

Recognition Technique for ATM based on IRIS Technology

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Abstract—Iris recognition system has proven its capability in implementing reliable biometric security protocols in various high risk sectors like aviation, border patrol and defence. The banking and financial sector has to adopt this system because of its robustness and the advantages it provides in cutting costs and making processes more streamlined. The technology started out as a novelty however due exigencies in the banking sector characterized by decreasing profits it became a necessity. The use of Biometric ATM's based on iris recognition technology has gone a long way in improving customer service by providing a safe and paperless banking environment. A biometric system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. Biometrics gained lot of attention over recent years as a way to identify individuals. As technology and services have developed in the modern world, human activities and transactions have proliferated in which rapid and reliable personal identification is required. The developments in science and technology have made it possible to use biometrics in applications where it is required to establish or confirm the identity of individuals. The use of biometric indicia for identification purposes requires that a particular biometric factor be unique for each individual that it can be readily measured, and that it is invariant over time. Human iris on the other hand as an internal organ of the eye and as well protected from the external environment, yet it is easily visible from within one meter of distance makes it a perfect biometric for an identification system with the ease of speed, reliability and automation. The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. The iris is perforated close to its centre by a circular aperture known as the pupil. The function of the iris is to control the amount of light entering through the pupil, and this is done by the sphincter and the dilator muscles, which adjust the size of the pupil. The iris recognition systems have recently shown very high accuracies in verifying an individual's identity. A complete iris recognition system can be split into four stages: Image acquisition, segmentation, encoding and matching. The results of this system are very efficient for ATM transactions.

Keywords—Biometrics, IRIS, ATM, Segmentation, Feature extraction, IRIS localization, Normalization.

I. INTRODUCTION

Iris scan biometrics employs the unique characteristics and features of the human iris in order to verify the identity of an individual. The iris is the area of the eye where the pigmented or colored circle, usually brown or blue, rings the dark pupil of the eye. The iris-scan process begins with a photograph. A specialized camera, typically very close to the subject, no more than three feet, uses an infrared imager to illuminate the eye and capture a very high-resolution photograph. This process takes only one to two seconds and provides the details of the iris that are mapped, recorded and stored for future matching/verification. Eyeglasses and contact lenses present no problems to the quality of the image and the iris-scan systems test for a live eye by checking for the normal continuous fluctuation in pupil size. The inner edge of the iris is located by an iris-scan algorithm which maps the iris' distinct patterns and characteristics. An algorithm is a series of directives that tell a biometric system how to interpret a specific problem. Algorithms have a number of steps and are used by the biometric system to determine if a biometric sample and record is a match. Iris' are composed before birth and, except in the event of an injury to the eyeball, remain unchanged throughout an individual's lifetime. Iris patterns are extremely complex, carry an astonishing amount of information and have over 200 unique spots. The fact that an individual's right and left eyes are different and that patterns are easy to capture, establishes iris-scan technology as one of the biometrics that is very resistant to false matching and fraud.

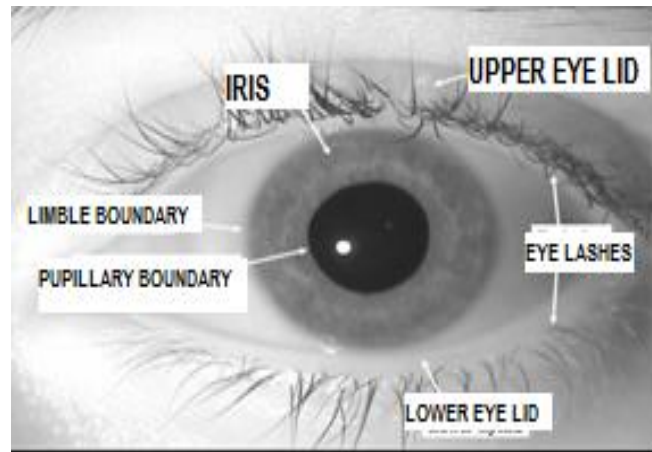


Figure 1.1 – A front view of the human

The false acceptance rate for iris recognition systems is 1 in 1.2 million, statistically better than the average fingerprint recognition system. The real benefit is in the false-rejection rate, a measure of authenticated users who are rejected. Fingerprint scanners have a 3 percent false-rejection rate, whereas iris scanning systems boast rates at the 0 percent level. A highly accurate technology such as iris-scan has vast appeal because the inherent argument for any biometric is, of course, increased security.

II. BENEFITS OF USING IRIS TECHNOLOGY

The iris is a thin membrane on the interior of the eyeball. Iris patterns are extremely complex. Patterns are individual (even in fraternal or identical twins). Patterns are formed by six months after birth, stable after a year. They remain the same for life. Imitation is almost impossible. Patterns are easy to capture and encode. Biometrics is the automated recognition of individuals based on behavioural and biological characteristics. The technology is designed to automatically take a picture from person and match it to the digitized image stored in the biometric passport. In the field of financial services, biometric technology has shown a great potential in offering more comfort to customers while increasing their security. Applications due to information protection issues, it is believed that the technology will find its way to be widely used in many different applications. Biometrics such as signatures, photographs, fingerprints, voiceprints, DNA and retinal blood vessel patterns all have significant drawbacks. Face Recognition: Changes with Age, Expression, Viewing angle, Illumination. Finger Print Recognition: Fingerprints or handprints require physical contact, and they also can be counterfeited and marred by artifacts. IRIS recognition is one among the biometric systems the tool used for this recognition is MATLAB. To determine the uniqueness of iris patterns in terms of hamming distance distribution by comparing template generated from different eyes. The iris consists of a number of layers the lowest is the epithelium layer, which contains dense pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two iris muscles. The density of stromal pigmentation determines. The color of the iris. The externally visible surface of the multi-layered iris contains two zones, which often differ in color. An outer ciliary zone and an inner pupillary zone, and these two zones are divided by the collarets which appears as a zigzag pattern.

2.1 Success rate: Failure rate using IRIS technology in just 1 in 1.2 million. When compared to other technology systems this was found as very efficient. Hence we have chosen this technology.

III. ARCHITECTURE OF IRIS RECOGNITION

A complete iris recognition system can be split into four stages: Image acquisition, segmentation, encoding and matching. The data acquisition step captures the iris images. Infra-red illumination is used in most iris image acquisition. The iris segmentation step localizes the iris region in the image. For most algorithms, and assuming near-frontal presentation of the pupil, the iris boundaries are modelled as two circles, which are not necessarily concentric. The inner circle is the pupillary boundary (between the pupil and the iris). The outer circle is the limbic boundary (between the iris and the sclera). The noise processing is often included in the segmentation stage. The encoding stage encodes the iris image texture into a bit vector code. In most algorithms, filters are utilized to obtain information about the iris texture. Then the outputs of the filters are encoded into a bit vector code. The corresponding matching stage calculates the distance between iris codes, and decides whether it is an authorized match or unauthorized match.

3.1 Enrollment: The enrollment phase creates a user profile for subsequent authentication activities. Typically, a new user provides multiple biometric reading samples that are combined to form one stored record.

3.2 Authentication: Where a template is created for an individual and then a match is searched for in the database of pre-enrolled templates.

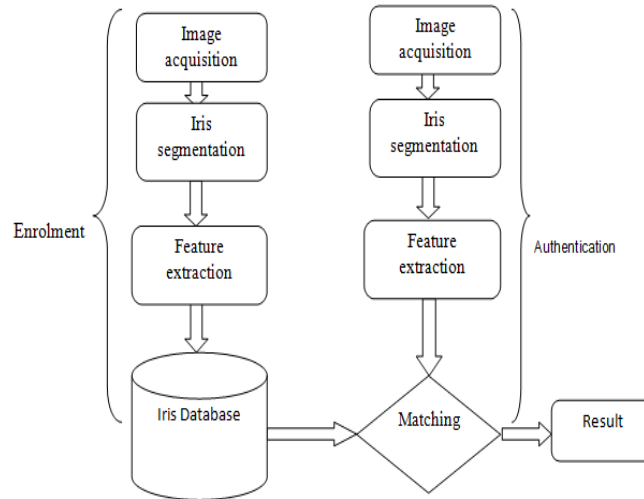


Fig3.1 Architecture of iris recognition system

3.3 Image acquisition: One of the major challenges of automated iris recognition is to capture a high-quality image of the iris while remaining non-invasive to the human operator.

3.4 Image Segmentation: At this stage, the iris is extracted from the eye image. The extracted iris region was then normalized into a rectangular block with constant dimensions to account for imaging inconsistencies. The integro-differential operator for locating the circular iris and pupil regions, and also the arcs of the upper and lower eye lids. The integro-differential operator is defined as $\max_{(r,x_p,y_o)} \left| G_\sigma * \frac{d}{dx} \oint_{(r,x_0,y_0)} \frac{I(x,y)}{2\pi r} ds \right|$

Where $I(x,y)$ is the eye image, r is the radius to search for, $G_\sigma(r)$ is a Gaussian smoothing function, and s is the contour of the circle given by r, x_0, y_0 . The operator searches for the circular path where there is maximum change in pixel values, by varying the radius and centre x and y position of the circular contour. The operator is applied iteratively with the amount of smoothing progressively reduced in order to attain precise localization. Eyelids are localized in a similar manner, with the path of contour integration changed from circular to an arc. The segmented iris image is normalized and converted from Cartesian image coordinates to polar image coordinates.

3.5 Feature Extraction: The iris contains important unique features, such as stripes, freckles, coronas, etc. These features are collectively referred to as the texture of the iris. The 2D version of Gabor filters in order to encode iris pattern data. A 2D Gabor filter over the an image domain (x, y) is represented as

$$G(x, y) = e^{-\pi \left[\frac{(x-x_0)^2}{\alpha^2} + \frac{(y-y_0)^2}{\beta^2} \right]} e^{-2\pi [u_0(x-x_0) + v_0(y-y_0)]}$$

Where (x_0, y_0) specify position in the image, (α, β) specify the effective width and length, and (u_0, v_0) specify modulation, which has spatial frequency. The odd symmetric and even symmetric 2D Gabor filters are shown in figure.

Daugmand modulates the output of the Gabor filters in order to compress the data. This is done by quantizing the phase information into four levels, for each possible quadrant in the complex plane.

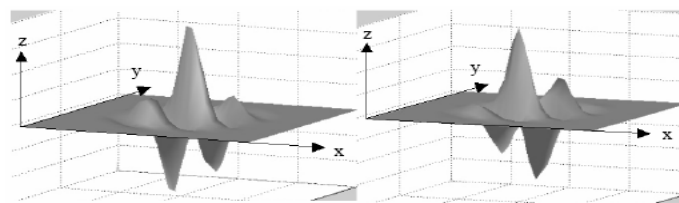


Figure 3.2 a quadrature pair of 2D Gabor filters

3.6 Matching: This phase consists of two steps, namely matching and identification. In the matching process, the extracted features of the iris are compared with the iris images in the database. If enough similarity is found, the subject is then identified. The Hamming distance gives a measure of how many bits are the same between two bit patterns. Using the Hamming distance of two bit patterns, a decision can be made as to whether the two patterns were generated from different irises or from the same one. In comparing the bit patterns X and Y , the Hamming distance, HD , is defined as the sum of disagreeing bits (sum of the exclusive-OR between X and Y) over N , the total number of bits in the bit pattern.

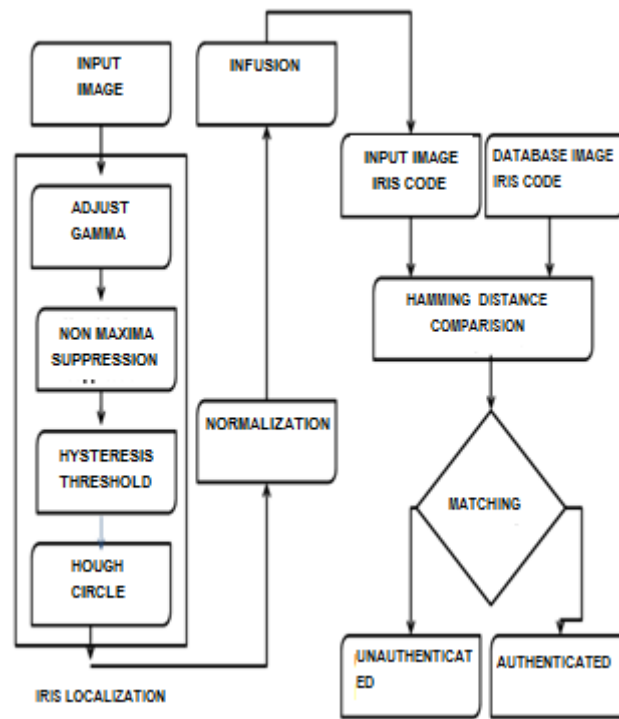


Fig 3.3 Flow chart for IRIS recognition technique

3.7 Hamming Distance: Hamming distance was originally conceived for detection and correction of errors in digital communication. It is simply defined as the number of bits that are different between two bit vectors.

$$HD = \frac{1}{N} \sum_{j=1}^N X_j(XOR)Y_j$$

IV. PROPOSED IRIS RECOGNITION ALGORITHM

A block diagram of the proposed iris recognition system is shown in figure 3. The iris recognition system has seven modules: Eye image acquisition, challenge-response test (CRT), iris segmentation, iris normalization, iris enrichment, and iris feature encoding and iris discriminator design.

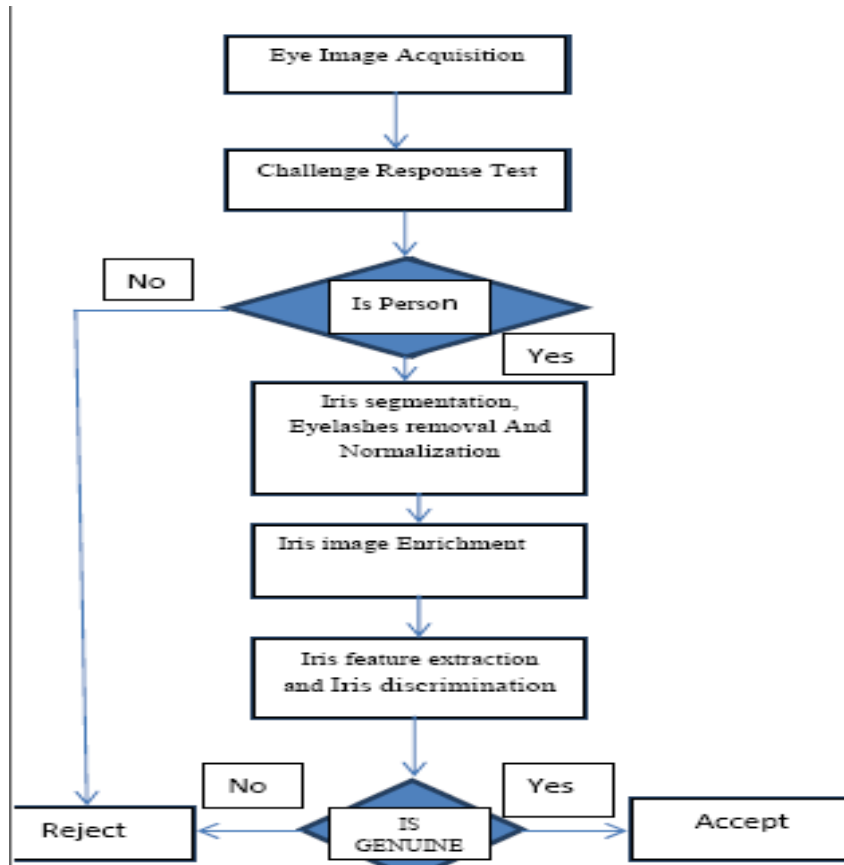


Fig 4.1 Block diagram of the proposed approach

4.1 Eye image acquisition: An important and complex step of iris recognition system is image acquisition. Especially for Indians, the iris is small in size and dark in color. It is difficult to acquire clear images.

4.2 Challenge-response test: Biometric features may be counterfeited and criminally used. This is a crucial weakness of the biometric system. This module aims to ensure that an input image actually originates from a person instead of iris photographs, phony eyes, or other artificial sources.

This method verifies the response of the pupil diameter by varying illumination levels at the same distance from the eye. The algorithm of this method is elaborated as follows:

Step 1: Capture the same person's eye images under different lighting levels

Step 2: Measure the pupil diameter from the captured eye images. If these values are divergent then the image is actually from a real source (human), otherwise artificial sources may have been used. The diameter of the pupil is calculated by satisfying (1). Equations (2) and (3) describe the challenge-response process.

$$(x - x_1)(x - x_2) + (y - y_1)(y - y_2) = 0,$$

$$T_d = n-1 \sum_{i=0}^n |i - i+1|, CRT = _True, \text{ if } T_d = 0, \text{ False, otherwise}$$

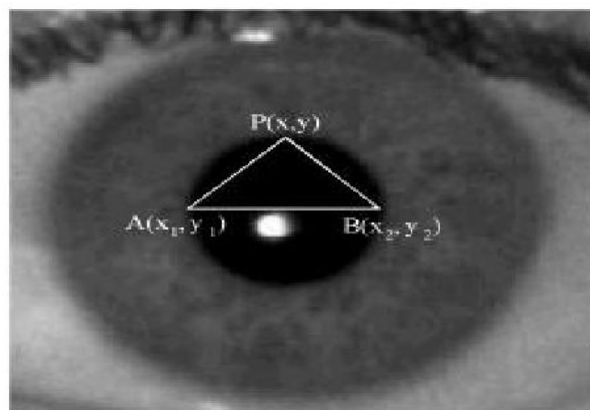


Fig 4.2 Measurement of diameter of the pupil boundary.

Where T_d is total diameter of the pupil in the capturing sequences, CRT is a challenge-response test parameter, n is number of eye images, $_i$ and $_{i+1}$ are diameters of the pupil under different illuminations. This method assures that an input is coming from a real sequence and not from photographs or other artificial sources. The biometrics-capturing device needs to be capable of ensuring that they are inspecting genuine user features (as opposed to a photograph or recording) and that the output signal is not substituted. This is used to prevent replay attacks lifted from video-signals, for instance by connecting a video recorder to the frame-grabber.

V. IRIS LOCALIZATION STEPS

5.1 Adjusted Gamma value: For this process we are taking the Edge strength image. In that image we are going to increase the gamma value. Gamma value must be a positive. Values in the range 0-1 enhance contrast of bright regions, values > 1 enhance contrast in dark regions.

5.2 Non maxima Suppression: After the edge directions are known, non-maximum suppression now has to be applied. Non-maximum suppression is used to trace along the edge in the edge direction and suppress any pixel value (sets it equal to 0) that is not considered to be an edge. This will give a thin line in the output image.

5.3 Hysteresis Thresholds: Here we are going to compare non maxima suppressed image pixels with two threshold levels. If current pixel value is greater than two threshold levels means that current pixel & 8 neighbour pixels also marked as edges. If that current pixel value is greater than only one threshold means that current pixel only marked as an edge.

5.4 Hough Transform: The Hough transform is a standard computer vision algorithm can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. The circular Hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions. From the edge map, votes are cast in Hough space for the parameters of circles passing through each edge point. These parameters are the centre coordinates x_c and y_c , and the radius r , which are able to define any circle according to the equation.

$$x_c^2 + y_c^2 - r^2 = 0$$

A maximum point in the Hough space will correspond to the radius and centre coordinates of the circle best defined by the edge points. Wildes and Kong also make use of the parabolic Hough transform to detect the eyelids, approximating the upper and lower eyelids with parabolic arcs, which are represented as.

$$-(x - h_j) \sin \theta_j + (y - k_j) \cos \theta_j)^2 = a_j ((x - h_j) \cos \theta_j + (y - k_j) \sin \theta_j)$$

Where a_j controls the curvature, (h_j, k_j) is the peak of the parabola and θ_j is the angle of rotation relative to the x-axis. In performing the preceding edge detection step, Wilds et al. bias the derivatives in the horizontal direction for detecting the eyelids, and in the vertical direction for detecting the outer circular boundary of the iris

5.5 Iris Image Normalization: As the iris is captured under different conditions like non-uniform illumination, eye blink, pupil radius change due to varying lighting etc., it is possible for the output of iris images to be in different sizes. These variations may affect the results of iris matching. To overcome this issue, iris image has been converted to standard size with width and height as 360 and 48 pixels respectively. Iris dilation or erosion process is also carried out to extend or squeeze iris strip size when fewer/higher amounts of data are obtained in the iris portion. This process is called iris normalization process of radial scan module.

$$x = x_c + r_i \cos((\delta/180)^\circ), y = y_c + r_i \sin((\delta/180)^\circ) \quad (6)$$

5.6 Canny edge detection: Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edges in images are areas with strong intensity contrasts a jump in intensity from one pixel to the next. Edge detecting an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. The Canny edge detection algorithm is known to many as the optimal edge detector.

5.7 Iris Image Enrichment: Image enrichment process is based on spatial domain approach. The original iris image has low contrast and may have non-uniform illumination caused due to the irregular position of the light source. These problems may affect subsequent feature extraction and iris matching process. In order to obtain a well-distributed texture image, the iris image is enriched using local histogram equalization. Figure 10a shows the effect of applying histogram equalization process.

VI. FEATURE ENCODING

The final process is the generation of the iris code. For this, the most discriminating feature in the iris pattern is extracted. The resulting phasor lies using the wavelet.

$$H_{\{Re, Im\}} \text{Sgn}_{\{Re, Im\}} \iint_{\rho, \theta} I(\rho, \theta) e^{-i\omega(\theta_0 - \theta)} \cdot e^{-\frac{(r_0 - \rho)^2}{\alpha^2}} e^{-\frac{-(\theta_0 - \theta)^2}{\beta^2}} \rho \, d\rho \, d\theta$$

Where, $h_{\{Re, Im\}}$ has the real and imaginary part, each having the value 1 or 0, depending on which quadrant it lies in. The frequency response of a Log-Gabor filter is given as.

$$G(f) = \exp\left(\frac{-(\log(\frac{f}{f_0}))^2}{2(\log(\frac{\sigma}{f_0}))^2}\right)$$

Where f_0 represents the centre frequency, and σ gives the bandwidth of the filter encoding process is illustrated in Figure

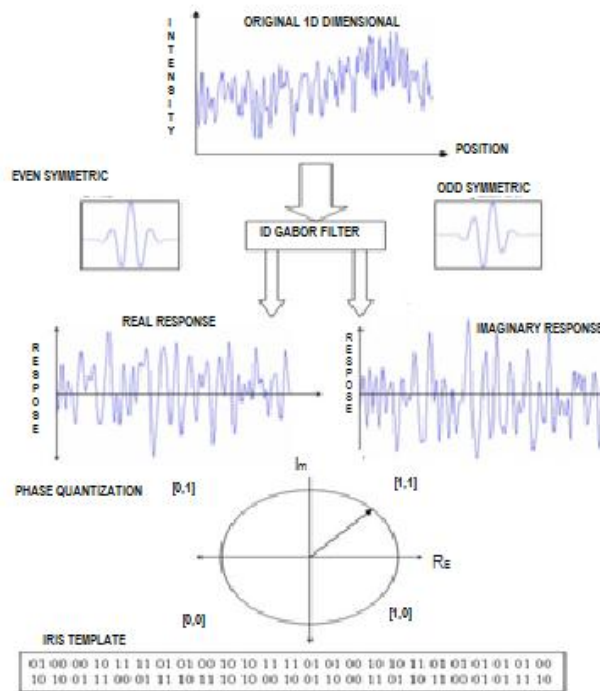


Fig 6.1 An illustration of the feature encoding process.

6.1 Performance Evaluation: The performance evaluation of proposed method was measured by the two error rates such as FRR (False Rejection Rate) and FAR (False Acceptance Rate). The FAR and FRR was computed as

$$FAR(\%) = \frac{\text{No of false acceptances}}{\text{Total no of imposter attempts}}$$

$$FRR(\%) = \frac{\text{No of false rejection}}{\text{Total no of authentic attempts}}$$

VII. CONCLUSION

Finally, in this section gives features of the iris implementation encoded by convolving the normalised iris region with 1D Log-Gabor filters and phase quantising the output in order to produce a bit-wise biometric template. The Hamming distance was chosen as a matching metric. The experimental results show that the proposed approach has a faster operation and good recognition performance. All experimental results have demonstrated that the proposed algorithm has an encouraging performance. This also confirms that effective iris segmentation is important for an iris recognition system. However, efforts remain to be taken to further improve its performance. In order to improve the automatic segmentation algorithm, a more elaborate eyelid and eyelash detection system could be implemented.

Thus the above method can be efficiently implemented for the ATM transactions

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