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Iris Recognition using Savitzky-Golay filter for Better Security Outcomes

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ABSTRACT: Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on video images of one or both of the irises of an individual's eyes, whose complex patterns are unique, stable, and can be seen from some distance. The iris has remained a preferred biometric trait compared to other biometrics because of its uniqueness, stability properties. However, degraded iris images captured under less constrained acquisition setups and varying lighting conditions will affect the performance of iris based biometrics systems. This system proposes an iris recognition or authentication system using Savitzky-Golay filter for iris feature extraction. The approach also proves that the symbolic representation effectively handles noise and degradations, including low resolution, specular reflection, and occlusion of eyelids present in the eye images and uses minimum number of features to represent iris image. Here the proposed system provides better security outcomes with precise feature extraction.

KEYWORDS: IRIS recognition, Biometric System, Savitzky-Golay Filter, Feature Extraction, Eye Lids.

I. INTRODUCTION

IRIS is a biometric feature among human that uniquely identifies them. Iris formation started from the 3rd month of an embryonic life. But the formation of unique patterns of IRIS started after a year of life.

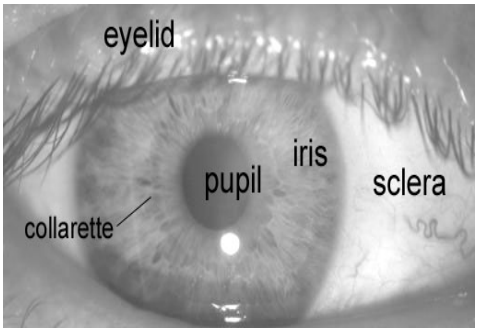

Fig. 1.1 Palm Features [5]

The digital image of IRIS contains unique features that can be used for authentication system. Iris recognition technique evolves various stages to get it precisely detected, which includes image acquisition in which wavelength of light, light reflected from the base of iris and some other factors are considered. Preprocessing is the next stage of recognition in which boundaries and other parts of an eye are taken into account with enhanced image quality. Image segmentation which includes the analysis of background texture, image normalization is used to change the intensity

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value of pixels obtained from an image. Feature extraction is considered as a crucial stage of recognition, as it extracts the vectors of those areas of an image which is taken under consideration. Final stage is matching where the acquired data in terms of coding from previous stage is compared with the existing information stored in the database to accomplish the recognition process. Various algorithms have been developed to execute those operations of localization, preprocessing, normalization, feature extraction and matching.

II. RELATED WORK

Fabián Rolando Jiménez López et al. developed a method for biometric iris recognition system which elaborates the segmentation and normalization process. Exploitation of these processes extracts the features of an eye. Implementation of segmentation algorithm took place by utilizing Gabor filters and Hough Transform. [1] Arezou Banitalebi Dehkordi et al. proposed a technique which uses multiple thresholding process for the identification of eyelids. Eyelash textures and light reflection and pupil pixels. Proposed work for Iris identification system depends on normalization and segmentation methods proposed by Daugman. [2] P.Thirumuruga et al. proposed a system which developed a fusion technique of Canny Edge detection algorithm and Hough transform. Hough transform is a feature extraction technique used in image analysis, computer vision, and digital image processing. Moreover wavelet transformation technique is used to extract the cognitive patterns from the iris of an eye. [3] Navjot Kaur et al. proposed a review on existing algorithms and different methods developed by various researchers used for iris recognition system. Canny edge detector is used to find the edges of an iris whereas Hough transform is used to establish the boundary of an iris. [4] Amena Khatun, A. K. M. Fazlul Haque et al. proposed a biometric based attendance system, which needs iris recognition to identify a student. System consists of both hardware and software execution. Implementation of proposed method took place by capturing images using webcam and processes it in MATLAB to extract their feature and further compare it with the existing images stored in the database. [5] Mateusz Trokielewicz et al. proposed a paper, which generated a database of iris images captured from mobile cameras in presence of proper lighting. Proposed paper shows the result obtained from the experiment taken place in existing iris recognition methods which are : IriCore, VeriEye, MIRLIN and OSIRIS. Observation took place in four different criteria taken into account. [6] Sarika B Solanke et al. proposed a system to summarize the prior work done on characteristics of Iris identification methods. Various techniques have developed for the segmentation proposes, proposed paper assessed those methods. [7] Jagadeesh N. et al. Proposed an algorithm of image processing for iris recognition system. Proposed work further processed the segmentation method by using GUI i.e. graphical user interface. Recognition process took place in predefined format which uses Pre-Processing, Segmentation, Canny Edge Detection, Gaussian Filter, Finding the intensity gradient of the image, and others, till matching with the existing data in UPOL database and processed the algorithm in MATLAB. [8]

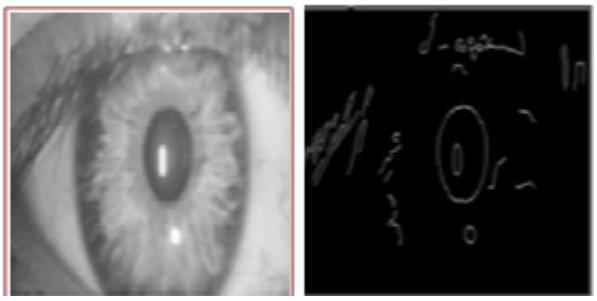

Fig.2.1) Input Image, b) Edge Detection [3]

III. PROPOSED WORK

The proposed system is able to provide better authentication approach towards IRIS. Proposed system acquires user's IRIS in the form of frame and later processes it for feature extraction that can be compared with the stored template.

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The true acceptance rate of proposed is bit higher as compare to the earlier implemented system with minimal error rate.

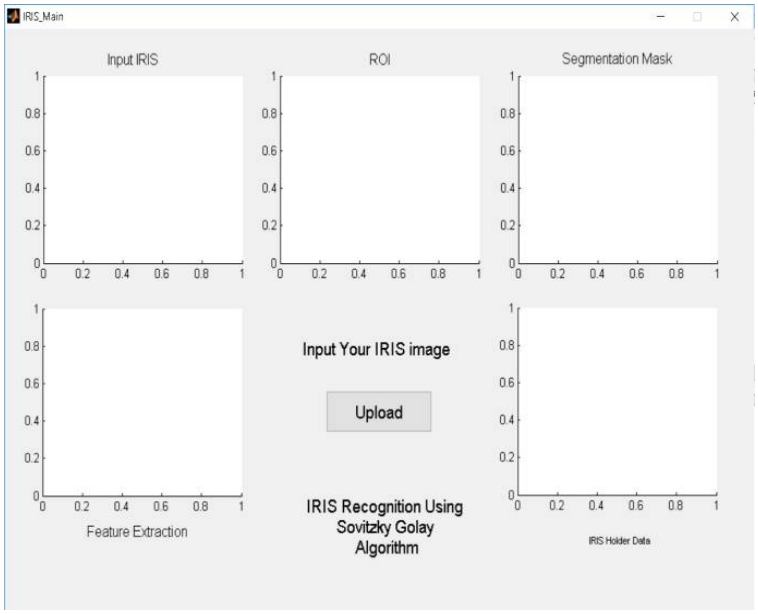

Fig. 3.1 Proposed System GUI

The system has been implemented in MATLAB with Savitzky Golay Filter and extract feature for matching with templates.

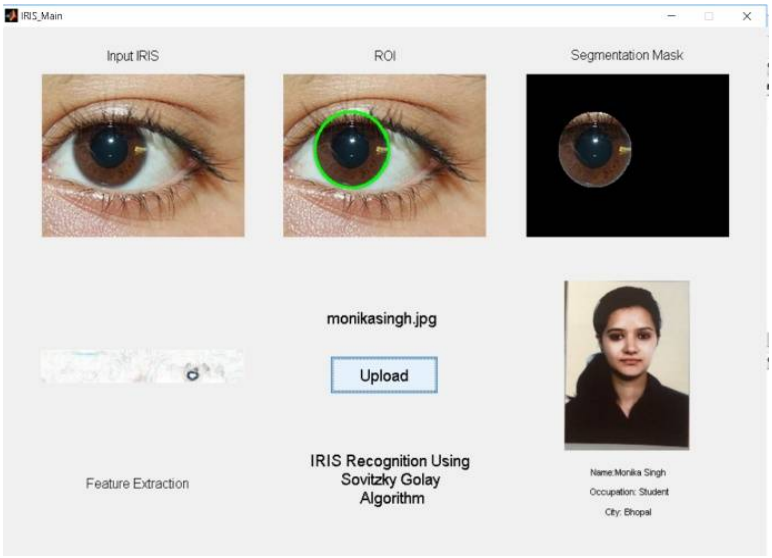

Fig. 3.2 Processed IRIS with successful authentication

Once the feature has been extracted, it matches with the stored templates and if the matching feature is greater than the threshold value or key points; the referential result will be returned with holder's detail. System is capable to return true positive results with minimal false or fake results. System has been tested with many enrolments and system observed as effective biometric authentication system. Recognizing IRIS to verify an individual is an authentic technique which can be employed for the verification process.

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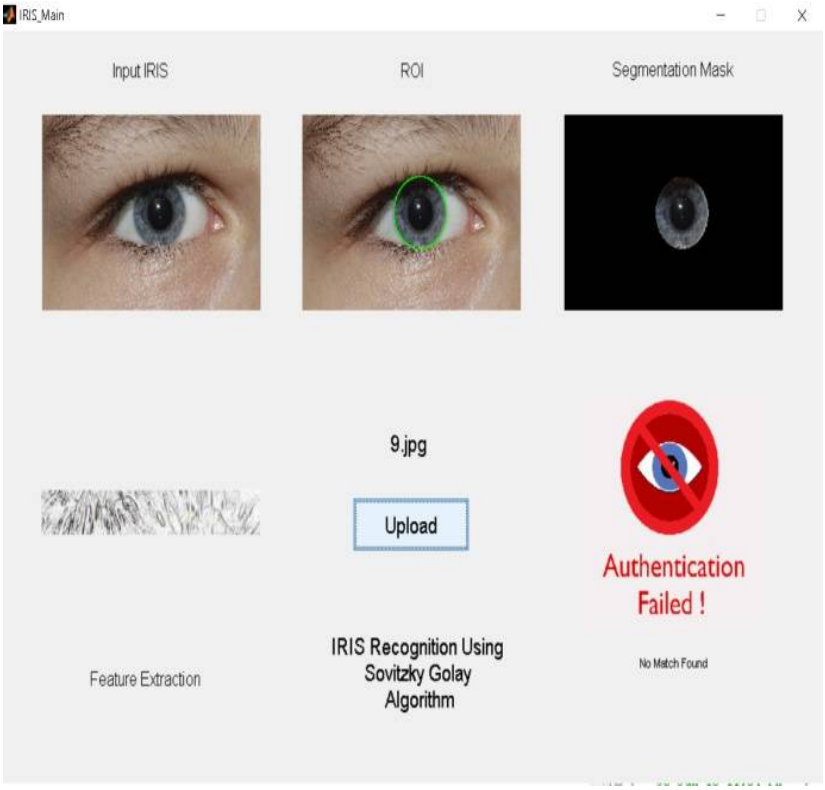

Fig. 3.3 Processed IRIS with denied authentication

System is able to recognize the IRIS location from an image if it exists. If the extracted data set is greater than the key point threshold then it will authenticate the user else it will deny and return no results. First of all the IRIS image has been acquired for extracting ROI as per the IRIS information. Once it has been acquired system applies Savitzky Golay algorithm for filtering smoothen data that can extract feature from IRIS image and stored as template that can be compared later with input IRIS. System is able to reject false or unauthorized user that does not belong to the database and accept the true one. While training only feature will be extracted and stored as template feature that can be compared while authenticating user.

The extraction process is similar to the training process except template matching. Once the feature has been extracted, it compared with the template that stored previously. If it is greater than the threshold data points then it will fetch the user details else it will deny the user. A Savitzky–Golay is a filter that is used for digital filtrations for the purpose of smoothing the data, that is, to increase the signal-to-noise ratio without distorting the signal. This process is also knows as convolution method, in this process a set of data points extracted from an image and applying polynomial variables for smoothing data for feature extraction. This method is based on mathematical procedures; it can be operated on 2 or 3 dimensional data.

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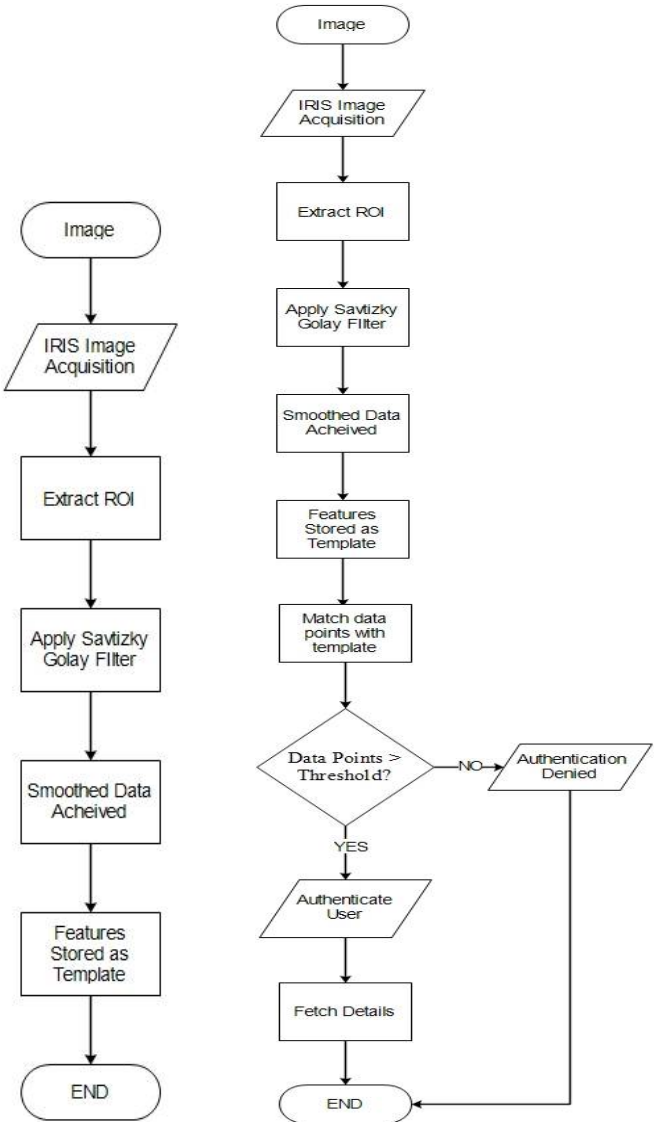

Fig. 3.4 Flow Chart for Feature Template & Matching

3.2 SGF (Savitzky Golay Filter) Algorithm –

Require: I as input image, x_j is a variable that differ from current data, y_j is observed data, Y_j is feature data, m & C_i are convolution coefficients, $\bar{x}$ is the value of the central point and h is an gap.

Input: IRIS Image

Output: IRIS feature

1: I as input IRIS image

2: Mark ROI // Region of Interest

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3: Mask background except ROI

4: Extract n{x_j, y_j} set of data that contains IRIS where j=1,2,3….n, x_j is a variable & y_j is an observed value

5: Calculate Y_j

$$Y_j = \sum_{i=-\frac{m-1}{2}}^{\frac{m-1}{2}} C_i \, y_{j+i}, \qquad \frac{m-1}{2} \le j \le n - \frac{m-1}{2}$$

where Y_j is smoothed data, m & C_i are convolution coefficients

6: Find the changes of variable

$$z = \frac{x - \bar{x}}{h}$$

where $\bar{x}$ is the value of the central point and h is an gap

z takes the values

$$\frac{1-m}{2}, \cdots, 0, \cdots, \frac{m-1}{2}$$

z=2,1,0,-1,-2 if m=5 polynomial quadratics

where m is an odd number goes to 5, 3 and 1

7: **if** (Y_j > z) **then**

scored key points satisfy stored template;

else

no template exist;

end else

end if

8: End

In the algorithm, first of all an IRIS image has been acquired, then system requires to extract region of interest i.e. ROI and mask the rest background which is not related to the required information. Then extract the set of data points that belong to IRIS. Once it has been done, system requires calculating the smoothed data and later comparing with the variables or the data which has been stored in the database as template. If it is greater than the threshold or desired key points then system can authenticate the details otherwise it will deny the user because there is no template stored with those key points.

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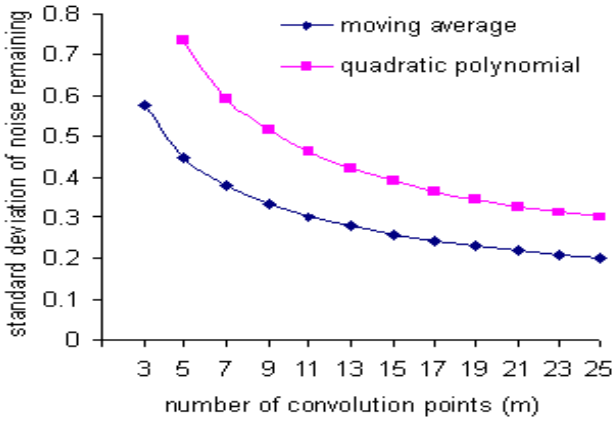

Graph No. 3.2 Savitzy Golay Polynomial

Table No. 4.1 Result Analysis for Authentic Users or True Acceptance & Unauthorized Users or False Rejection

id	user_authenticated	result
1	yes	true acceptance
2	yes	true acceptance
3	yes	true acceptance
4	yes	true acceptance
5	yes	true acceptance
6	yes	true acceptance
7	yes	true acceptance
8	yes	true acceptance
9	yes	true acceptance
10	yes	true acceptance
11	yes	true acceptance
12	yes	true acceptance
13	yes	true acceptance
14	yes	true acceptance
15	yes	true acceptance
16	yes	true acceptance
17	yes	true acceptance
18	yes	true acceptance
19	yes	true acceptance
20	yes	true acceptance
21	yes	true acceptance
22	yes	true acceptance
23	no	true rejection
24	yes	true acceptance
25	yes	true acceptance

id	user_authenticated	result
1	no	false rejection
2	no	false rejection
3	no	false rejection
4	no	false rejection
5	no	false rejection
6	no	false rejection
7	no	false rejection
8	no	false rejection
9	no	false rejection
10	no	false rejection
11	no	false rejection
12	no	false rejection
13	no	false rejection
14	no	false rejection
15	no	false rejection
16	no	false rejection
17	no	false rejection
18	no	false rejection
19	no	false rejection
20	no	false rejection
21	no	false rejection
22	no	false rejection
23	no	false rejection
24	no	false rejection
25	no	false rejection

Check All / Uncheck All With selected:

Table No. 4.1 shows how many users are get authenticated when authentic IRIS tested. Here the system has been tested with 25 IRIS images which have been enrolled earlier and system achieved 24 images as true acceptance and 1 as true rejection. It means that 24 IRIS has been recognized correctly or identified as authentic user but rejected one IRIS

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image that also belongs to the correct feature template. System also tested with unregistered IRIS images that should be rejected every time and indeed it rejected all false users and no authentication has been provided over there.

TA- True Acceptance, TR- True Rejection, FA – False Acceptance, FR – False Rejection

$$Accuracy = \frac{(TA + FR)}{Total\ Testing\ Class} * 100\ \%$$

$$Accuracy = \frac{(24 + 25)}{50} * 100\ \%$$

$$Accuracy = \frac{49}{50} * 100\ \%$$

$$Accuracy = 98\ \%$$

IV. CONCLUSION & FUTURE SCOPE

Thus the currently proposed system is able to recognize IRIS region along with its features that correctly authenticate the user and rejecting the false one. Precision if calculated over the false acceptance, false rejection, true acceptance and true rejection. As per the false acceptance rate that relies to zero that means that there is no false user accepted here whether a true user rejected. So, the accuracy rate of proposed relies with 98% along with 100% false rejection rate. Savitzky Golay Filter is liable to acquire the accuracy rate which is bit higher especially for false rejection and true acceptance. IRIS based authentication system can be implemented with bit higher precision in future and applicable in various fields of authentication.

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