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# Fusion of Local and Global Iris Features to Construct Feature Vector Using Genetic Algorithm

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**Abstract -- Extracting important features from an image is a complicated phase in the field of image processing, biometrics and computer vision. After crossing over phases such as denoising, segmentation and normalization in any pattern (Iris) Recognition System, feature extraction takes place which represents the features in the form of numerals or binary known as feature vector. In Iris Recognition System (IRS), this feature vector is named as Iris Code which determines the matching or similarity score when test image is compared with database image for verification/authentication of an individual. In more general, IRS has used wavelet transform for feature extraction. In this paper, a new feature extraction technique is proposed that fuses both local and global properties of a normalized iris image using two cross over scheme in genetic algorithm and constructs 64 bit binary feature vector. The proposed technique is experimented using MATLAB 12a and the execution time for the proposed system is calculated. Based on the experimental results it is clear that the proposed feature extraction technique frames the Iris Code with success that minimizes an elapsed time to 196.7ms. And also it gives 98.75% accuracy.**

**Keywords - Local Features, Global features, Feature Vector, Biometrics, Correlation and Iris.**

## I. INTRODUCTION

Technically, IRS consists of five main processing steps namely Image acquisition, Image segmentation, Normalization, Feature Extraction and finally matching. Among these, feature extraction plays an important role. Feature extraction is a key process where the two dimensional image is converted to a set of mathematical parameters. It determines the matching score and in turn determines the identity of a person. The iris contains important unique features, such as stripes, freckles, coronas crypts radial furrow, rings and zigzag collarette which are collectively referred to as the texture of the iris. The significant features of the iris must be encoded so that comparisons between templates can be made. Gabor filter and wavelet transform are well-known techniques in texture analysis [1, 2]. A good feature set contains discriminating information, which can distinguish one object from other objects. It must be as robust as possible in order to prevent generating different feature codes for the objects in the same class. The selected set of features should be a small set whose values efficiently discriminate among patterns of different classes, but are similar for patterns within the same class.

The following figure shows the general structure of feature extraction Method in IRS.

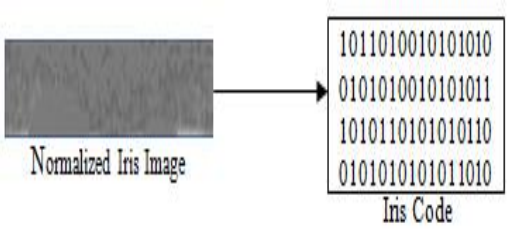



Figure 1. Feature Extraction in IRS

Normally, image features refers to global or local properties of an image. i.e., Features can be classified into two categories: Generally, average gray level, shape, hue, saturation and colour features falls into global properties. And circles, lines and texture come under the category of local properties. In this research work, a novel feature extraction technique is proposed by combining local and global features of normalized iris image using two cross over scheme of genetic algorithm.

## II. RELATED WORKS

The basic iris code algorithm was developed and patented by Dr.John Daugman. The extracted iris patterns are encoded using 2D Gabor wavelet demodulation(512 bytes) in order to construct the iris code which is of length 256 bytes. After developing the iris code, the captured iris record is compared with the one stored in the database. Hamming Distance is used as a measuring component which intern uses XOR operator to detect the disagreement between two iris-codes.

From the 11mm diameter iris, Daugman's algorithms provide 3.4 bits of data per square mm. This density of information is such that each iris can be said to have 266 unique "spots", as opposed to 13–60 for traditional biometric technologies (I.e. fingerprint). Daugman concludes that 173 "independent binary degrees– of–freedom" can be extracted from his algorithm–an exceptionally large number for a biometric [3].

Mahmoud Elgamal, Nasser Al-Biqami proposed a new approach for iris image compression and feature extraction based on discrete wavelet transformation (DWT).The obtained features dimensionality were further reduced by using principle component analysis (PCA), which drastically reduces the size of the iris database images. In the matching stage, a supervised classifier is introduced, namely k-nearest neighbor (k-NN). The classification attained was 99.5%. This technique is robust and effective compared with other recent works [4].

C.M.Patil and Sudarshan Patilkulkarni proposed an algorithm for iris feature extraction using lifting wavelet transform. The Lifting (integer) wavelet-based algorithm enhances iris images, reduces noise to the maximum extent possible and extracts the important features from the image. Then the similarity between two iris images is estimated using Euclidean distance and comparison of threshold. This technique is computationally effective with recognition rate of 99.97 % on iris database. This approach will be simple and effective [5].

Jong-Gook Ko et al proposed a novel iris recognition method. This method employs iris feature extraction using a cumulative-sum-based change analysis. In order to extract iris features, a normalized iris image is divided into basic cells. Iris codes for these cells are generated by their code generation algorithm which uses the cumulative sums of each cell. This method is relatively simple and efficient compared to existing methods. Experimental results show that this approach has good recognition performance and speed [6].

A. Latif and K. Hessampour proposed a method using orthogonal class-wise transformation, which converts the input feature space into more classifiable feature space. And also this method uses genetic programming and reduces the dimension of automatic modulation recognition regardless of the input feature space [7].

## III. FEATURE EXTRACTION TECHNIQUES

Most of the commonly used feature extraction techniques rely on global or local properties of an image. Good features should include locality, accuracy, distinctiveness, robustness, efficiency, invariance and quality. The efficient feature extraction technique should extract a huge amount of information from an image as much as possible such as color information, objects, edges, pixel definition, texture, shape, histogram dimensions, etc.

### *A. Local Feature Extraction*

A local feature describes a patch within an image which is robust. SIFT, SURF FAST, Harris, Shi & Tomasi corner detector, GLCM, MSER, BRISK, FREAK, HoG descriptors are some of the methods that extracts local properties. The GLCM is a statistical method that includes local features like Contrast, Correlation, Energy, Homogeneity, Sum of squares, Inverse difference moment, Sum average , Sum variance, Sum entropy, Entropy, Difference variance, Difference entropy, Information measure of correlation (IMC), Dissimilarity, autocorrelation, cluster, prominence, cluster shade and maximum probability. The SIFT (Scale Invariant Feature Transform) features proposed by Lowe [8], which use local maxima of the difference-of-Gaussians function as interest points and histograms of gradient orientations computed around the points as the descriptors.

### *B. Global Feature Extraction*

The global features denote the whole image but it is not robust. The global features should be insensitive to shift changes and noise, be easy to compute, and take a small intra-class variance and a large inter-class variance [9]. Shape is known as an important cue for human beings to identify and recognize the real-world objects, whose purpose is to encode simple geometrical forms such as straight lines in different directions. Shape feature extraction techniques can be broadly classified into two groups [10], viz., contour based and region based methods. The former calculates shape features only from the boundary of the shape, while the latter method extracts features from the entire region.

Texture is a useful characterization that can only be measured from a group of pixels. Based on the domain from which the texture feature is extracted, they can be broadly classified into spatial texture feature extraction methods and spectral texture feature extraction methods. For the former approach, texture features are extracted by computing the pixel statistics or finding the local pixel structures in original image domain, whereas the latter transforms an image into frequency domain and then calculates feature from the transformed image [11].

## IV. THE PROPOSED FEATURE EXTRACTION TECHNIQUE

Iris preprocessing phase takes place before extracting an iris features. This phase processed to localize the inner and outer boundary of iris in the captured iris image. And then, the localized iris region is transformed into polar coordinate to compensate iris image deformation due to the variation of pupil size in the conditions of iris acquisition [12]. After that feature extraction phase is carried out in IRS. In this work, coefficient correlation, mean gray level, standard deviation, and histogram are taken as global features that are extracted and stored in global feature vector (GFV) which is 64 bit length. In addition to that, four local features like Contrast, Correlation, Energy, and Homogeneity are extracted using GLCM method and 64 bits local feature vector (LFV) is constructed. After that, both feature vectors gets fused using two point cross over scheme of genetic algorithm.

***Fusion using two cross over scheme***

In this crossover scheme two points are selected from the binary string of Features Vectors. From the beginning point to the first crossover point, the binary string is copied from LFV and from first crossover point to the second crossover point, string is copied from the GFV and the rest is copied from the
LFV which forms Child Feature Vector1 (CFV1). The remaining strings at both feature vector forms Child Feature Vector2 (CFV2). Among these two children vector, CFV1 is treated as a Fusion Feature Vector (FFV) which is 64 bits length. Hence the resultant feature vector consists only 64 bits; the execution time for calculating matching score is reduced.

Fusion Feature Vector (FFV) = CFV1

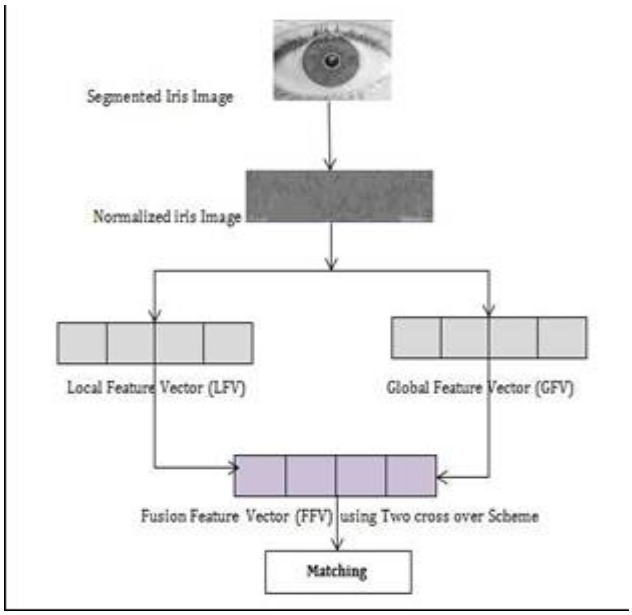
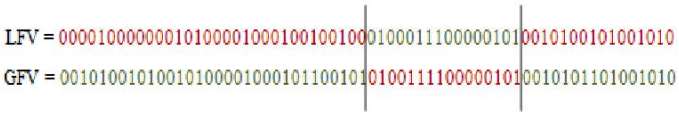
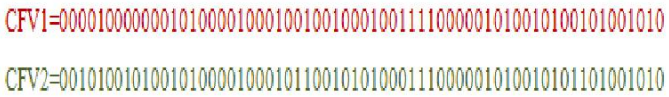



Figure 2. Design of proposed Feature Extraction Technique using Genetic

Algorithm




## V. RESULTS AND DISCUSSIONS

To experiment the proposed Feature Extraction Technique, 8 data sets each containing 10 iris images are taken from IIT Delhi database and tested using MATLAB 12a tool. The local and global feature extraction of 5 sample images namely Iris21, Iris38, Iris44, Iris507 and Iris860 are shown in figures. The following figures show the step by step procedure of IRS and the results of proposed feature extraction method. Recognition rate refers the degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard.

Figure 3. Segmented Iris Image

Figure 4. Normalized Iris Image

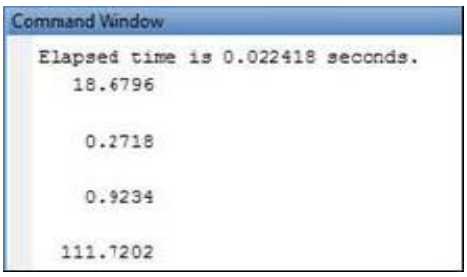



Figure 5. Global Feature Extraction and elapsed time calculation

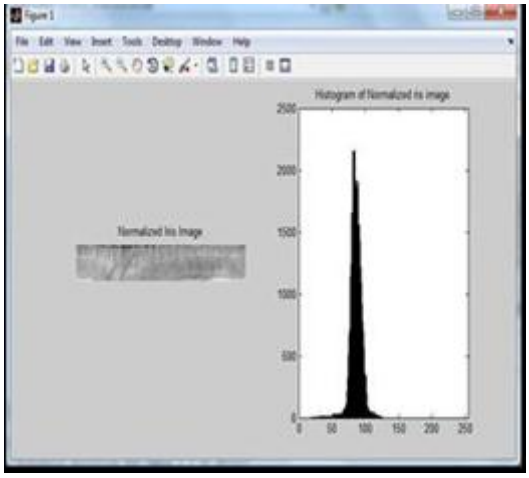



Figure 6. Histogram of Normalized Iris Image

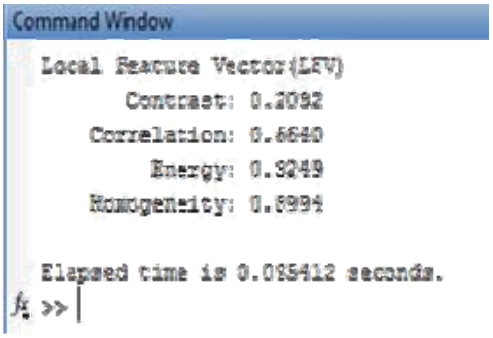



Figure 7. Local Feature Extraction using GLCM Method and elapsed time calculation

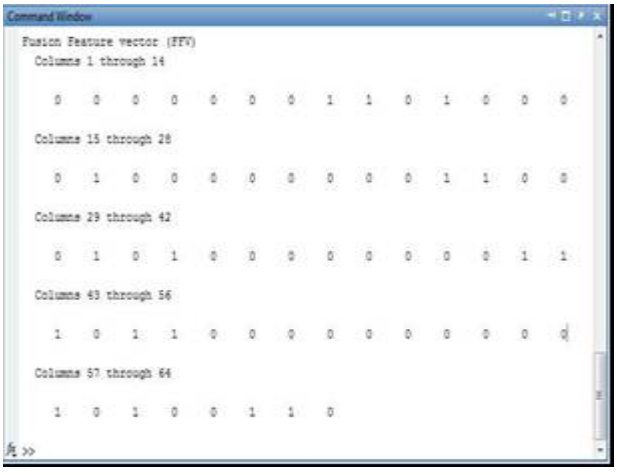



Figure 8. Fusion Feature Vector (FFV) using proposed technique

The table I and table II shows the local and global

features that are extracted from normalized iris image and Table III shows the comparison of proposed with various competent Feature Extraction Techniques.

Table I. Local Features for different normalized Iris image using GLCM technique

| Image Name | Local Features (Using Gray Level Co-occurrence Matrix) | | | | |
|---|---|---|---|---|---|
| | Contrast | Corr | Energy | Homo geneity | Elapsed Time |
| Iris21 | 0.0830 | 0.7533 | 0.5981 | 0.9585 | 51ms |
| Iris38 | 0.2504 | 0.5318 | 0.5110 | 0.9012 | 56ms |
| Iris44 | 1.6311 | 0.7725 | 0.0368 | 0.6516 | 67ms |
| Iris507 | 0.2032 | 0.6640 | 0.3249 | 0.8994 | 95ms |
| Iris860 | 0.2691 | 0.5578 | 0.2909 | 0.8685 | 83ms |

Table II. Global Features for different Normalized Iris Image

| Image Name | Global Features | | | | |
|---|---|---|---|---|---|
| | Std_dev | Corr1 | Corr2 | MeanGL | Elapsed Time |
| Iris21 | 8.8819 | 0.3107 | 0.9843 | 85.0789 | 39ms |
| Iris38 | 18.6796 | 0.2718 | 0.9234 | 111.7202 | 22ms |
| Iris44 | 66.6465 | 0.0850 | 0.9226 | 130.4930 | 33ms |
| Iris507 | 16.5465 | 0.0622 | 0.9707 | 165.8260 | 53ms |
| Iris860 | 76.7759 | 0.1332 | 0.8934 | 157.1565 | 70ms |

Table III. Comparison of proposed with various competent Feature Extraction Techniques

| S.no | Feature Extraction Techniques | Elapsed Time | Recognition Rate % |
|---|---|---|---|
| 1 | Daugman's Method | 682.5 ms | 99.37 |
| 2 | Boles Method | 170.3 ms | 92.61 |
| 3 | Li Ma Method | 244.2 ms | 95.68 |
| 4 | Tan Method | 426.8 ms | 97.25 |
| 5 | Proposed method (Fusion of local & global Features) | 196.7 ms | 98.75 |

## VI CONCLUSION

The proposed feature extraction method extracts the global properties as well as local properties of normalized iris image using genetic algorithm which reduces the time complexity and increases the accuracy. It takes only a very few seconds (196.7ms) to extract the global and local features of a person. And also it gives high accuracy of 98.75%. The proposed produces only 64bit Fusion Feature Vector (FFV) which is used to identify the person effectively in IRS and also reduces the storage space in database. In future both local and local and global properties will be combined using some other advanced technique to improve the proposed system to some extent.

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