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Biometric Security Enhancement using GLCM Method: A Review

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Abstract— **Iris texture pattern can be used for biometric verification and identification of a person from a large dataset. However, such a biometric recognition system can only recognize those people who have already been enrolled in the system. Iris recognition systems have been an active area of research since long and iris recognition applications are increasing day by day. The performance of biometric system based on iris recognition depends on the selection of iris features. In this paper Gray Level Co-occurrence Matrix(GLCM) method is used for extracting the texture. The GLCM is a statistical method that includes local features like Contrast, Correlation, Energy, Homogeneity, Entropy. This approach is invariant to iris rotation.**

***Index Terms— Iris Recognition, Pupil, Pre-processing,* Grey Level Co-occurrence matrices (GLCM),**

I. INTRODUCTION

In today's information technology world, security for systems is becoming more and more important. Iris recognition is one of the leading automatic biometric systems in the area of security which is used to identify the individual person. Every human body has some traits which differentiate one human being with another. These traits establish the individual identity of every person. Nowadays a lot of biometric techniques are being developed based on different features and algorithms. Each technique has its strengths and limitations, not being possible to determine which is the best without considering the application environment. From all of these techniques, iris recognition is one of the most promising for high security applications.

Iris Recognition is a method of identification and verification of a person from his / her iris pattern. An individual can be identified through biometric systems because of his/her unique features and characteristics. Iris recognition has become an accurate and reliable biometric technology. There are five fundamentals sections of iris recognition systems: image acquisition, segmentation, normalization, encoding and matching. Iris recognition feature extracted schemes can be subdivided into phase base methods, zero crossing, texture analysis and the intensity variation procedures. [1] Iris Recognition works in different steps: in first step image are processed to extract the iris pattern and then these patterns are matched with other iris pattern stored in the database. Segmentation step plays major role in iris recognition system which includes pupil detection, eyelashes and eyelid removal etc. To recognize the image iris is divided into multiple region and detection of single region recognize a person.

Accuracy and performance of the iris region is increased if only the quality images are used. Image quality should be checked before it is matched in the enrolled database. [2]

II. STRUCTURE OF IRIS

Human eye is the most complex organ in our body. Main parts of human eye are sclera, iris, pupil, lens, retina and cornea etc. and each part has its special function. The iris is a thin, circular, highly protected, colored and most visible part of the eye. The time light enters into the eye it passes through the lens and image is focused onto the retina that converts light images into electrical signals and via the optic nerve sends these signals to the brain. In case of bright light, iris contracts to avoid too much light. The dark round in the center of the iris is called the pupil which dilates and constrict by tiny muscles embedded in iris. Iris surface is divided into two major layers: pupillary zones and the ciliary zone. Pupillary zone is the inner part that forms boundary of the pupil. An outer ciliary zone is the remaining part of the iris, and these are separated by the collarette – shows a pattern flower or zigzag. These patterns acquire a high level of randomness which provides robust biometric indication for human recognition. Several iris image databases such as CASIA, MMU, Bath, UPOL, ICE, WWU, UBIRIS are freely available for experimentation purposes.

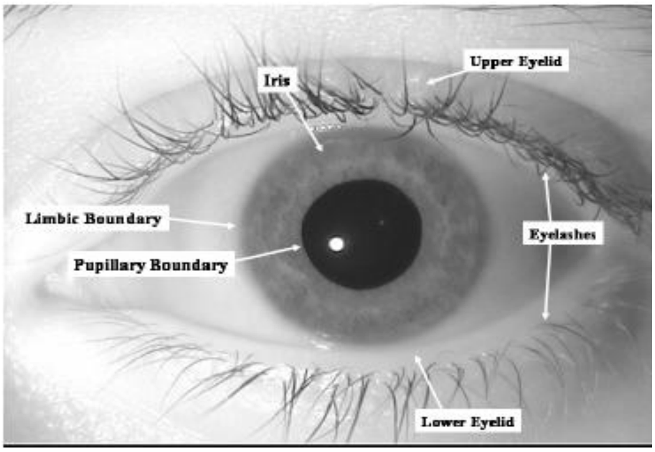

Figure1: Human Iris Image

Iris recognition systems ordinarily face the following multiple challenges: [3]

- Iris localization (i.e., iris position from distance) is a key challenge in iris recognition systems. Although

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technology has evolved enough that "iris on the move" and "iris at a distance" systems have been designed and developed, but iris localization is still a big challenge.

- Processing the blur and noisy image. Different geometric model are developed recently to solve the problem of off-axis iris image.
- Identifying the repeated binary string from the sample of the same iris is another challenge
- Saving facial attributes with iris images. Performance and accuracy level of iris recognition system can be increased by considering other facial attributes such as skin color and texture, facial marks etc.
- Ensuring security and privacy of millions of iris templates stored on a system is also another challenge.

III. LITERATURE REVIEW

There are a lot of researches in the way of visual features extraction: for example texture has been considered as one of the most important features that refer to natural relationship between objects and theirs environment in an image. Several authors have worked in finding descriptors and features for texture identification. Existing features and techniques for modelling textures include Bidirectional Texture Function(BTF), a sampled 6D data structure parameterized by position (x,y) as well as light (wi) and view (wo) direction: b(x,y;wi,wo). Essentially, BTFs are textures that vary with view and light direction and are acquired by taking photographs of a material under many view/light configurations. Kautz et al. introduced a set of editing operators that enable the manipulation of view and light-dependent BTF effects. For effective editing, these operators can be restricted to work on subsets of the BTF, e.g., shadow areas, using selections. A current major limitation of BTFs is that the user is limited to the measured data and cannot easily modify the material appearance. [5]

Mayank Vatsa, Richa Singh, P. Gupta (2004) have compared the algorithms for iris recognition. Four algorithms due to Avila, Li Ma , Tisse and Daugman are implemented and compared on the CASIA iris image database. The algorithms are generally divided into four steps, viz. Localization, Normalization, Feature Extraction and Matching. The experimental comparison show that the Daugman's algorithm gave the highest accuracy of 99.9%. The algorithms are implemented in MATLAB 6.5.[4]

Some invariant feature descriptors such as Zernike moments among these, Haralick features are the most widely used. In his work, Haralick et. Al suggested the use of Gray-tone Spatial-dependence matrices also called Gray-level co-occurrence matrices (GLCM) to extract texture features from an image. Since then, GLCMs became widely used for image texture features extraction in many types of applications. [5]

Bachoo and Tapamo have proposed the eyelash detection using the gray-level co-occurrence matrix [GLCM] pattern analysis technique. The GLCM is computed for (21 x 21) windows of the image using the most significant 64 grey levels. A fuzzy C-means algorithm is used to cluster windows into from 2 to 5 types (skin, eyelash, sclera, pupil, and iris) based on features of the GLCM. [6]

Daugman have proposed active contour model based on Fourier series expansion for iris segmentation. [7]

He et al. have proposed Adaboost-cascade Learning and Pulling & Pushing method for iris segmentation. [8]

IV. WORKING OF IRIS RECOGNITION ALGORITHM

Iris Recognition algorithm include four basic steps:

Step-1 Image Acquisition: The first step of the iris recognition system is image acquisition. This step is very complicated because the size and color of iris of every person is different. It is very difficult to capture clear images using the standard CCD camera in different environmental conditions. Sometimes the acquisition process produces different results for the same person due to the different lighting effect, positioning and different separation of distance.

Figure2: Scan Iris Image

Step-2 Pre-processing:

It is a process to isolate the iris region from the rest of the acquired image. Iris can be approximated by two circles, one for iris/sclera boundary and another for iris/pupil boundary.

Step-3 Texture Extraction:

GLCM method is a way of extracting second order statistical texture features. The approach has been used in a number of applications. A GLCM is a matrix where the number of rows and columns is equal to the number of gray levels, G, in the image. The matrix element **P(i, j | Δx, Δy)** is the relative frequency with which two pixels, separated by a pixel distance **(Δx, Δy)**,occur within a given neighbourhood, one with intensity i and the other with intensity j. One may also say that the matrix element **P(i, j | d, θ)** contains the second order statistical probability values for changes between gray levels i and j at a particular displacement distance d and at a particular angle (θ).

A GLCM Pd [i, j] is defined by first specifying a displacement vector d = (dx, dy) and counting all pairs of pixels separated by d having gray levels i and j.

$$P_d[i,j]=n_{ij}$$

where n_{ij} is the number of occurrences of the pixel values (i, j) lying at distance d in the image.
The co-occurrence matrix P_d has dimension n x n, where n is the number of gray levels in the image. From this co-occurrence matrix P_d we can derive the following statistics as texture features.

1) Contrast

$$\text{Contrast} = \sum_{i\,j=1}^{n} P_d\,(i-j)^2$$

Contrast returns a measure of the intensity contrast between a pixel and its neighbour over the whole image.

2) Dissimilarity and Homogenity

$$\text{Dissimilarity} = \sum_{i\,j=1}^{n} P_d\,|i-j|$$

$$\text{Homogenity} = \sum_{i\,j=1}^{n} \frac{P_d}{1+|i+j|}$$

Homogeneity returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal.

1) Angular Second Moment (Energy)

$$\text{ASM (Energy)} = \sum_{i\,j=1}^{n} {P_d}^2$$

ASM returns the sum of squared elements in the GLCM.

1) Entropy

$$\text{Entropy} = \sum_{i\,j=1}^{n} P_d\,(-\ln P_d)$$

Entropy is a measure of information content. It measures the randomness of intensity distribution.

Step-4 Matching:

The maximum Hamming distance that exists between two irises belonging to the same person is 0.32. Thus, when comparing two iris images, their corresponding binary feature vectors are passed to a function responsible of calculating the Hamming distance between the two.
If hamming Distance<=0.32, then
Accept the person (same person).
Else
Reject the person (different person). [9]

V. Conclusion

This paper present a review of existing methods. The algorithm are generally divided into four main steps: acquisition, preprocessing, texture extraction and matching. The research shows that the GLCM method can be effectively used in image texture classification system. The GLCM can be used for gathering vector information. This method increases the accuracy and is invariant to iris rotation.

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