© IJCIRAS | ISSN (O) - 2581-5334
May 2020 | Vol. 2 Issue. 12

PERFORMANCE ANALYSIS OF FEATURES EXTRACTION ON IRIS RECOGNITION SYSTEM

Thiri Kyaw[1], Khaing Thanda Swe[2], Phyo Thu Zar Tun [3]

Lecturer, Mandalay Technological University, Mandalay, +095, Myanmar

Abstract

One of the most reliable biometric advancements is iris recognition system. The performance of an iris recognition system can be determined by the feature extraction time and recognition rate. The selection of the feature subset and the classification has become an important issue in the field of iris recognition. In the proposed system, it implements the iris recognition system using a new correlation method based on entropy and skewness. Here, the system uses the eye image from the CASIA Iris Database version 4.0 instead of scanning from the eye camera real time. After that the system removes the noise from the eye image using median filtering. Then the system detects the edge using Sobel edge detection. And the system performs the segmentation with the degree of 36. So the segments are a total of 10. Finally the system extracts the features using the correlation method based on entropy and skewness. Then the system evaluates the performance of the iris features extraction compared with other traditional iris feature extraction system.

Keyword: — iris, entropy, CASIA and skewness

1.INTRODUCTION

Today, the use of computers in various fields is becoming more and more important with the advance of information and communication technology. Most of the people who want to get quickly the information about their applications and requirements are using the advancement of digitized system to accept their required information sources.
Physiological and behavioral attributes as of now utilized for programmed ID incorporate fingerprints, voice, iris, retina, hand, face, penmanship, keystroke, and finger shape. Be that as it may, this is just a halfway rundown as new measures, (for example, step, ear shape, head reverberation, optical skin reflectance and personal stench) are being built up constantly. As a result of the wide scope of attributes utilized, the imaging prerequisites for the innovation shift extraordinarily. Frameworks may quantify a simultaneous one-dimensional sign (voice); a few synchronous one-dimensional signs (hand-composing); a simultaneous two-dimensional picture (unique mark); numerous two-dimensional measures (hand geometry); a period arrangement of two-dimensional pictures (face and iris); or a three-dimensional picture (some facial acknowledgment frameworks). The perfect biometric trademark has five characteristics: robustness, uniqueness, accessibility, availability and adequacy.
With increasing technologies on human identification, iris recognition has mostly got the intriguing topics. The proposed system implements the faster feature extraction and better recognition rate using entropy, skewness and correlation in terms of statistical feature extraction. And then the system evaluates the performance with the traditional iris recognition system [1].

Figure1. Image of IRIS

2. LITERATURE REVIEWS

Many researchers have done on work of Iris Recognition System, since last 3-4 years. Most of the cases, authors claimed the better performance of speed in capturing images and recognition over the existing systems available at that time. To gather the knowledge, we have considered the following selective works.

The digital personal identification system was the result of some visionary thinking by people in the early 21st century that saw great potential value in allowing computers to share information on research and development in scientific and military fields. In 1998, W.W.Boles and B.Boashash in reported a new algorithm for recognizing the iris of the human eye based on the wavelet transform is presented. It uses only a few selected intermediated resolution levels for matching, thus making it computationally efficient and less sensitive to noise and quantization errors. The proposed iris recognition system is designed to handle noisy conditions as well as possible in illumination and camera-to-face distances [2].

Although significant progress has been achieved iris recognition, some problems remain unsolved. To evaluate the performance of the existing iris recognition algorithms and provide more knowledge of essential information of iris characteristics, larger iris databases are needed. In 2011, P.P.Chitte, J.G.Rana, R.R.Bhambare, V.A.More, R.A.Kadu and M.R.Bendre in focused on the construction of iris databases with synthesis method. The objective of this system was to produce a working prototype program that functions as an iris recognition tool using the algorithms described by Professor John Daugman and other systems so as to execute this in an exact and helpful manner that is additionally easy to use. Right now, iris image combination technique dependent on Principal Component Analysis (PCA), Independent Component Analysis (ICA) and Daugman's elastic sheet model is proposed [3].

In 2012, Pankaj P.Chitte, J.G.Rana and Sachin Taware in proposed an iris image synthesis method based on Principal Component Analysis (PCA), Independent Component Analysis (ICA) and Daugman’s rubber sheet model & hybrid model. Here, different techniques i.e. ICA,PCA, Daugman’s rubber sheet model & hybrid model which is combination of all above three along with RFID system are compared. After using lot many algorithms for iris recognition, Daugman’s rubber sheet model is better. And if distance between input error and validation error for image is small then performance is good and performance is poor for large distance [4].

Wildes [4] prepared iris segmentation through straightforward sifting and histogram activities. Eyelid edges were recognized when edge identifiers were prepared with horizontal and afterward displayed as parabolas. No direction preference leaded to the pupil boundary.

Boles and Boashah [6], Lim et al., Noh et al. and Tisse et al. mostly centered on the iris image representation and feature matching, and didn't present the data about noise removing. Kong and Zhang presented a noise detection model in. As every other strategy, noise regions were fragmented from unique iris images.

In 1936, ophthalmologist Frank Burch proposed the idea of utilizing iris designs as a strategy to perceive a person. In 1985, Drs. Leonard Flom and Aran Safir, ophthalmologists, proposed the idea that no two irides are similar, and were granted a patent for the iris distinguishing proof idea in 1987. Dr. Flom drew closer Dr. John Daugman to build up a calculation to develop recognizable proof of the human iris. In 1993, the Defense Nuclear Agency started work to test and convey a model unit, which was effectively finished by 1995 because of the joined endeavors of Drs. Flom, Safir, and Daugman. In 1994, Dr. Daugman was granted a patent for his developed iris acknowledgment calculations. In 1995, the primary business items opened up. In 2005, the wide patent covering the fundamental idea of iris acknowledgment, giving showcasing chances to different organizations that have built up their own calculations for iris recognition. The patent on the Iris Codes implementation of iris recognition developed by Dr.Daugman will not expire until 2011 [5].

But most of the existing methods have limited capabilities in recognizing relatively complex features in realistic practical situations. To meet the increasingly security requirement of the current commercial society, personal identification is becoming more and more important. Now the proposed system implements the better feature extraction time and recognition rate than the traditional methods using statistical iris features and correlation.

3. BACKGROUND THEORY

This section describes the general knowledge of the methods used in proposed feature extraction system. It presents about introduction to iris recognition and working flow of iris recognition.

3.1. Introduction to Iris Recognition

Before acknowledgment of the iris happens, the iris is found utilizing features highlights. These features highlights and the particular state of the iris take into account imaging, include separation, and extraction. Localization of the iris is a significant advance in iris acknowledgment in light of the fact that, whenever done inappropriately, resultant commotion (e.g., eyelashes, reflections, students and eyelids) in the picture may prompt terrible showing [7].

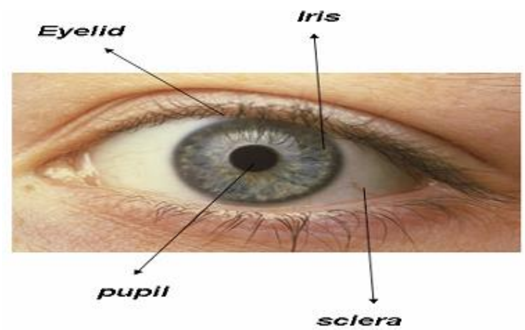


Figure 2. A front-on view of the iris [7]

Iris imaging requires utilization of an excellent advanced camera. The present business iris cameras regularly utilize infrared light to illuminate the iris without making harm or discomfort to the subject. Iris patterns are depicted by an IrisCode utilizing stage data gathered in the phasors. The stage can't paradoxically, camera increase, or enlightenment levels. The stage normal for an iris can be depicted utilizing 256 bytes of information utilizing a polar facilitate framework. Also included in the description of the iris are control bytes that are used to exclude eyelashes, reflection, and other unwanted data [7].

3.2. Eye Image Acquisition

Iris recognition has been an active research region throughout the previous not many years because of its high accuracy and the encouragement of both the government and private entities to replace conventional security frameworks, which endure observable safety buffer. Be that as it may, early research was discouraged by the absence of iris images. Presently a few free databases exit on the web for testing utilization.
A well known database is the CASIA Iris Image Database (version 1.0 and 3.0) provided by the Chinese Academy of Sciences. The CASIA version 1.0 iris image database includes 756 iris images from 108 eyes collected over two sessions over a period of two months. The images are the size of 320*280 pixels. There are 2655 iris images of size 320*280 pixels from 396 eyes in CASIA Iris Image Database Version 3. The CASIA Iris Image Database Version 4.0 has 54601 iris images of size 320*280 pixels from 512 people.
A person stands in front of the iris identification system, generally between one and three feet away, while a wide angle camera calculates the position of the eye. The time it takes for a iris system to identify the iris is approximately two seconds. Due to so many unique characteristics, the iris has six times more distinct identifiable features than a fingerprint [8].

3.3. Eye Image Preprocessing

In the preprocessing stage, the images are changed from RGB to gray level. Before performing iris design coordinating, the limits of the iris ought to be found. As such, we should identify the piece of the image that stretches out from inside the limbus (the border between the sclera and the iris) to the outside of the pupil.
The preprocessing is composed of three steps:
(i) Iris localization
(ii) Iris normalization
(iii) Image enhancement
(i) Iris Localization

Iris Localization step involves in detecting edges using some edge detectors followed by boundary detection algorithms. The works of iris localization are:

1. Detect Iris's two boundaries:
- pupillary boundary or inner boundary
-outer boundary or Limbic boundary
2. The inner boundary is so much darker and easy to detect it.
3. But the outer boundary is difficult to detect cause of the low contrast between the two sides of the boundary.
4. So, the outer boundary can be detected by maximizing changes of the perimeter-normalized sum of gray level values along the circle.

(ii) Iris Normalization

To compensate the deformation in the iris texture, it is easy to map the iris ring to a rectangular block of texture of a fixed size. Once the segmentation module has estimated the iris's boundary, the segmentation module uses image registration technique to transform the iris texture from Cartesian to polar coordinates. The procedure, regularly called iris unwrapping, yields a rectangular entity that is utilized for processing.

Iris normalization is a step in which iris is unwrapped to a rectangular strip for feature extraction. Iris images of the same eye have different iris sizes due to the difference between camera and eye. Brightening has direct effect on pupil size and causes non-straight varieties of iris patterns. A legitimate normalization system is required to change the iris image to compensate these variations.

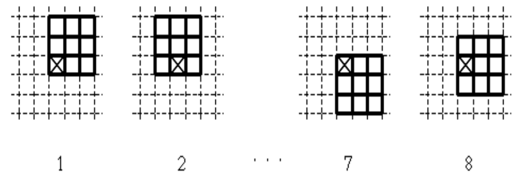
Iris Normalization has three advantages:

- It represents varieties in pupil size because of changes in outer light that may impact iris size.
- It guarantees that the irises of various people are mapped onto a typical picture space notwithstanding the varieties in understudy size across subjects.
- It empowers iris registration during the coordinating stage through a basic interpretation activity that can represent in-plane eye and head rotations.

Related with each opened up iris is a paired veil that isolates iris pixels (marked with a "1") from pixels that compare to the eyelids and eyelashes (named with a "0") distinguished during division. After standardization, photometric changes upgrade the opened up iris' textural structure [9].

(iii) Noise Removal (Median Filtering)

The acquired image always contains not only the 'useful' parts but also some 'irrelevant' parts. One such method is known as median filtering. The median filter is based on neighborhood operation. It consists of a window which is encompassed over the image to order pixels in the image area and then replace the central pixel with determined pixels. Then, the texture features are extracted from the median filtered image for the retrieval on similar images.



- Consider each image pixel (i,j).
- Calculate dispersion in the mask for all possible mask rotations about pixel(i,j) according to the equation.
- Choose the mask with minimum dispersion.
- Assign to the pixel g(i,j) in the output image the average brightness in the chosen mask.

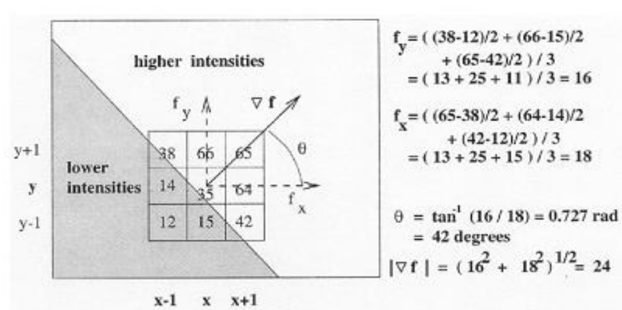
3.4. Sobel Edge Detection

One of the most commonly used edge detectors is Sobel operator. In this operator, gradient is calculated in 3*3 neighborhood pixels for the gradient calculations. The Sobel operator is magnitude of the gradient computed by the following equation.

Mag $=\sqrt{S_x^2 + S_y^2}$

Sx is the first order partial derivatives in x and Sy is the first order partial derivatives in y direction respectively. If 3 dimensional matrix neighborhood of pixel (i,j) is as follows:

A1	A2	A3
A4	[i,j]	A5
A6	A7	A8



Then Sx and Sy are computed using the equations:

$S_x = (a_3 + ca_5 + a_8) - (a_1 + ca_4 + a_6)$

$S_y = (a_1 + ca_2 + a_3) - (a_6 + ca_7 + a_8)$,

where the constant c = 2.

These are implemented using convolution masks:

$$S_x = \begin{matrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{matrix} \quad \text{and} \quad S_y = \begin{matrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{matrix}$$

This operator places an emphasis on pixels that are closer to the center of the mask [9].

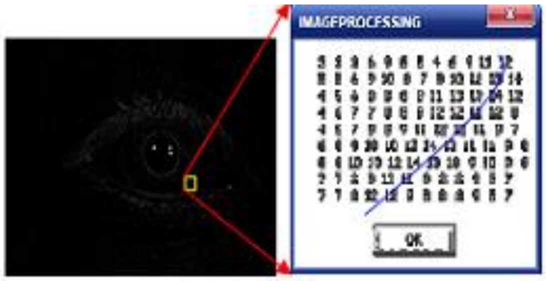


Figure 3. Gradient Image after Sobel Operator

3.5. Eye Image Segmentation

Iris segmentation, it is desired to distinguish the iris texture from the rest of the image. An iris is typically divided by distinguishing its inner (pupil) and outerl (limbus) boundaries. Notable strategies, for example, the Integro-differential, Hough change and dynamic form models have been effective systems in recognizing the boundaries. The main stage manages iris segmentation. This comprises in localize the iris inner(pupillary) and outer (scleric) boundaries. There have been two major strategies in r iris segmentation: to use a rigid or deformable template of the iris or its boundary. The next stage is the feature extraction. Iris recognition approaches can be classified into three major categories: phase-based methods, zero-crossing methods and texture analysis based methods. In the final stage, it is made a comparison between iris signatures, producing a numeric dissimilarity value. On the off chance that this value is higher than a threshold, the framework yields a "nonmatch", implying that every signature has a place with various irises. Otherwise, the system outputs a “match”, meaning that both signatures were extracted from images of the same iris [10].

3.6. Iris Features Extraction

Features are extracted using the normalized iris image. The most discriminating data in an iris pattern must be extricated. Just the noteworthy highlights of the iris must be encoded with the goal that examinations between templates can be made. The commonly used feature extraction methods are Gabor Filter, Log Gabor Filter, Zero Crossings of 1D Wavelets and Haar Wavelet.

One of the most interesting aspects of the world is that it can be considered to be made up of patterns. A pattern is essentially an arrangement. It is characterized by the request for the components of which it is made, instead of by the characteristic idea of these components. Indeed, this progression is dependable of extricating the examples of the iris considering the relationship between neighboring pixels. In this process statistical feature extraction methods are proposed for iris recognition process [10].

4. IMPLEMENTATION PROCESS OF PROPOSED SYSTEM

In the proposed iris statistical feature extraction, there are three main steps. These are eye image acquisition, eye image preprocessing and iris feature extraction.

(I) Eye Image Acquisition: The human iris is an annular region between the black pupil and the white sclera. Every subject has an important texture. The iris is a relatively small (typically about 1 cm in diameter), and dark object. The iris image is captured using a standard camera with both visible light and infrared light.

A high-quality camera for the capture of iris is so expensive and difficult to purchase. So, the proposed system uses the iris database from the production of Chinese Academy of Science Institute and Association (CASIA). The CASIA has produced three versions for the capture of iris image. The CASIA version 1.0 iris image database includes 756 iris images from 108 eyes collected over two sessions within a period of two months. The images are the size of 320*280 pixels. There are 2655 iris images of size 320*280 pixels from 396 eyes in CASIA Iris Database Version 3.0. The CASIA Iris Image Database Version 4.0 has 54601 iris images of size 320*280 pixels from 512 people. Here, the proposed system uses the CASIA version 4 iris database.

The CASIA Iris system of version 4.0 aims to be able to capture useful images in a volume of space 20 cm wide and 10 cm deep, at a distance of approximately 3 feet. The height of the capture volume is normally 20 cm.

Subjects may be required to remove sunglasses, depending on the optical density of those sunglasses. Most subjects should be able to wear normal eyeglasses or contact lenses.

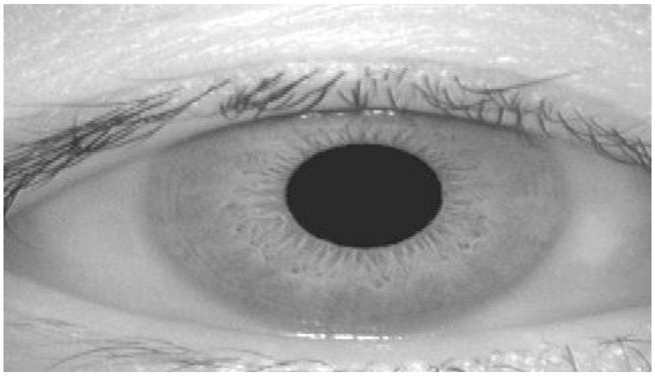


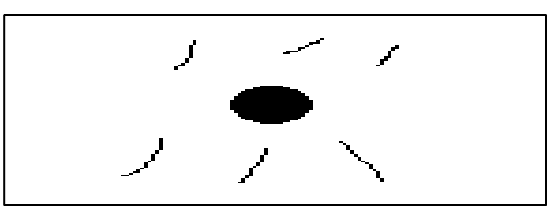
Figure 4. Eye Image Acquisition

(II) Eye Image Preprocessing: In the proposed eye image preprocessing, there are six steps. These are conversion to binary image, noise removal, finding the center of pupil, locating to the original eye, detecting the inner and outer boundary and segmentation.

Conversion to Binary Image: The system makes to extract two colored regions such as black and white region from the incoming user's eye image using thresholding function. In the proposed system, the threshold value is set to 50. If the eye image's intensity value is less than or equal to 50, the image is set to value zero (black). Otherwise, the image is set to value one (white).

$$f(x,y) = \begin{cases} 0 \text{ (Black)} & f(x,y) <= 50 \\ 1 \text{ (White)} & f(x,y) > 50 \end{cases}$$

After applying the thresholding function, the resulted eye image is a binary image.



Noise Removal: The acquired image always contains not only the "useful" parts but also some "irrelevant" parts. There are so many noise removal methods in the current research area. These are

To remove noise and get an enhanced image, the median filter is applied on the histogram equalized grayscale image. The median filter is based on neighborhood operations. It consists of a window which is encompassed over the image to order pixels in the image area and then replace the central pixel with determined values. The texture features are extracted from the median filtered image.

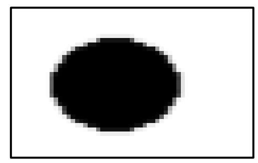


Figure 5.3. Noise Removal Image

Finding the Center of Pupil: In this stage, it is necessary to predict the center of the pupil.

$$C = (x_c, y_c) = \frac{1}{N}\sum_{i=1}^{N} Vi$$

where, N = number of pixels
Vi = value of intensity

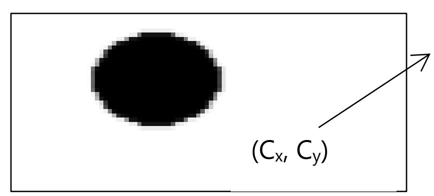


Figure 5. Center of Pupil

Locating to the Original Eye: In this stage, the system puts the pupil into the original eye image.

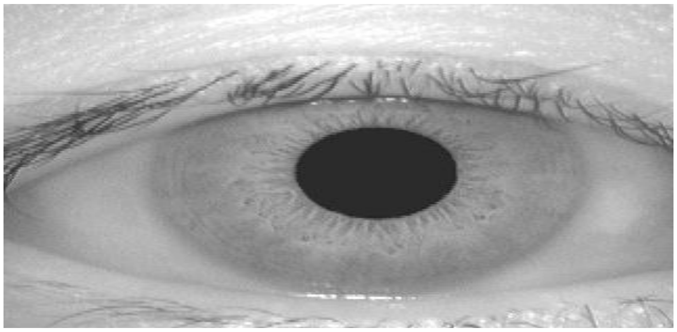


Figure 6. Locating Pupil to the Original Eye Image

Detecting the Inner and outer Boundary: An edge operator is a neighborhood operation which determines the extent to which each pixel's neighborhood can be partitioned by a simple arc passing through the pixel. The most common edge detection operators are Laplacian operator, zero-crossing operator, Prewitt, Roberts, Hough Transform Daugman's Method, Wildes Method, Boles Method, Li Ma's Method, integro-differential operator method and Sobel Edge detection method.

The proposed system uses the Sobel operator, one of the most commonly used operator. In this operator, gradient is calculated in 3*3 neighborhood pixels for the gradient calculations. The magnitude of the gradient is computed by the following equation:

Mag $=\sqrt{S_x^2 \quad} + S_y^2$

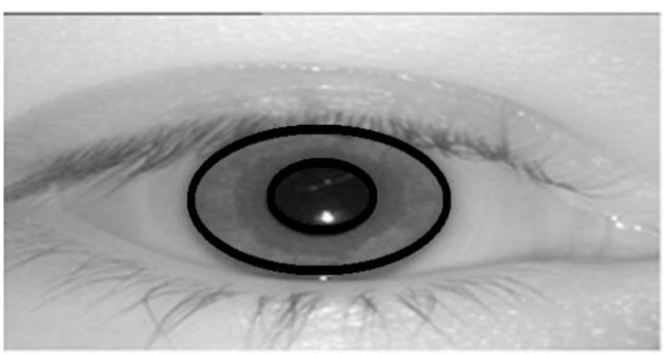


Figure 7. Edge Detected Image Using Sobel Operator

Segmentation: Segmentation is the first processing stage of an iris recognition system. In this stage, it is essential to segment the eye image into 10 sectors by 36 degree.

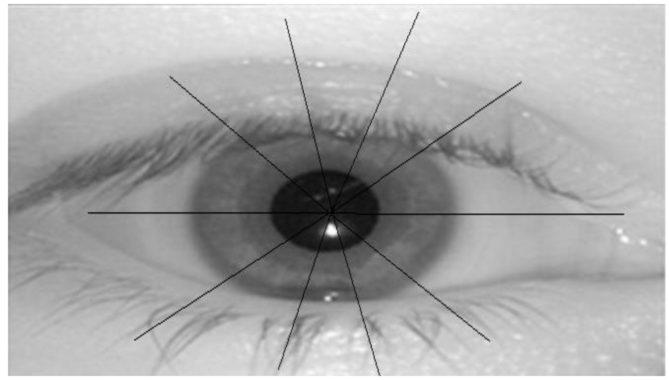


Figure 8. Segmented Eye Image

(III) Iris Feature Extraction: The next step of iris recognition is feature extraction. There are so many statistical feature extractions. Here, the proposed system uses two statistical feature; entropy and skewness.

The system segments the eye image into 10 sectors that each has 36 degree for the whole eye image. If the system takes the entropy value from these 10 segments, first it computes the average value of the intensity values from sector 1 to 10. Then the system stores the extracted feature value for entropy into the array [1-10].

H(X) = -∑ p(x) log p(x)

Moreover, the system takes the skewness value from the same eye image. The system computes the skewness value of the intensity values from segmented 10 sectors. Then, the system stores all extractedvalues into array [1-10].

The skewness is the measurement of the inequality of the intensity level distribution about the mean. The value can be positive or negative.

Positive: Large number of intensity values is on the right side of the mean.

Negative: Large number of intensity value is on the left side of the mean.

Zero: Distribution of intensity values is relatively equal on both sides of the mean.

SKEW = [∑(b-mean)2 p(b)]/ (stddev)3

Finally the system examines the relationship between entropy value and skewness value using correlation method.

5. RESULTS AND PERFORMANCE EVALUATION

This portion shows the comparison result of the following system with the proposed system in means of

feature extraction time (ms). The following systems have run the same platform.
Daugman tested the statistical independence methods. When these statistical independence methods are used by Daugman, the feature extraction time for this system is 682.5 ms.
Boles tested the wavelet transform method. The feature extraction time for Boles's wavelet transform method is 170.3 ms.
Li Ma tried iris texture analysis. The feature extraction time for these analysis is 244.2 ms.
Y.Wang attempted ICA (Independent Component Analysis) methods. The feature extraction time for this method is 426.8 ms.
The proposed system tested two statistical feature extraction methods such as mean and median. The proposed system has for feature extraction time running the same platform with the above methods.

Methods	Feature Extraction (ms)
Daugman	682.5
Boles	170.3
Li Ma	244.2
Y. Wang	426.8
Proposed correlation method	125.6

Table 1. Comparison of Proposed System with Existing System in Feature Extraction Time (ms)

In order to analyze the performance of the proposed method, 50 images are used for testing. For these images, all of them are taken from CASIA Iris Database Version 4.0. Then the system extracts the iris codes from statistical iris feature extraction method for 10 sectors. The system also carries out the feature extraction time for five sectors, ten sectors, fifty sectors, twenty sectors and thirty sectors. Then the system analyzes the feature extraction time for these sectors.

6. DISCUSSION AND CONCLUSION

In the proposed system, the main idea is to get the faster execution time compared with other traditional methods. The system uses the correlation method based on skewness and entropy. In this system, the segmentation portion is unique. The eye has 360 degree. So the system segments the 10 portions each with 36 degree. After that the system extracts the features from each portion using the statistical features extraction method especially entropy and skewness. Then the system computes the correlation between them. Finally the system evaluates the recognition using Eucildean distance. According to the test and result, the proposed system can give the faster execution time. The system is implemented with C# programming language.

REFERENCES

[1] C. Diaz (Ed.) et al.: Advanced Applications for e-ID Cards in Flanders, ADAPID Deliverable D2, Requirement Study, April 2006.
[2] The State of RFID Implementation and Its Policy Implications: An IEEE-USA White Paper, 15 April 2009.
[3] Emmett Erwin, Christian Kern.: Radio Frequency Identification in Libraries, March 2005, 18 (1).
[4] Contactless Payment and the Retail Point of Sale: Applications, Technologies and Transaction Models, A Smart Card Alliance Report, March 2003, PT- 03002.
[5] Daniel Castro.: Explaining International Leadership: Electronic Identification Systems, The Information Technology and Innovation Foundation, September 2011.
[6] European Technology Assessment Group.: RFID and Identity Management in Everyday Life, October 2006, Deliverable No. 2.
[7] Michael Silbermann.: Security Analysis of Contactless Payment Systems in Practice, November 2, 2009.
[8] Nuberk Saparkhojayev and Selim Guvercin.: "Attendance Control System based on RFID Technology". International Journal of Computer Science Issues, 9(3), May 2012.
[9] W.W.Boles and B.Boashash.: "A Human Identification Technique using Images of the Iris and Wavelet Transform". IEEE Transactions on Signal Processing, 46(4), April 1998.
[10] Mr.P.P.Chitte, Prof.J.G.Rana, Prof.R.R.Bhambare, Prof.V.A.More, Mr.R.A.Kadu, M.R.Bendre.: "Iris Recognition System using ICA, PCA, Daugman's Rubber

Sheet Model Together". International Journal of Computer Technology and Electronics Engineering, 2(1), 2011.