dark areas in the image. While the bright areas surrounding the image are surrounded by the dark areas, the dark areas surrounded by the bright areas are weakening, even depending on the size of the image element and the dark toned area. Grayscale image erosion process, increases the brightness of the image. The shaded areas

surrounded by the dark areas of the image are shrinking, dark-toned regions surrounded by bright regions expand[18].

2.2.9 Partitioning

Partitioning is one of the most difficult functions of image processing. The more realistic the segmentation, the more accurate the recognition process.

2.2.10 Data Base

A known issue is about the code in the database of an image processing device. In addition to guiding each process, the database also provides communication between the modules.

2.3 TECHNIQUES USED IN IMAGE PROCESSING

2.3.1 Shadow Correction

When images are obtained from material objects, they may form obvious shadows on the image due to the sparkle, the receiver or the real object. In some cases, the picture becomes heavier as it gets closer to the bright edges in the middle, or it is in a work that is exactly the opposite type and brightens towards the dark edges in the middle. Or, as you go from left to right, the glow can lighten or multiply. Shadowing, non-uniform illumination, non-uniform camera sensitivity, even the lens may be dirty. For this reason, ghosting is an undesirable condition. However, if the purpose is image analysis, it will be the same as before the rescue from view [19].

2.3.2 Normalization

These are the processes that were done prior to starting the image processing. This preprocessing should be as short as possible. Because the intention of normalizing is to examine the response and action of the algorithm to be used for unnecessary information. Images taken from the scanner vary in size and resolution. Color images from the scanner are first changed to gray scale. If the

size of these images is large, the process of learning and analyzing the artificial neural network takes a long time when the image is processed. In fact, using large sizes increases processing time and reduces processing efficiency.

For this reason, it is necessary to reduce the images from the scanner to a certain standard [16]. As a result of this detection, the number of pixels of the images we have to change to 128x128.

2.3.3 Thresholding

One of the basic methods used in image processing is thresholding. The purpose of performing a thresholding operation of a numerical view is to make it easy to determine the properties of the view. To display an image with unique gray-tone levels in a binary, black and white color, the image can be changed into two colors. Before thresholding is performed, a threshold value is present. This is done by selecting a threshold value as in figure 2.9. Pixels with a gray level higher than the threshold value are assigned a value of 1 and pixels with a lower value are assigned a value of 0, so that the image is more simply changed in black and white. In Figure 10, an image is seen before the thresholding process (left image) and the next image (right image) [20].

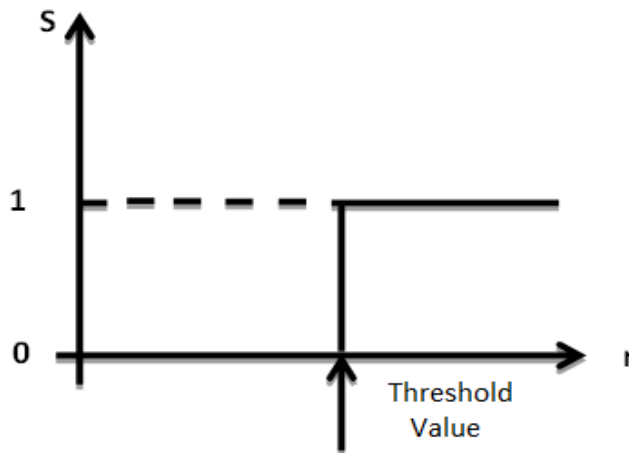
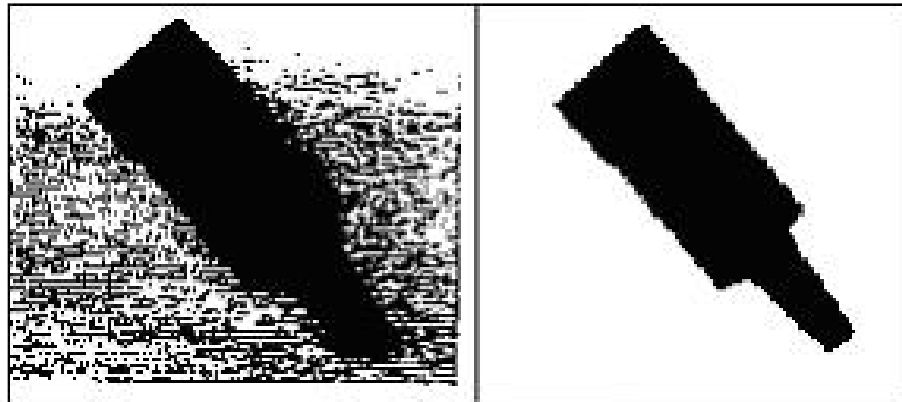


Figure 2. 9: Threshold Value

$$r \geq th \Rightarrow s = 1 \quad (2.1)$$

$$r < th \Rightarrow s = 0 \quad (2.2)$$



(a)

(b)

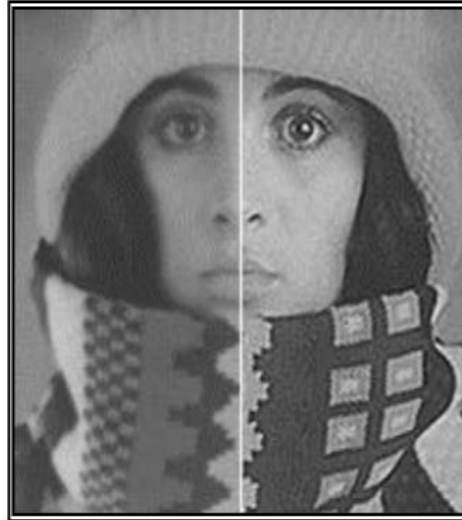
Figure 2. 10: Before (a), and after (b) thresholding.

2.4 IMAGE IMPROVEMENT AND REPAIR METHODS

The time to obtain a digital image is usually caused by loss of image. From these mechanical problems, contamination from the focus problems, from the movement of the lens, from the unfavorable lighting, creates a worse digital image than the original shape. The purpose of image enhancement is to obtain the most ideal image visually from the recorded image. The purpose of image repair is to switch from the recorded image to the image that may be closest to the original image. While the goal of image enhancement is to flourish, the aim of image repair is reality[21].

2.4.1 Sharpness Filter

A well-known method of image enhancement is to enhance the edges of the image. The method is called sharpness filtering. Improving the edges of an image with sharpness filtering is firstly referred to as the separation of these edges, subsequent strengthening, and further image attachment. Figure 2.11 the improved image is shown using the Laplacian Sharpness filter [21].



(a)

(b)

Figure 2. 11: Comparison of original and improved image by applying Laplacian Sharpness filter
(a) Original (b) Laplacian.

2.4.2 Noise suppression

Among the line masks used as noise suppression process, the best filtering is done with Wiener mask. Here, the most appropriate word is used to give mean error (mean-square error). The most appropriate mask is also the root mean-square (RMS) error. Five different methods for noise suppression process are shown in figure 2.12 a known image mask is applied for the image spectrum and the pollution spectrum. The values of the other masks (neighborhood measure etc.) were made by choosing RMS to be the least[21].

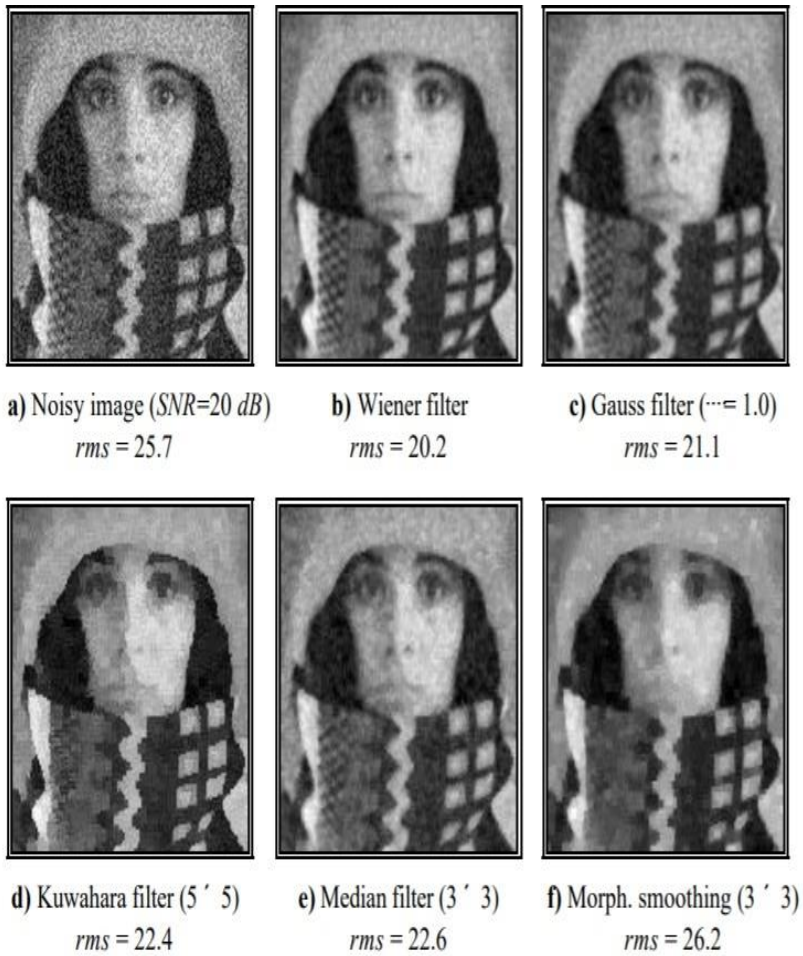


Figure 2. 12: Comparison of noise suppression operations using different techniques

2.4.3 Edge Finding

Firstly, the masks play a key role in these methods before moving on to edge detection methods. In the digital image, there are many techniques used to determine the three basic elements of the gray level continuity, lines and edges. This is done by passing the calculation mask for the passes. As shown in figure 2.13, the masks are each a 3×3 matrix.

$$\begin{bmatrix} w_1 & w_2 & w_3 \\ w_4 & w_5 & w_6 \\ w_7 & w_8 & w_9 \end{bmatrix}$$

Figure 2. 13: $[3 \times 3]$ mask matrix

The multiplication of the coefficients, which are contained in the gray level on the individual pixels plotted by the mask, with each other must be summed. In general, the exact midpoint of the matrix is defined as the space corresponding to the response for each point of the mask. The answer for each point in this picture is;

$$R = w_1z_1 + w_2z_2 + w_3z_3 + k + w_nz_n \quad (2.3)$$

$$R = \sum_{i=1}^n w_i z_i$$

Edge detection is an approach to sharpening color transitions by applying it, facilitating the acquisition of objects or differences within the image. It can also be described as a modern approach that achieves the most successful result by using different image processing methods appropriately. Edge detection images are very important in the sense that they contain meaningful features of images and enable them to reveal information. Edges are usually adapted to the boundaries of objects and shadow transitions.

Edge is the property of a region of a pixel and its immediate neighbors. also size and direction. Very light-colored images are used in edge calculations, and the image Gradient function calculates the edges. It is important that we measure edge-to-edge gray color gradients.

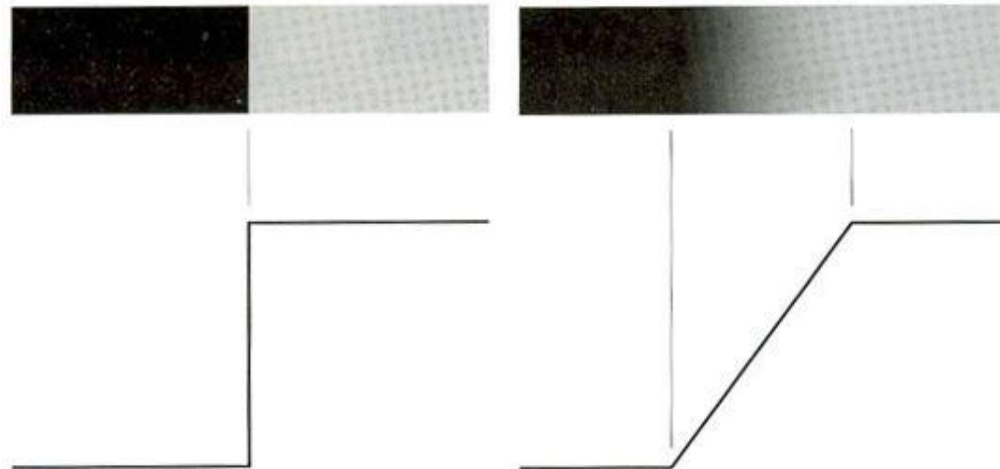


Figure 2. 14: Horizontal Line Curve on Gray Level Image

In figure 2.14 the most ideal edge feature is the left image in gray level, gray level while the right image is shown as non-ideal. There is no blurring in the transitions, it will not be direct and sharp like the one on the left. In the pattern of the ramp edge shown on the right, the slope of the edge is related to the level of the blurring of the edges [17].

2.5 IMAGE PROCESSING APPLICATION AREAS

Modern technology makes it possible to process multidimensional signals in many systems from simple circuit systems to complex computer systems. The purpose of this process is [22]:

Image Processing > Image input - Image output

Image Analysis > Image input – Measured dimensions output

Image Understanding > Image enters - Higher order definitions output

divided into three categories [23].

2.5.1 Histogram

The scale is an image and each pixel carry a specific value. The gray level histogram or histogram from the first level shows the distribution of brightness in the image. Graphic representation of the number of iterations in the image histogram is called pixel brightness values. A histogram also represents the horizontal axis image and the vertical axis pixel brightness values, i.e., the brightness of each pixel in the image. Scales an image to a specific value in pixel.

The gray level histogram or histogram from the first level shows the distribution of brightness in the image. Input image brightness Assuming a gray image with 256 levels, the range of values for each pixel of the image is $[0, 255]$. To obtain a histogram from the image (all pixels to be shifted from the image only), it calculates the number of pixels with each brightness level. In a simple histogram, the space position information of the pixel, that is, the coordinate information is lost, and only the gray values of the pixels in the image are obtained. Histograms have no position information, only frequency information. It is possible to filter by selecting a gray level value related to the image (0-255). Figure 2.15 shows the gray level histogram of an image[15].

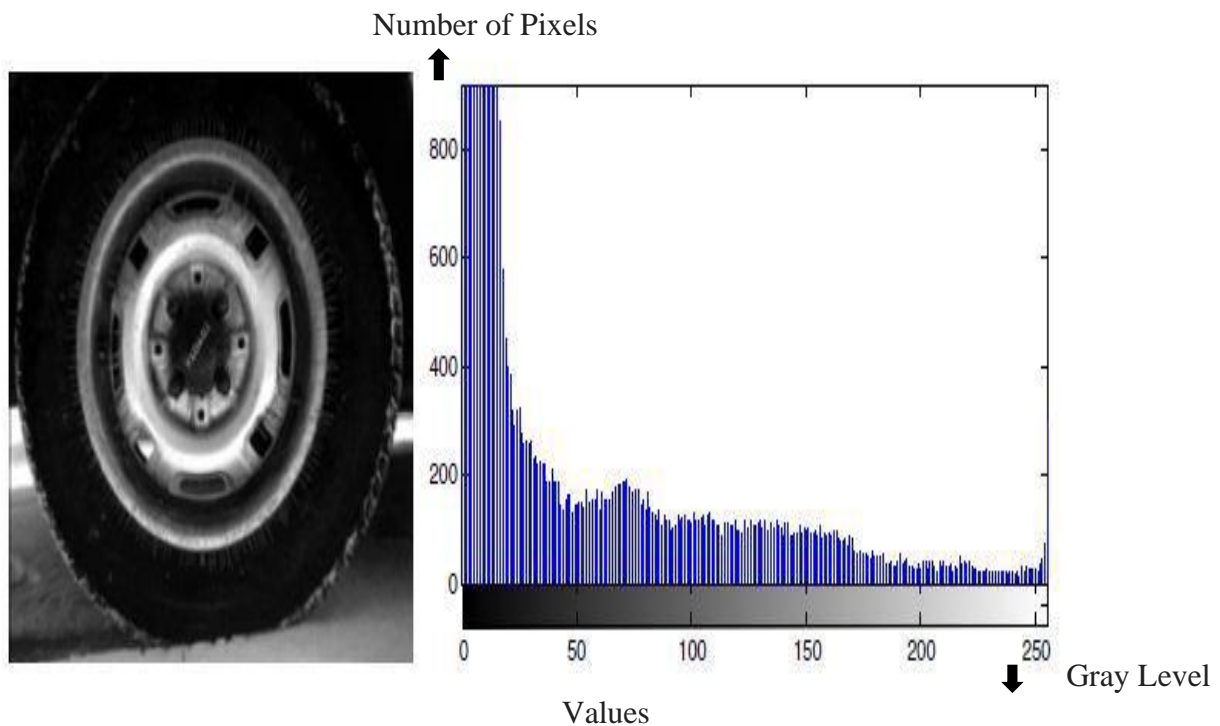


Figure 2. 15: Histogram of an image [24]

2.5.2 Histogram equalization

Histogram equalization is useful for images that are stacked in areas that do not change at the gray level. In this way the image contrast will be low, and the histogram can be well processed after synchronization. As can be seen in Figure 2.16, the histogram is intended to ensure that the

frequencies of the colors are distributed appropriately, without collapsing the frequencies on the histogram [24].

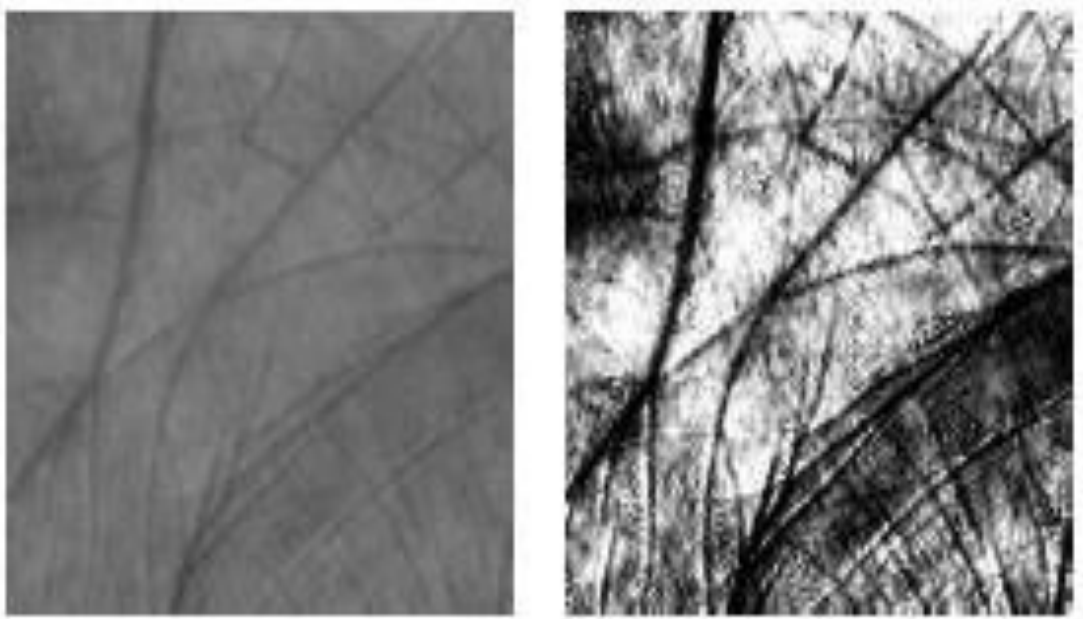


Figure 2. 16: Histogram equalized palm image [24]

The left image in figure 2.16 is in the value range of 61-142 in gray level and the histogram has values between 0-255 in gray level in right image after synchronization.

3. METHODOLOGY

3.1 FIRST SECTION

In Palm recognition system is a biometric system using intelligent automatic methods to identify or verify the identification of a person based on physiological characteristics. In this system the getting high accuracy recognition is big problem. In palmprint most features are close to each other and the separating the features has problem. Collecting of the dataset for many peoples that they are working in the security place is not easy.

Current methods of identifying palms uses of four types of palm's features: texture, lines, appearance and orientation. According to the extracted features are divided into five categories:

- A. Texture based methods which using the filters such as Gabor, discrete Fourier, Wavelet and Rydan.
- B. Line based methods are like identifier of palm's directed lines, sober performance, multi-resolution filters and Rydan filter.
- C. Appearance based methods are that uses from the analyzing of principal component, analysis of linear distinct appearance of local guard and analyzing of kernel principal component.
- D. Orientation based methods which usually uses the Gabor filters.
- E. Multi feature based method, such as the combination of features of palm's lines and filed in a same vector. Typically combinations are done in four levels, data feature, matching, and the decision.

In figure 3.1 the biometric process is shown.

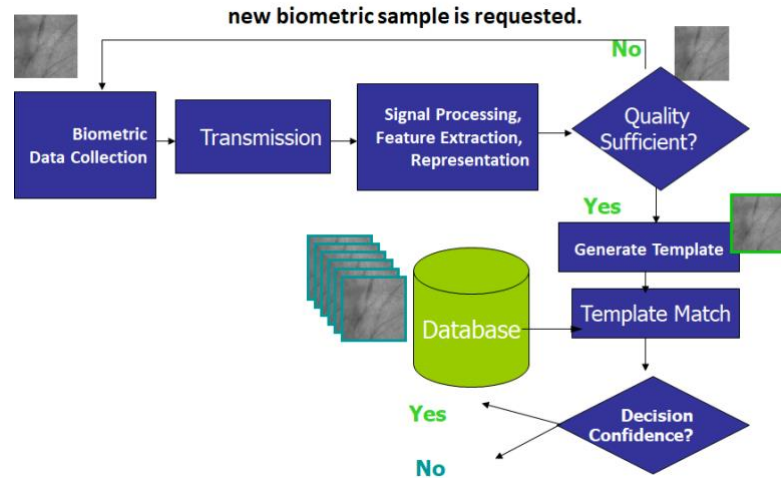


Figure 3. 1: Biometric process

As seen at this figure at first the data collect from the biometric data. Then these data transfer to signal processing and feature extraction and representation. If the quality is sufficient then generate the template. If the template is match with other data then decide the image. Finally we can understand that the this palm image is depended for which person.

The steps of the palmprint image acquisition and preprocessing is shown in figure 3.2 This figure also shows that how one image that taken from inside of the hand converts to the image and how to understanding the features of the image. For real time application this figure is best scenario showing.

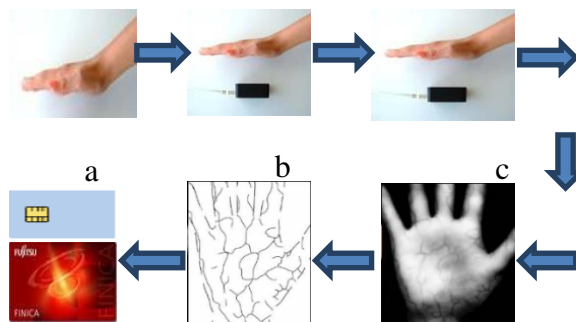


Figure 3. 2: a) Palm has to be positioned 3-8 cm over the sensor, b) Sensor emits near infrared beam to the palm, c) Oxygen reduced blood within the veins absorbs the near infrared light, d) The sensors wide angular near infrared camera takes a raw image of the palm vein pattern, e) The sensors template library SW changes the raw image into template data, f) The generated template can be stored in either a database.

For palmprint recognition, The Hong Kong Polytechnic University (PolyU) Multispectral Palmprint Database [25] are used. The data set can be download from this website. <http://www.comp.polyu.edu.hk/~biometrics/MultispectralPalmprint/MSP.htm>

Also the proposed method implement by Matlab R2019a version. It includes a set of photos of 500 different people and for each person there are 102 different images. The purpose of the thesis is to get the best result of accuracy. We select N number of test images and M number of train images, then we apply feature extraction on them and compare the test images with the all 500 person's train pictures features then we find the minimum number to recognize if it belongs to the same person or photo set. The Flowchart of complete process is shown in figure 3.3.

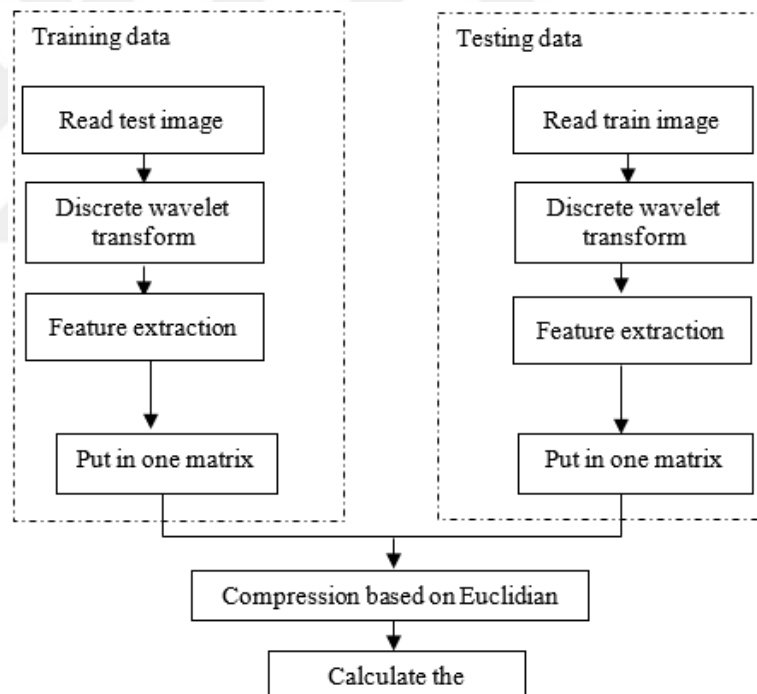


Figure 3. 3: Summary of human recognition with palmprint images

For testing of the proposed method, we have selected different test images and different train images. The minimum number of test image is 1 and maximum test images are 11. When the 1 image select for test then 11 image selected to train. Also for 11 test image we select only 1 image for training. The test images are compared with the train of all 500 people, which makes it $N_{tr} * 500$ images. Here N_{tr} mean the number of train images that we select in each scenario.

For example, if the selected test image are 2^{id} and 11th then these images compared with all training images in this dataset. image number for testing. We compared 3^{id} number image with all features in the “*FeatureImage*” matrix.

We give the first person’s fifth picture as a test image, we see that the feature extraction by Euclidean norm result is approximately equal to the person number 500’s 11th picture. For this feature extraction comparison, the result is wrong because they do not belong to the same person.

3.2 FEATURE EXTRACTION

3.2.1 LBP Features Selection

Local binary pattern considered the most famous type in computer vision that is because of its ability for covering a larger surface of picture. In most observations, the extracted of LBP histograms are done by dividing the input image into a little amounts and the main blocks are further collected together into a special made of improved vector. Furthermore, there are some recent method which happens to give us a large amount of dimension vector which is not good. Some examples of this recent variations is the expanded pattern. It is assumed that the gained characteristics is providing us with representation of some things that we do not want [26][27].

In result to make it more special for us we can decrease it. Moreover, if we want to have a system with good information given we have to ensure that the representations depending to the LBP have decreased its length. In the result of all the problem that this demonstrator have a lot of studies doing on it. here is two important points studied [28]:

- Using uniform method to decrease the characteristics length.
- Getting the special pattern by using the helping of characteristics extraction.

Every one of this two categories has its own property. The first one is easy but has a lot of limitation things while the second one is costing more money but it has a good characteristics extraction.

In numerous applications, it is valuable to process the info picture before LBP highlight extract[29].

3.2.1.1 Rule technique

The pattern of uniform representation is a powerful and useful rule for selecting characteristics. It is used very much. In addition there are also other methods which could be used. For example, lahdenoja et al has presented for decreasing the length effective of the vector while we are trying to get the characteristics from picture. This method named (Lsym) which is giving or assuming the most little number for the 0 or 1 in any pattern. For example, Lsym giving the value of two to the (00011111 and 00011100). According the definition of the symmetry level it shows that it is rotation invariant. The most value of the symmetric is having 0 and 1 which it is representing the edge. In the other hand the lowest value of the symmetric is having only ones which contain 0 and 1. In addition it is showing that the high value symmetry having better and special power. In the examination of this method they stated that when they did their experiment and do comparison they took only the high value symmetric and also they decreased the length of characteristics vector by less than the half [28].

3.2.1.2 Boosting characteristics

The studying of this method is very important thing because it is having a good result in characteristics choosing. It is presented that while moving and doing some scale for a picture, we get more area which helping in building the histogram of picture. Also if you have two photos you can use their both histogram and the distance between the both of them be helpful in the observations. In addition to this Ada Boost can be helpful because it is giving us the most important properties. Compared with other studies it is giving better result but its histogram does not calculate the local areas. The same result was also presented in many articles [30].

According to the article [30] the n^{th} bin give the needed property of the all area. Also the property choosing performed at region level. Ada Boost is also useful if want to know the unique points in histogram of LBP because sometimes there is points which is not interesting us. It was also mentioned that it give a high performance in decreasing the vector length. Ada Boost in choosing the characteristics is being very famous in many applications. Yao et al has shown inviting Rank Boost for choosing the unique characteristics [31].

3.2.1.3 LBP Subspace Learning

Choosing a special characteristics from LBP mentioned in a lot of examinations, one of them that which was called dual space LPD. Zhao et al in choosing the characteristics has tried the “Laplace PCA”. Wolf and Guttmann tried the maximum plus method while choosing the properties. In their examination they got a better efficiency than the older method. Shan et al in his examination used LPP. GAO and Wang prefer the boosting learning in many things such that the different low dimension which it is coming from the original of choosing highest dimension characteristics spaces as it is entering to boosting [28].

Reducing the dimension of a diagram starts from the high dimension to the low dimension, so we can apply this while choosing characteristics of the LBP if we want to have a less representation. An example of this is the method which has discovered by Chan et al. This is named Linear Discriminant Analysis (LDA). It is helping in giving a lot of scale of properties and representing it in special space. The same project after it was presented which is calculating the properties of colored picture in many scale. The LDA has a size problem. To deal with this Shan et al suggested the using of Ensemble of Piecewise LDA. This method is splitting the vector into parts. After that it applies LDA to every part one by one. This strategy showed that it is giving better efficiency [28].

3.2.2 Local Binary Pattern

The LBPidea is a picture administrator which changes a picture into an exhibit or picture of whole number names portraying picture looking. The best generally utilized variants of this working idea are intended for still pictures yet it has been broadened likewise in picture of recordings and volumetric information. The most important thing in its idea is to have a representation for the points which you get because you are going to need it in your observation. The fundamental LBPoperator, presented by his first inventor(OJALA et al). depended on the suspicion that surface has locally two correlative viewpoints, an example and its quality [29].

In local binary pattern the original operator of LBP labeling the pixels of the needed image with decimal numbers, the produced decimal numbers called Local Binary Patterns or LBP codes, this happens with encoding the local structure around each pixel. Like it showed in the figure before. As I mentioned that we should find the difference between the eight points with respect to the middle.

Then in our next step we see if it is lower than the middle we write 0. If it is higher than the middle we write 1. After that A binary number is acquired by concatenate all the observed codes in a clockwise direction. The left top should be our starting point, then to label we use their corresponding decimal value[29].

The small 3x3 neighborhood of LBP idea cannot catch the dominant character with in high manner, so this is one of its restrictions. To work with the texture at any manner, the idea was later generalized to use various size of surrounding points[32]. Though what is a local neighborhood? Local neighborhood can be said to be number which have a different places and they representing by a circle. If it happened and showed any another points in the circle that is not belonging to the wanted ones, we have to insert them using inserting method. In figure 3.4 we can see some examples of the modified working idea of this method. The first one represent (8, 1) while the second and the third are (16, 2), (24, 3) respectively. For the surrounding points we will use P simple and the R simple will represent the radius[29].

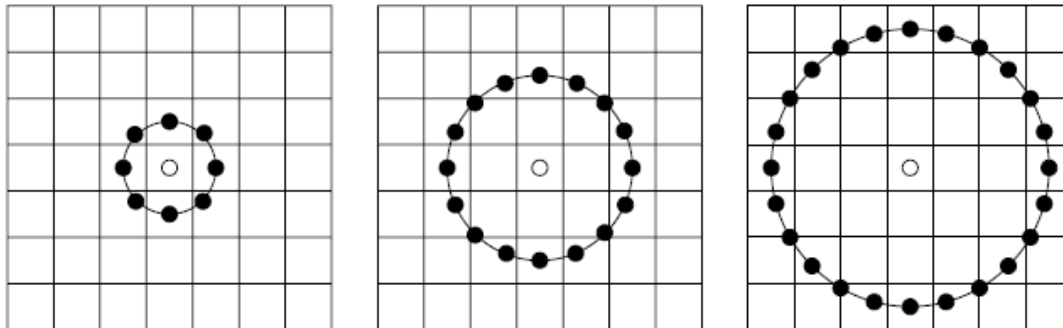


Figure 3. 4:Modified LBP[29]

Officially, if we have (X_k, Y_k) the result of the decimal number we will get is:

$$LBP_{p,r}(X_k, Y_k) = \sum_{p=0}^{p-1} s(i_p - i_c) 2^p \quad (3.1)$$

The center value point is referred by i_c while the surrounding ones are written as i_p and function $F(x)$ define as:

$$F(x) = \begin{cases} 1, & \text{iff } x \geq 0 \\ 0, & \text{iff } x < 0 \end{cases} \quad (3.2)$$

In a result of what I mentioned above, it was observed that the LBP manger is never changing on with the conversion of gray scale. Also it is keeping themeasurable amount of the brightness. That is an important thing to notice.

The $LBP_{(P,R)}$ manger giving us a 2^P unique output values. This amount is belonging to 2^P different values of binary pattern of the surrounding points. Here is a thing to notice, when we are changing the position of the points let's say we rotate it to different position, every points that is surrounding the middle pixel also we move (rotate) except the patterns which has a values of 0 and 1 will not move. Thus to avoid this rotation effect we have to use a method which is called a rotation invariant method that have the equation below.

$$LBP_{P,R}^{Ri} = \min \{ROR(LBP_{P,R}, i) | i = 0, 1, 2, \dots, P - 1\} \quad (3.3)$$

Where $ROR(x,i)$ referred to the circular bit-wise right shift on the P-bit number x i times. $LBP_{P,R}^{Ri}$ The calculating the change of happiness of the statistics in the rotation invariant belonging to specific micro-features in the picture; for this reason, in some articles they consider the patterns as a feature detector. Nevertheless, in some articles it was shown that it is not important thing for the manager of the rotation invariant to give a special information, because $LBP_{P,R}^{Ri}$ is already contains the frequency occurred of every pattern. Also it is having a large variation of the simple quantization of the angular spaces at 45° intervals[32].

From studies and research I have noticed that there are some of the patterns which is giving us more information's compared to the others. In addition if anyone want to clarify or explain any texture picture the only possible thing is to use the subset of 2^P binary patterns. OJALA et al who first introduced LBP called these patterns a uniform patterns and represented by $LBP_{p,r}^{U2}$. A LBP known if it is uniform or not by looking if it has two bitwise transitions or a moving from 0 to 1 only twice not more than that also the opposite . It can be move from one to zero. Let's say "00000000" (0 change) and "00111000" (2 change) so both are uniform. In the other hand a four change can be written as "11001001" and the six change can be written as "01010011" this both are not uniform. In addition we say the pattern is circular if it has string bit [32].

Some researchers shown in their observations that in the texture images the uniform patterns amount is approximately about ninety percent of all the patterns in an 8, 1 which is different from the neighborhood of the 16, 2 which have a seventy percent. In a same experiment which was calculated by the “FERET database” it shows that 90.6% of the patterns in a (8, 1) neighborhood and 85.2% in a (8, 2) neighborhood are uniform. In addition to this observations a recent observation by SHAN and GRITTI proved in the study of device depends method to represent the face give an occurrence of the uniform pattern. In their experiments they used ADABOOST in getting the unique representation that help us to detect the face and knowing it. Briefly their experiments explain that when we are using the 8, 2 manager for getting the representation of the pattern, there are ninety one percent of them which considered as uniform. Additionally when we collect the remaining patterns which they are not uniform that will give us a result of lower than 2^P labels. Essentially, the total number of labels in 8 pixels neighborhood is 256 for the basic LBP, yet only 59 for LBP^{U2} [32].

Additionally we have to notice that when the original local binary pattern manager intended ZABIH and WOODFILL present a method which called “Census Transform (CT)” method. This method looks like LBP method. Census Transformer doing the same for local neighbor surrounding a pixel into a binary string. Comparing between the two methods (“LBP and CT”) they differ in ordering of the bit [32].

3.2.3 Gray-Level Co-occurrence Matrix

The other feature extraction that used in this study is the gray-level Co-occurrence matrix technique. With this technique the specific statistical properties of the computation are computed. To compute these properties one must first obtain the gray-level coincidence event matrix for the input image. The output of this matrix is such that when n is the intensity level in the image. The output of the matrix will be $n \times n$.

This matrix contains the second-order statistics of neighborhood pixels in an image. Based on this matrix, such as contrast, the criterion for measuring the intensity contrast between a pixel and all neighboring pixels in the whole image, the measure of similarity of each pixel to all neighboring pixels in the whole image, energy, entropy, etc. are calculated.

Our observation of palm print image is to be allocated to regions with normal tissues. Using co-occurrence matrices so that in normal tissues need to represent. As in the figure 3.5, 0° , 45° , 90° and 135° from the co-occurrence matrix is used.

In figure 3.5 the example of GLCM is illustrated.

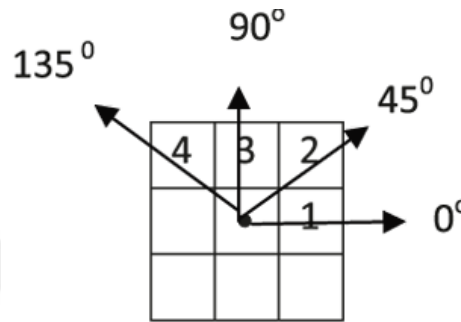


Figure 3. 5: GLCM construction based on a (a) test image along four possible directions (b) 0° (c) 45° (d) 90° and (e) 135° with a distance $d = 1$.

3.2.3.1 Feature extraction using entropy methods (Gray Level Co-Occurrence matrix)

In this thesis, gray level coexistence matrix (GLCM) is used for feature extraction. There are 4 ways to extract attributes in GLCM. The distance is also important for pixels. In this thesis, we use $D = 3$, $\theta = 0$ degrees, 45 degrees, 90 degrees, and 135 degrees for GLCM [33][34]. So there are four building matrices. According to the GLCM on each computer, the successful constituent matrix that describes the performance of the statistical property is the best-case scenario calculation. We also used the second angle of moment, contrast, correlation, difference, entropy, homogeneity, maximum likelihood, mean. The equations of these properties are as follows: [33][34].

The GLCM is calculated at $d = 3$, $\theta = 0^\circ$, 45° , 90° and 135° . So there are four building matrices. According to GLCM on each computer, a successful matrix 8 is created, which describes the statistical property attribute. The equations of these properties are as follows:

1- Contrast:

$$f_1 = \sum_i \sum_j (i - j)^2 p(x, y) \quad (3.4)$$

2- Correlation:

$$f_2 = \sum_i \sum_j \frac{(i-\mu_x)(j-\mu_y)p(x,y)}{\sigma_x \sigma_y} \quad (3.5)$$

3- Entropy:

$$f_3 = \sum_i \sum_j \left(\frac{p(x,y)}{\log p(x,y)} \right) \quad (3.6)$$

4- Homogeneity:

$$f_4 = \sum_i \sum_j \left(\frac{p(x,y)}{1+|i-j|} \right) \quad (3.7)$$

In this equations x and y represent the coordinate of pixel. The output of GLCM matrix is represented by $p(x, y)$. The length of row and column of image are i and j respectively.

5- Angular Second Moment:

$$f_5 = \sum_i \sum_j p(x,y)^2 \quad (3.8)$$

6- Contrast:

$$f_6 = \sum_i \sum_j (i-j)^2 p(x,y) \quad (3.9)$$

7- Correlation:

$$f_7 = \sum_i \sum_j \frac{(i-\mu_x)(j-\mu_y)p(x,y)}{\sigma_x \sigma_y} \quad (3.10)$$

8- Dissimilarity:

$$f_8 = \sum_i \sum_j |i-j| p(x,y) \quad (3.11)$$

9- Entropy:

$$f_9 = \sum_i \sum_j \left(\frac{p(x,y)}{\log p(x,y)} \right) \quad (3.12)$$

10- Homogeneity:

$$f_{10} = \sum_i \sum_j \left(\frac{p(x,y)}{1+|i-j|} \right) \quad (3.13)$$

11- Maximum probability

$$f_{11} = \max \left(\frac{p(x,y)}{i*j} \right) \quad (3.14)$$

12- Mean

$$f_{12} = \frac{\sum p(x,y)}{i*j} \quad (3.15)$$

Where, x and y is coordinate of pixel. $p(x,y)$ is intensity of output gray level co-occurrence matrix. i and j is the length of row and column of image.

3.3 CLASSIFICATION

3.3.1 Euclidean norm

In an ordinary Euclidean space, vectors are representable as oriented segments between points in that space. Given a vector of a Euclidean vector space, the norm of a vector is defined as the Euclidean distance (in a straight line) between two points A and B that delimit said vector. In fact, in a Euclidean space the norm of a vector coincides precisely with the modulus of the vector \vec{AB} .

In two dimensions:

$\|\vec{AB}\| = \sqrt{(b_1 - a_1)^2 + (b_2 - a_2)^2}$ being $\vec{OA} = (a_1, a_2), \vec{OB} = (b_1, b_2)$ and the coordinate origin of said space.

Extending the above to the three-dimensional Euclidean space, it is also elementary that:

$\|\vec{AB}\| = \sqrt{(b_1 - a_1)^2 + (b_2 - a_2)^2 + (b_3 - a_3)^2}$ being $\vec{OB} = (b_1, b_2, b_3)$

In the general case of a n - dimensional Euclidean space we have:

$\|\vec{AB}\| = \sqrt{(b_1 - a_1)^2 + (b_2 - a_2)^2 + \dots + (b_n - a_n)^2}$ being $\vec{OA} = (a_1, a_2, \dots, a_n), \vec{OB} = (b_1, b_2, \dots, b_n)$.

From the above it follows that, fixed a basis orthonormal \mathcal{B} in which a vector \mathbf{v} is given by its components in this base, $\mathbf{v}_{\mathcal{B}} = (v_1, v_2, \dots, v_n)$ then the norm of said vector is given by:

$$\|\mathbf{v}\| = \sqrt{v_1^2 + v_2^2 + \dots + v_n^2} = \sqrt{\sum_{i=1}^n v_i^2} \quad (3.16)$$

In this thesis we used the Euclidian distance method for finding the minimum distance between the test and train features.

4. EXPERIMENTAL RESULT

In this thesis the local binary pattern are used for feature extraction of the palmprint images. Then from each image the gray level co-occurrence matrix features are calculated. The goal of this thesis is implementing the famous database of palmprint and using the LBP and GLCM together for feature extraction for palmprint image recognition. The principle component analysis, maximum entropy, traditional local binary pattern etc. are used for feature extraction methods.

4.1 IMAGE PRE-PROCESSING

In image pre-processing the image need for enhancement. Actually the palmprint images has low quality and this is big problem in palmprint recognition. For this reason we need some preprocessing like the filtering, skeletonization, and extract the high information from images. Therefore, with enhancement of these images we will get high accuracy and high recognition performance. As example we used the database in this study is carried out from Polytechnique Taiwan university palmprint database that is publicly available. This database contains 500 people images from inside of hands and provided images are index finger, middle finger and ring finger and for each palm imagetwelve different images are captured.

4.2 LOCAL BINARY PATTERN (LBP)

In many different studies, local binary pattern (LBP) has been accepted as one of the most useful methods. In many applications, very strong results have been obtained and this method has become widely used in quite different fields such as computer vision, photo analysis. The removal of the characteristic of the finger veins played an important role in computer vision and image processing. This method, which is famous for handling a pixel with the pixels around it, was first used by Ojala et al[35]. There are many applications that recommend this method because it is effective and efficient considering the criteria such as discrimination performance and processing time. Local binary pattern (LBP) works by handling the values in the $3 * 3$ area around the pixel. Then, in this area, the difference between the remaining pixels and the middle pixel is found [36].

4.2.1 Description of the Local Binary Pattern

There are many methods inspired by the LBP operator. In this way, the successful development of neighborhood definitions in images has been achieved. One of them is local phase quantization. This method depends on the phase where Fourier Transform will be applied in the neighborhood. Under some conditions, the phase can be viewed as a constant feature. Recently, this method has been used quite widely in defining constant properties. Comparing with the LBP approach, the histogram of this method is used for surface identification purposes. In addition, this method is insensitive to blur and therefore proven to be exceptionally successful, especially in facial recognition.

LBP can be compared to a painter who can obtain a brand new painting made with numbers from virtually any painting. The ideal and most common use of this concept is made for still images, but the concept has been expanded similarly for recorded images and volumetric applications. An important point in the logic of LBP is to be able to express the points in the picture obtained in a symbolic way, that is, with numbers, because this will be necessary in all operations.

The equation (4.1) shows the composing relationship of local binary pattern in each pixel:

$$LBP_{P,R(x,y)} = \sum_{p=0}^{P-1} s(g_p - g_c) 2^p \quad (4.1)$$

Which s denotes the sign 1, g_p and g_c , denotes the amount of the gray levels of neighboring and central pixels. Also 2^p is a required factor for each neighbor because LBP method contains tissues with different ratios.

4.2.2 The Uniform Local Binary Pattern

If a local binary pattern consists of a maximum of 2-bit transition from 0 to 1 or vice versa is called uniform. For example 0000000000 patterns (0 transition) and 11001001(4 transitions) are respectively the uniform and non-uniform. It has been shown that using the neighborhood (1, 8) and (16, 2) respectively are about 90% and 70% of entire pattern. The overall pattern of binary with P bits consists of P+2(P-1) of monotone model. From $LBP_{P,R}^{u2}$ notations has been using for

LBP uniform which below script express use of neighborhood (P,R) and the superscript indicates the using of uniform pattern .Uniform binary model according to equation (4.2) is calculated.

$$LBP_{P,R}^{U_2}(x,y) = \begin{cases} I(LBP_{P,R}(x,y)) & \text{if } \begin{cases} U(LBP_{P,R}) \leq 2 \\ I(z) \in [0, (P-1)P+2] \end{cases} \\ (P-1)P+2 & \text{otherwise} \end{cases} \quad (4.2)$$

That U(x) is the detonator of the number of transitions between bits, and is defined like equation (4.3):

$$U(LBP_{P,R}) = |s(g_{P-1} - g_c) - s(g_0 - g_c)| + \sum_{P=1}^P |s(g_{P-1} - g_c) - s(g_{P-1} - g_c)| \quad (4.3)$$

If U(x) is smaller than 2 pixels, the currently pixels labeled with an indicator function I(z), otherwise, the (P-1) P+2 will assigned to it. Indicator function index I(z) which includes the (P-1) P+2 which is applied for specific index for to each of the uniform patterns.

4.3 APPEARANCE DATABASE

The databases of images that used in this article, is part of the image database which is collected at Hong Kong Polytechnic University. A device that is used for taking pictures is scanner which is based on CCD camera. The size of images is 384×284 pixels with 750 dpi resolution. Figure 4.1 shows the image acquisition device and the sample images which is captured by it.

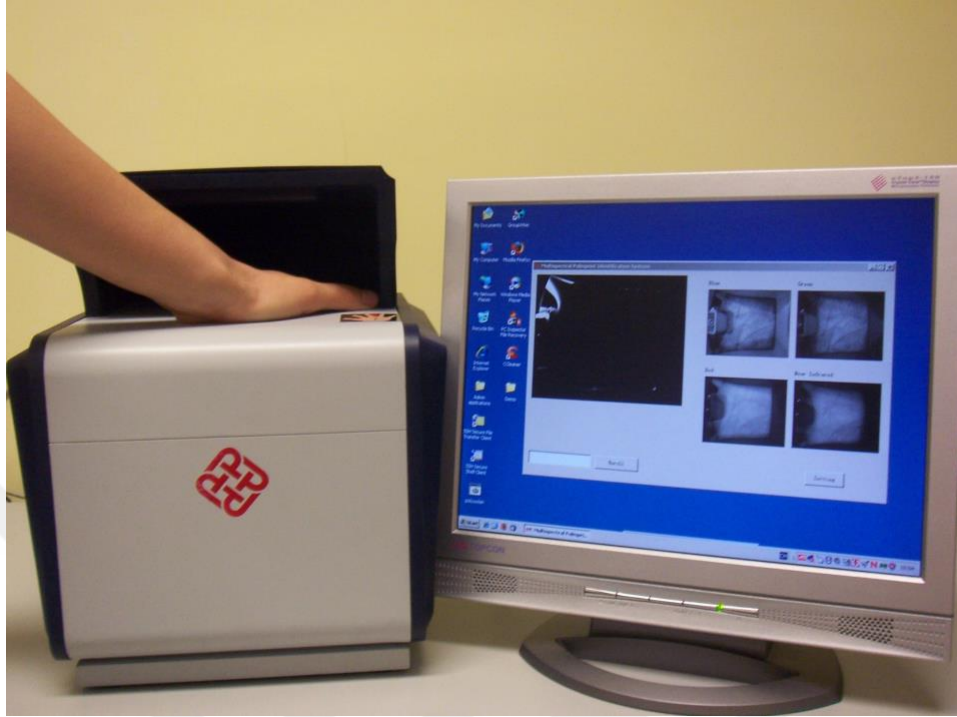


Figure 4. 1. Image acquisition device and the sample images which is captured by it.

To evaluate the proposed method, a number of image from this databases are selected these image due to skin pigmentation and the small difference between levels of gray lines and other areas; they have different levels of brightness. The size of the original images is 384×284 . After preprocessing, the central part of the image (size is 128×128), is cropped for feature extraction and matching. Figure 4.2 shows some samples of one palm after preprocessing.

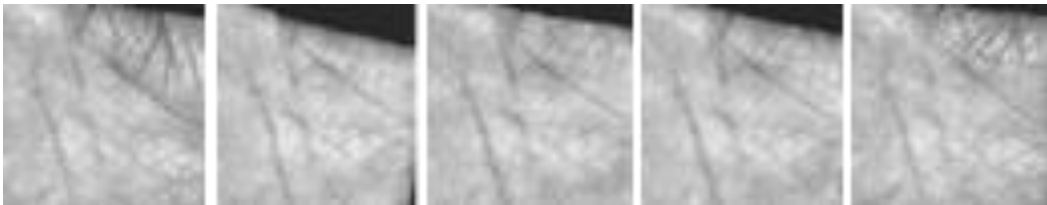


Figure 4. 2. Some samples of one palm after preprocessing

4.4 THE SIMULATION RESULTS

Evaluations were done on a standard database of palms of Polytechnic University of Hong Kong Poly U Palm print. Dataset included the 600 picture of palms of 500 person which is included in

the approximately there are 12 available images from per person. There are two solutions for calculating the similarity between feature vectors. Ones calculate the distance between two feature vectors, and second, calculate the similarity. These two measurements are against each other. There are different criteria to evaluate the distance and similarity, that in this thesis, the similarity between test image S and the training image T we used chi-square distance.

It is expressed as Eq. 4.4.

$$D(S,T) = \sum_{n=1}^N \frac{(S_n - T_n)^2}{(S_n + T_n)} \quad (4.4)$$

Minimum 1 and maximum 4 images in the palm of our test subjects got used to the training.

Experiments were performed on the database. The proposed method has higher accuracy than the LBP standard. Performance-based approaches which appear strongly have been influenced by the number of training images. So in the third experiment, we investigated the influence of this parameter on our method. In this experiment we used minimum and maximum of 4 images of per person to train ourselves. Experiments were performed on the database, and the results are presented on different algorithms.

In our experiments the number of training images for one of the database has changed from 1 to 4, and the last photo is selected for testing. This experiment was performed 20 times in each stage. The obtained average values are recorded. In Figure 4.3, the change in accuracy percentage terms of the training number images is shown.

Experiments were conducted to demonstrate the performance of the proposed approach. Our algorithm was validated on palm print images. The proposed recognition method outlined for Palm print images were implemented using the Matlab programming language and run on a PC with an Intel, Duo CPU 2.00 GHz, 2.00 GB of RAM and yielded the results in the figure 4.3, 4.4. In the experiment, we selected the samples from the first session for training, and the samples from the second session for testing. Thus the total number of training samples and test images are both 300. Proposed LBP method is an effective method; no less than 4% improvement could be gotten by multiscale scheme. As more information could be extracted, the proposed method could get better result than traditionally multiscale method.

We have run the Matlab code with these possible scenarios and obtained their results. The simulation result for LBP is illustrated in table 4.1.

Table 4. 1:Result from LBP

Scenario	Train number	Test number	Best Result	Worst result	Average
1	1	11	95.5	83	92.25
2	2	10	100	97.5	98.3
3	3	9	100	97.5	99.1
4	4	8	100	98	99.15
5	5	7	100	98.5	99.4
6	6	6	100	98.5	99.5
7	7	5	100	97	99.05
8	8	4	100	97.5	98.85
9	9	3	100	99.5	99.7
10	10	2	100	98.5	99.15
11	11	1	99.5	97.5	98.4

Accuracy percentage vs. training sample with using LBP is shown in figure 4.3.

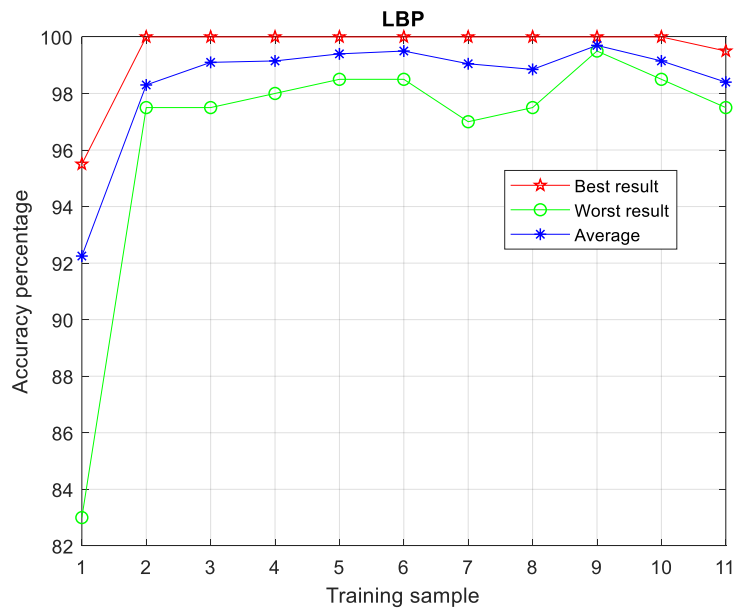


Figure 4. 3: Accuracy percentage vs. training sample with using LBP

The simulation result for GLCM is illustrated in table 4.2.

Table 4. 2: Result from GLCM

Scenario	Train number	Test number	Best Result	Worst result	Average
1	1	11	28	12.5	21.25
2	2	10	32	16.5	26.05
3	3	9	34.5	21.5	28.3
4	4	8	33.5	22.5	29
5	5	7	33.5	28	30.35
6	6	6	34.5	24.5	29.75
7	7	5	30	23.5	26.5
8	8	4	30	24	27.05
9	9	3	30	22.5	26.75
10	10	2	25	20	23.5
11	11	1	24.5	19	22.4

Accuracy percentage vs. training sample with using GLCM is shown in figure 4.4.

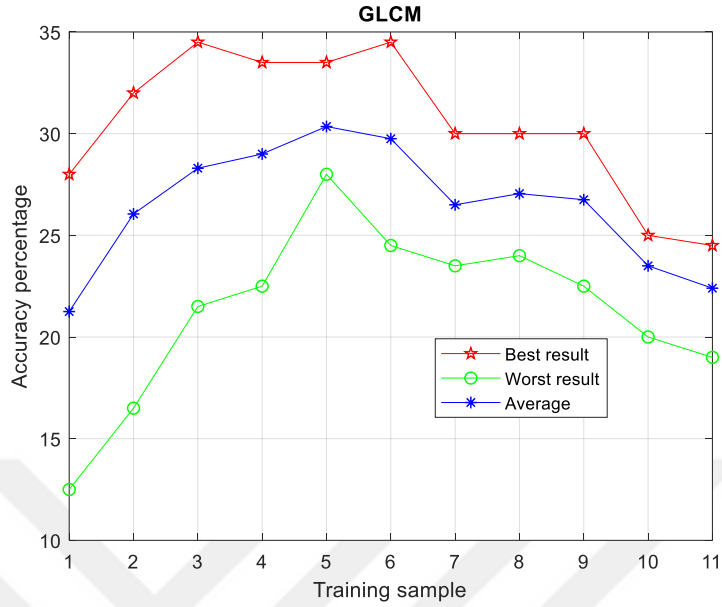


Figure 4. 4: Accuracy percentage vs. training sample with using GLCM

The simulation result for LBP with GLCM is illustrated in table 4.3.

Table 4. 3: Result from combined LBP and GLCM

Scenario	Train number	Test number	Best Result	Worst result	Average
1	1	11	29.5	16.5	22.9
2	2	10	31.5	18.5	25.45
3	3	9	34	26	30.5
4	4	8	33.5	22.5	29.35
5	5	7	33.5	26	30
6	6	6	32.5	24.5	28.75
7	7	5	33	25	27.3
8	8	4	26.5	20	24.2
9	9	3	24	18.5	21.1
10	10	2	24	18	21.2
11	11	1	24	18	21.5

Accuracy percentage vs. training sample with using LBP with GLCM is shown in figure 4.5.

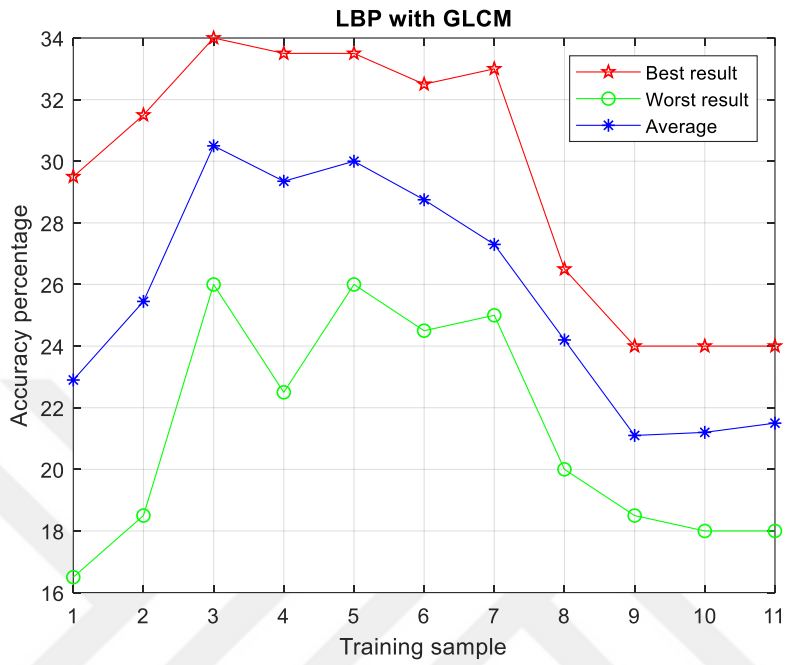


Figure 4. 5: Accuracy percentage vs. training sample with using combined LBP and GLCM

5. CONCLUSION AND FUTURE WORKS

5.1 CONCLUSION

With the development of technology every day, the devices technology also changing. In the result of that the person safety and security should also developed. We can notice that there are number of devices starting using a new security for devices especially in our phones they are starting using the face recognition technique instead of the old technique which is the palmprint. Palmprint security is taking place in many application. But this technology showed to be not much secure.

The aim of this thesis is to use the local binary pattern, which is strong in state, light changes. Additionally, most of the palm recognition systems which based on binary pattern uses for identifying , just from a steady local binary pattern form and only with a certain scale. Obtained characteristics by using local binary pattern single-scale methods gain structure of the image at a particular resolution is not useful for diagnosis of overall image texture and by this method with many discriminate models to obtain useful properties are excluded. Multi-scale approach can provide more features under different settings. So to achieve more discriminate features with less waste, we use from combination of uniform local binary pattern with a different radius.

In this thesis a human identification using palmprint image with local binary pattern is presented. Human identification with its high safety performance became famous in many security devices. Palmprint identifying technique has become the most preferred because it's low device restrictions and avoid forgery. Generally it focuses on several aspects. First, palmprint image identification system presented. Also the methods have been used for extracting features of the palmprint image is shown. Finally the local binary pattern used for the propose of this project. In this thesis, a robust method for palmprint recognition with gray level co- occurrence matrix based on the local binary pattern presented. The combination of local binary pattern and gray level co- occurrence matrix give the robust accuracy than other methods. The simulation results show that this method is robust and fast for feature extraction and classification.

5.2 FUTURE WORKS

In future we can use the real time application for palmprint recognition. Also we can use the proposed method for palm vein recognition.



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