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EMBEDDED SYSTEMS FOR IRIS RECOGNITION

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ABSTRACT

Iris Recognition increasingly used method of biometric authentication that involves pattern-recognition techniques of images of irides to uniquely identify a person. In this paper, IRIS biometrics has been chosen for implementation due to the reduced error rates and the robustness their algorithms provide. The goal of this paper is to design a detached system, to implement a working prototype of the techniques and methods used for iris recognition. A powerful ARM7TDMI-S core based micro controller LPC2148 is used to demonstrate the algorithms required for generating biometric templates from IRIS database for matching. The results from this device is compared to Matlab run PC which will give the insight required to compare the performance analysis of the algorithms in use proceedings.

KEYWORDS: Embedded systems, hamming distance, iris biometrics, segmentation.

INTRODUCTION

BIOMETRIC technology uses person's unique and physical or interactive characteristics to validate the individuality of a person. It provides higher level of security for individuality validation than any other basic authentications like PIN, password or token. Biometric methods, which identify people based on physical or behavioral characteristics, are of interest because people cannot forget or lose their physical characteristics in the way that they can lose passwords or ID cards.[1] Some of popular biometric technologies include fingerprint, face, voice and IRIS. Out of above mentioned methods, IRIS recognition is considered to be one of the most secure and reliable technologies[1],[2],[6]; however, while matching algorithms in IRIS recognition are straightforward, the signal processing prior to matching requires a significant amount of processing power. IRIS recognition is a method of identifying people based on unique patterns within the ring-shaped region surrounding the pupil of the eye. The IRIS usually has a brown, blue, gray, or greenish color, with complex patterns that are visible upon close inspection. As it uses the biological characteristic, IRIS recognition is considered as a biometric verification.

The rest of the paper is organized as follows. Proposed IRIS recognition algorithm, followed by details of the implementation of Embedded system are explained in section II. Section III presents the experimental results obtained from. This paper concludes and discusses possible future work in section IV.

PROPOSED ALGORIDM AND SYSTEM ARCHITECTURE

Algorithm for Iris Recognition **:**

In iris recognition, the identification process is carried out by gathering one or more detailed images of the eye with a sophisticated, high-resolution digital camera at visible or infrared (IR) Wavelength, and then using a specialized computer program called a matching engine to compare the subject's IRIS pattern with images stored in a database

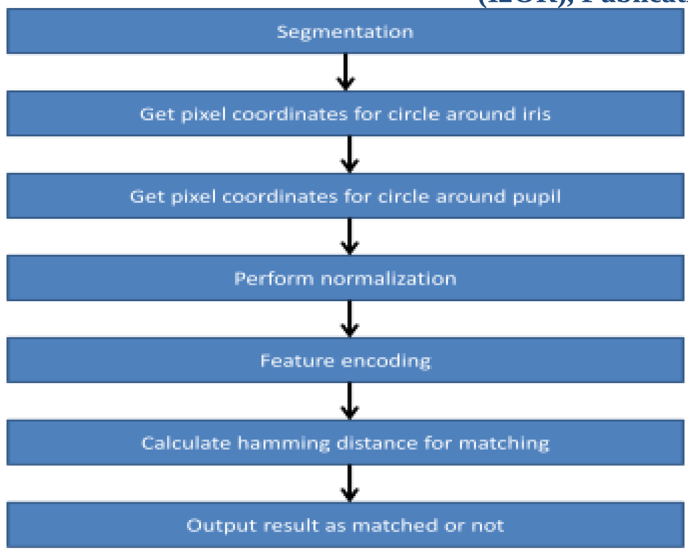

Fig.*1.Algorithm for IRIS Recognition*

A. Iris Segmentation :

The main purpose of this process is to locate the iris on the image and isolate it from the rest of the eye image for further processing.

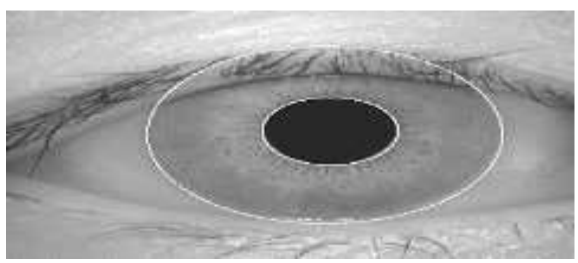

Fig.2 Iris image with inner and outer boundaries

The iris region, shown in Figure 2, can be approximated by two circles, one for the iris/sclera boundary and another, interior to the first, for the iris/pupil boundary. The eyelids and eyelashes normally block the upper and lower parts of the iris region. Also, specular reflections can occur within the iris region corrupting the iris pattern. A technique is required to isolate and exclude these artifacts as well as locating the circular iris region. Some other important tasks that are also performed in this iris segmentation block include image quality enhancement, noise reduction, and importance of the ridges of the iris.

It is decided to use circular Hough transform for detecting the iris and pupil boundaries. This involves first use of Canny edge detection to generate an edge map. In order to make the circle detection process more efficient and accurate, the Hough transform for the iris/sclera boundary was performed first, then the Hough transform for the iris/pupil boundary was performed within the iris region, instead of the whole eye region, since the pupil is always within the iris region. After this process was complete, six parameters are stored, the radius, and x and y centre coordinates for both circles. Canny edge detection is used to create an edge map, and only horizontal gradient information is taken. Finally, eyelid detection is carried out by using a separate Hough transform for elliptical figures.

B. Normalization :

After establishing the parameters of the non concentric circles of the outer and inner borders of the iris, the image can be converted to the polar coordinate system, called as "Iris normalization", converts the round image of the iris

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to a rectangular shape. This normalization becomes necessary when considering that the pupil varies in size for different light intensities. The normalization method varies from changes to the polar coordinate system, as Daugman proposed, to only considering a virtual line drawn around the pupil, known as the iris signature. Normalization by Daugman's rubber sheet model-The normalization process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location.The normalized iris image can be displayed as a rectangular image, with the radial coordinate on the vertical axis, and the angular coordinate on the horizontal axis. In such a representation, the pupillary boundary is on the bottom of the image, and the limbic boundary is on the top. The left side of the normalized image marks 0 degrees on the iris image, and the right side marks 360 degrees. The division between 0 and 360 degrees is somewhat arbitrary, because a simple tilt of the head can affect the angular coordinate.

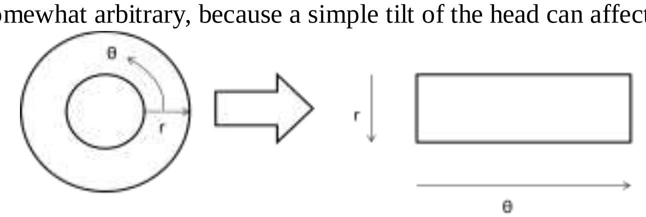

Fig.3 Diagram of Daugman's rubber sheet model

The homogenous rubber sheet model devised by Daugman remaps each point within the iris region to a pair of polar coordinates (r,θ) where r is on the interval [0,1] and θ is angle [0,2π].

The remapping of the iris region from (x,y) Cartesian coordinates to the normalized non-concentric polar representation is modelled as,

$$I(x(r,\theta),\, y(r,\theta)) \rightarrow I(r,\theta)$$

With $x(r,\theta) = (1-r)xp(\theta) + rxs(\theta)$ and $y(r,\theta) = (1-r)yp(\theta) + rys(\theta)$

Where I(x,y) is the iris region image, (x,y) are the original Cartesian coordinates, (r,θ) are the corresponding normalized polar coordinates. Functions x(r,θ) and y(r,θ) are defined by a linear combination of coordinates of points on the border of the pupil (xp(θ), yp(θ)) and coordinates of points on the external border of the iris (xs(θ), ys(θ)).

C. Feature Encoding :

In order to provide accurate recognition of individuals, the most discerning information present in an iris pattern must be extracted. Only the important features of the iris must be encoded so that comparisons between templates can be made. Most iris recognition systems make use of a band pass decomposition of the iris image to create a biometric template.

Gabor Convolve is the function for convolving each row of an image with 1-D Log-Gabor Filter.

Zero DC component can be obtained for any bandwidth by using a Gabor filter which is Gaussian on a logarithmic scale, this is known as the Log-Gabor filter. The frequency response of a Log-Gabor filter is given as;

$$G(f) = \exp\left\{ -\log(f / f0))2 \;/\; 2\,(\log(\,\sigma\, / f0))2 \right\}$$

Where f0 represents the centre frequency, and σ gives the bandwidth of the filter.

D. Matching :

Most employed matching algorithm has been the Hamming distance, as was initially proposed by Daugman. 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. It is a logical XOR operation performed on two binary vectors and then calculating the ratio of the number of ones denoting the vector non-compliance in particular positions to the size L of the vectors .

$$HD(A,B)=1/L \sum_{i=0}^{L} (Pi \text{ XOR } yi)$$

where

L : the vector length and Pi : the ith component of the template and yi : the ith component sample vector.

B. SYSTEM ARCHITECTURE OF PLATFORM USED :

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints.

To perform the Algorithms required by IRIS recognition we need a powerful microcontroller, with sufficient RAM and Code memory. For faster and real time performance a USB Interface would be preferred. AN ARM 7 LPC2148 thus is a very obvious choice.

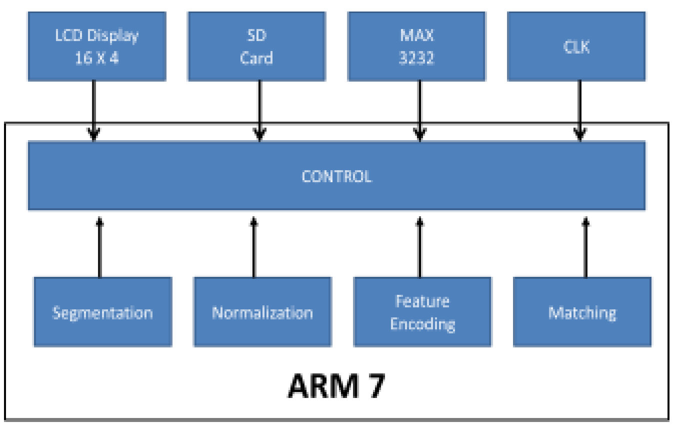

Fig. 4 Architecture of the platform used

An SDHC-CARD with a minimum capacity of 2 GB is used to store image database and log results. The SD-Card is connected on the SSP port of the microcontroller which provides faster interface as compared to a normal SPI Bus. A MAX3232 RS232 voltage Shifter is used for communication with PC. A graphical LCD has been interfaced in the design so as to enable monitoring and observing results and errors at various stages of the algorithms. The microcontroller is fed with a 12 Mhz Clock and internally multiplied to work at a high frequency of 60Mhz.

RESULTS AND DISCUSSION

To present the obtained results, the database used therein will be introduced. Following this, implementation details of platform chosen to carry out the process will be given. Finally, the results obtained considering several viewpoints, such as performance, processing time, occupied area, cost, and security level.

A. Database selected : For iris recognition, there are several public databases available for testing. For this work, the chosen database is CASIA Iris Image Database (version 1.0).

B. Implementation Details for the Chosen Platform : Several solutions for microcontroller platform are commercially available. The decisions made on choosing the hardware have been based on several characteristics, such as cost and ease of integration. A powerful ARM7TDMI-S core based microcontroller LPC2148 is used to demonstrate the algorithms required for generating biometric templates from IRIS database for matching. This microcontroller is a 16/32-bit RISC CPU designed by ARM in a tiny LQFP64 or HVQFN package. It has 8/16/32 KB of on-chip static RAM and 32/64/128/256/512 kB of on-chip flash program memory. The CPU operating voltage range is of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5V tolerant I/O pads. Due to its high computational power and reduced cost, it is widely used in several commercial applications.

C. Performance: The results from the standalone device compared to Matlab run PC will give the insight required to compare the performance analysis of the algorithms in use. Better performance in terms of operating time can be achieved.

CONCLUSION

Different platforms were studied for biometric authentication scenarios. In the case of high security environments, where low error rates are extremely important, the microcontroller solution is recommended, especially when the number of users in the system is relatively high. Also the system is portable and can be powered by a Li-ion battery pack. Dedicated system with less or no instance of software failure and easily customizable, to be able to integrate with other devices is very effective from security standpoint.

The results obtained in this study can be interfaced with other security devices to provide wholesome Security. Also can be interfaced in automobiles via CAN for Ignition control and other features and can be made compact to make it into a pocket device.

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