AN EFFICIENT IMPLEMENTATION OF IRIS RECOGNITION ALGORITHMS FOR PORTABLE EQUIPMENT

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ABSTRACT

An implementation of an efficient Iris recognition algorithm is presented in this paper. Its based on reducing the number of instructions and increasing its speed operation to be used properly by portable and handheld equipment, so that battery life is increased. This is achieved by using techniques minimize the number of instructions in the code. The proposed technique is used in the three stages of the paper: Segmentation, Normalization and finally Encoding. Comparison results with other tools verified the validity of the proposed technique.

Keywords: *Digital Image Processing, Iris Recognition, Hough Transformation, Low Power Design Techniques, Low Power Code.*

I. INTRODUCTION

Human from the early ages recognized the role of the security in daily life. Different tools and instruments have been developed and implemented to save life from various dangers. From the first decade of the previous century, finger recognition was the leader method to recognize the humans imprint. This method was simply based on comparing different finger imprints to recognize and acknowledge people. Various methods are appeared in the last decades to recognize people: finger imprint, voice pattern, face recognition. All of these techniques are recognized as efficient method in recognition[1] using low power design techniques[2].

Iris recognition recently has shown high accuracy in recognition; it successfully replaced passwords, finger print, PINs and other methods that were used for long time as secured methods [3]. It has shown high rate of accuracy and scalability, where it is the most accurate recognition used in place with retina recognition, it has offered almost 100% accuracy and scalability in recognizing people because for all person the left iris is not the same as the right iris[4], even between twins.

The rabid technology development makes from portable equipment to be the most frequent used devices. The main characteristic of these devices is the low power consuming. Various techniques of saving power are successfully implemented and designed at different portable devices: at the laptops, digital cameras, palmtops and many others. Reducing power dissipation could be implemented either by hardware or by software[2].

Different hardware saving power techniques demonstrated their efficiency as powerful techniques to save power such as parallel and pipelining architectures. Reducing power also could be achieved at the software division. This could be easily happened if the numbers of instructions are reduced or fast algorithms are implemented.

In this paper, we implement fast algorithms for Iris recognition based on minimum number of instructions, so that the power dissipation is at the minimum value, where this implementation could be used in portable devices.

II. FIRST STEP

The recognition by iris is based on real time system, people need to look at the Iris digital camera where a high performance software program based on different algorithms and methods are implemented and manipulated to recognize the iris, and then the results is given by time [6]. Different steps are needed in the case of the iris recognition: First an image of the eye is taken by a digital camera, the image is then segmented using efficient transformations of segmentation, then the output of the segmentation is normalized using normalization filters, and finally the image is encoded where the iris image is in a form of digital file of binary numbers called the iris template. A mask will be created and compared with other iris templates saved on huge database for identification. After templates are created, the database is searched for any match: If a match founded then the person can access the system, otherwise,e access is denied.

Matlab[7], a power full tool for image and digital signal processing, shows very important improvements in the area of the iris recognition in specific. The facilities that support this package from one part and the simplicity to use its language from other part make it our choice to use it.

For testing of the system, we have used the CASIA database of iris images because of the huge number of iris images in this set of database[6].

III. IRIS RECOGNITION AND SECURITY

The iris is a circular colored diaphragm, which lies between the cornea and the lens of the human eye, in the center of the iris exists the pupil where the iris monitors how much the amount of light access the pupil, and muscles controls the dilating of the pupil where the iris diameter average is about 12mm, and the pupil can vary from 10% to 80%of the iris diameter [8], Figure 1 shows the eye image with a clear iris region appeared [3].

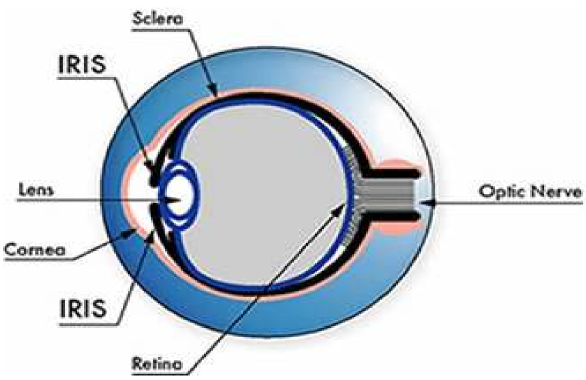


Figure 1: Eye Image with Iris Region

The three stages of Iris recognition are: Segmentation, Normalization, and Encoding [3]. They are defined as followed: The first stage which is the segmentation locates the iris region in an eye image. The second stage is the normalization which makes the iris region dimensionally consistent, and finally encoding which creates a template with the most selective features of the iris. Hough transform in[8] was used for segmentation because of its efficiency, effectively and simplicity comparing with other transformations of the same target published in[9][10]. In this stage the iris region is localized and the pupil region also excluding eyelids, eyelashes and reflections. Different forms of Gabor filters for Encoding patterns into two biometric templates are studied and implemented in [11][12][13]. Comparing these filters with each other, Gabor filter in [13] showed more flexibility regarding our target of optimizing the power, the speed and the performance. For matching and searching over the database of irises hamming distances where identical templates return a hamming distance with zero value.

IV. IRIS RECOGNITION STAGES:

As mentioned before, the main target of this work is to optimize the code using minimum number of instructions in each stage of the paper. This could happen by implementing different algorithms and transformation using the most powerful filters that have lowest number of instructions.

IV.I. SEGMENTATION

In Segmentation, we used the Hough transform is used to determine the parameters of objects in an image such as circles and lines, where the circular Hough transform can be used to figure out the coordinates and the radius of the pupil and iris regions [8]. Hough transform is used also to detect iris and pupil boundaries where canny detection is used to generate the edge map. For iris/sclera boundary we used vertical gradient direction, but for the iris/pupil boundary we used vertical and horizontal gradients. Linear Hough transform is used to isolate and exclude eyelids, where a line is drawn to the upper and lower eyelids. A horizontal line is drawn to intersect the previous line on the side where the iris edge is closest to the pupil. This process is done for top and bottom eyelids, another horizontal line is drawn to allow maximum isolation of eyelids region [3].

The ranges of radiuses of the CASIA database iris are from 90 to 150 pixels but the pupil radius ranges from 28-75 pixels [6]. For efficiency Hough transform was used for the iris/sclera boundary and then for the iris/pupil boundary, because the iris surrounds the pupil region. For detecting eyelashes in the CASIA database we used a simple threshold technique where the eyelashes are dark and could be compared to the whole input image. Figure 2 [6] illustrates the segmented iris for one of the CASIA database irises.

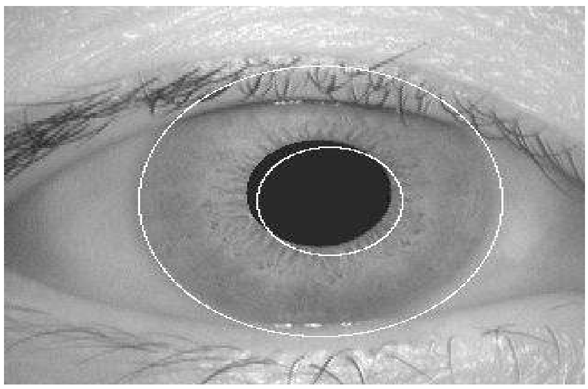


Figure 2: Segmented Iris of Random Eye in CASIA Database

As shown in the Figure 2 the Iris and pupil regions are localized using canny edge detection and Hough transform. The figure shows that the pupil region is localized depending on the iris coordinates and parameters detected before.

IV.II. NORMALIZATION

The iris muscles controls the dilation of the pupil which can lead to dimensional inconsistencies between eye images. Other reasons to cause inconsistency is varying in image distance, rotation of the camera, and the rotation of the eye, so normalization is used to create iris regions that have fixed dimension to allow comparison. This provides fair comparison when different images are used.

When rubber sheet model used, the iris region will be modelled as flexible rubber sheet with the pupil iris as a reference. The normalization is performed when attempting to match two iris regions rather than first, performing normalization and saving the results for incoming comparisons. Incase of two irises regions have the same dimensions, the features will be extracted from the iris [5].

The number of points extracted from each image is the same which are selected along the radial line and called the radial resolution; the number of radial lines in the iris region is defined as angular resolution. Two dimensional array will be produced, the vertical array for the radial resolution and the horizontal array for the angular resolution. The other two dimensional arrays will be produced to mark noise, reflections, eyelashes and eyelids that was detected during the segmentation.

Any data points on the borders of the iris and the pupil will be discarded. To remove inconsistency produced by rotational variance, rubber sheet model is used. Any data points located on the boundaries of the pupil and iris will be excluded. Figure 3 [5] shows the radial resolution of 10 pixels and angular resolution; non concentric is clear, while Figure 4 shows a normalized iris.

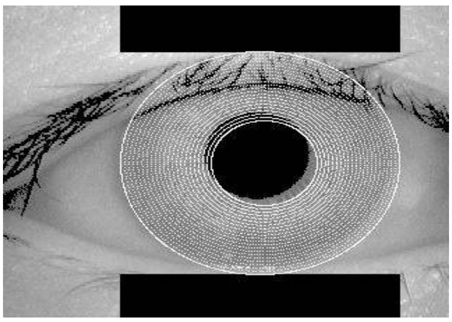


Figure 4: Normalized Iris

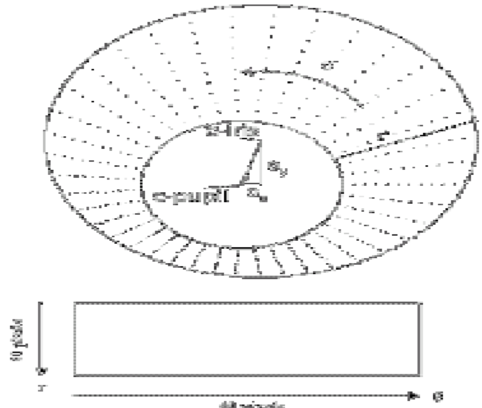


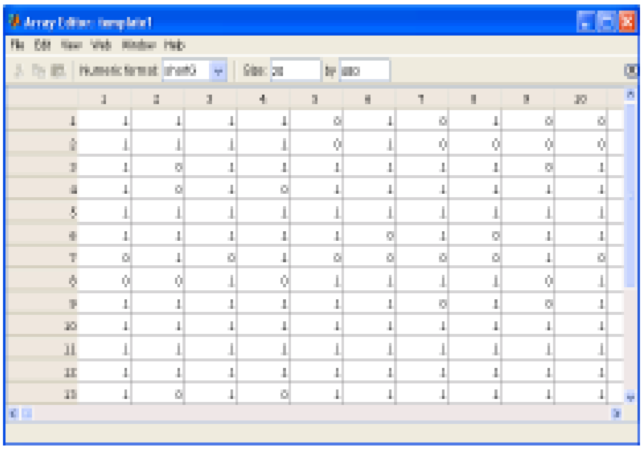
Figure-3: Radial resolution of 10 pixels and angular resolution of 40 pixels [6]

IV.III. ENCODING

The features of the iris must be encoded for future comparisons. Different types of wavelet encoding are presented and analyzed in literature review [14][15]. In this paper we aimed to use the wavelet encoder that saves power dissipation without loosing its performance. In order to verify this issue, we implemented different algorithms of wavelet, we have selected wavelet in[14] in our purpose for its performance and saving power. The need for Wavelet is to decompose iris region into components that appear at different resolution, so wavelet encoding is applied to the 2D array of iris region produced by the normalization function discussed previously, after applying wavelet filter the output is encoded to provide selective and compressed iris region, where Gabor filters is used. The reason of using Gabor filters that they apply optimum mutual representation of a signal in space and spatial frequency. Different forms of Gabor Filers are published in literature. We have implemented two different types of Gabor [16][17], and finally, the Gabor filter in [18] is selected in our work. The way to construct a Gabor filter is modulating a sine cosine wave with a Gaussian, which provides localization in space and frequency. Sine wave is perfectly localized in frequency but not in space, so modulation with Gaussian of the sine wave is provided to provide localization in space, but results in less localization in frequency. Decomposition was provided by using a quadrature pair of Gabor filters. The real part specified by the cosine modulated function by Gaussian, and imaginary part is specified by the sine modulated function with Gaussian.

The filter center frequency was specified by the frequency of the sine/cosine wave. The bandwidth of the filter is specified by the width of the Gaussian. The main disadvantage of Log Gabor filters is that has a DC component whenever the bandwidth exceeds one octave. To solve this and obtain a zero DC component we should use a Gabor filter with Gaussian on a logarithmic scale, which is log Gabor filters. The output of filtering is quantized to four stages using daugmans method with each bit producing two bits of data for each phasor, where daugmans method demodulates the output of the Gabor filters to compress data [18].

By completion of the encoding process, a binary template will be produced and a noise mask that corresponds to corrupted areas in the iris pattern, regions with zero amplitude is signed as corrupted and appears in the mask binary array, scales are the number of filters used. A binary template will be created for each image with a corresponding noise mask, as shown in Table I. where the scale is 20 by 480.



	1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	0	1	0	1	0	0
2	1	1	1	1	0	1	0	0	0	0
3	1	0	1	1	1	1	1	1	0	1
4	1	0	1	0	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	0	1	0	1	1
7	0	1	0	1	0	0	0	0	1	0
8	0	0	1	0	1	1	1	1	0	1
9	1	1	1	1	1	1	0	1	0	1
10	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1
13	1	0	1	0	1	1	1	1	1	1

Table I: A binary template image.

IV. MATCHING

As well as the iris templates and their corresponding masks are created, the next step was matching where the hamming distance was used. The suggested templates should be compared bit by bit, although the hamming distance algorithm in this case incorporates noise masking. The finite binary 0 and 1 sequence is sometimes called a "word" in coding theory. The length of different digits is called Hamming distance. If two iris templates are the same, then the hamming distance will return zero value. In case of $0.2 > hd > 0.4$ it will be of the same shape but of different image positioning. We attend in the proposed algorithm and its implementation if a match found.

V. EVALUATION RESULTS

Two public sets of Iris Images are available published for the public. Mostly they are used in the research of Iris Recognition: CASIA and LEI. In this paper we used CASIA set only in our testing to show the validity of the proposed code. The graphical user interface we programmed is shown as in Figure 5:

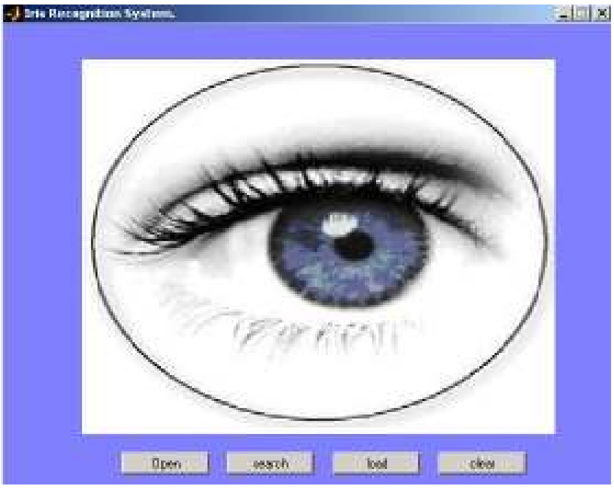


Figure 5: Graphical User Interface

There are four push buttons that works as the following:

- **Open**: Opens an image of bmp extension which is the image we need to search for.
- **Search**: Executes the search function which executes all the iris recognition
- **Load**: Opens any variable or template saved on the work space.
- **Clear**: Clears the database variables and resets the system to the main page.

After the selection of the specific Image from the database, the target image is selected and displayed, as shown in Figure 6.

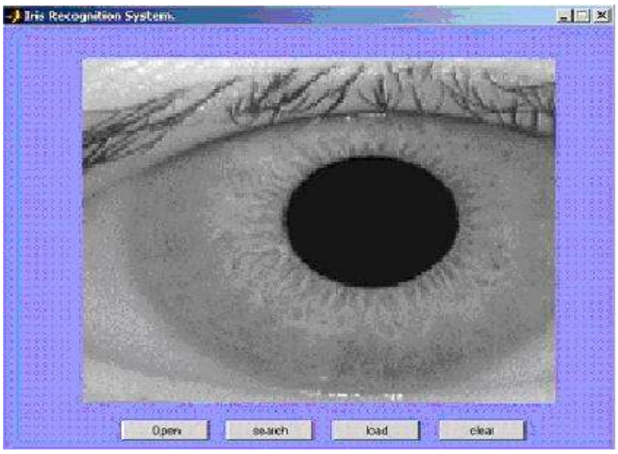
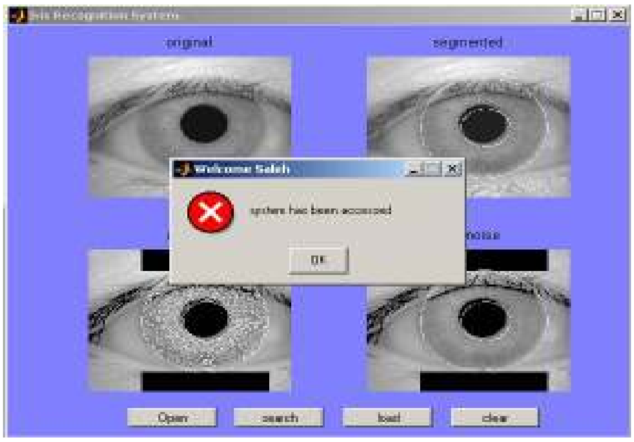


Figure 6: the iris image

From this point, different filters are implemented and run to create four types of images: The Original Iris Image, the Segmented Iris Image, the Normalized Iris

Image, and the Image with Noise, as shown in Figure 7.



Fingure 7: Four Images of Iris recognition: Original, Segmented, Encoded, and Matching

Giving these four outputs to the system, we can define if the target image is already in the database or not. Once it is in the dataset, the system reply by "System has been accessed" Figure 8, otherwise the system answer by "Access Denied" Figure 9.

Figure 8: The error message when a match is found

Figure 9: Access Denied, User is not in the System.

When pressing the load button an input dialog is opened to type the name of the variable you want to view.

VI. CONCLUSION

This paper has presented an iris recognition system using CASIA Iris Image set using our own interfacing. An automatic segmentation algorithm was presented, which would localize the iris region from an eye image and isolate eyelid, eyelash and reflection areas. Automatic segmentation was achieved through the use of the circular Hough transform for localizing the iris and pupil regions, and the linear Hough transform for localizing occluding eyelids. We have taken in mind to use lowest number of instructions in order to save more power and increase the speed operation of the system.

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