Efficient Biometric Authentication Technique Using The Gray Scale Information's Of Sclera, Iris And Pupil

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Abstract: The motive of this research is to accomplish a secure enhanced biometric authentication system by using the gray scale information's of Iris and Pupil. The gray scale values are in the range of 0-255 depending upon the colors of image before they converted as gray scale image. The Iris feature in an eye image has a lot of different structural patterns and these structural patterns will be distinguished by the difference in gray scale information's. The gray scale information's will clearly show the difference in the iris and pupil structural feature even the difference is very small. So the author preferred to use the gray scale value for a secure enhanced biometric authentication system. The proposed work is divided as (i) Image acquisition (ii) Preprocessing (iii) Finding iris length (iv) Creating templates (v) Creating stored templates and (vi) Feature Matching. The iris length is found out by using the gray scale information's appeared in the interfacial layer of sclera and iris. The required templates are created by using the gray scale information's from the specific row and column. During the execution the wrong matches will be rejected with in short time by comparing with iris length. If the iris length is matched well then the template matching process will be carried out. It will take appropriate time while the exact match enters in to the comparison. Finally the proposed work gives 99.88% accuracy with high performance.

Keywords: Iris Length, Gray scale values, Templates, Stored Templates and Interfacial layer.

1. Introduction

Prior to inspecting the exploration challenges engaged with an iris biometric framework, the iris anatomical design ought to be concentrated in detail. The perplexing conduct of the natural eye gives two explicit biometric qualities, the iris and the retina [3]. Between these two qualities, iris is viewed as the most appropriate biometric characteristic than the retina, as it is obvious even to the unaided eye. At the point when found in the noticeable light range, iris is viewed as a pigmented mosaic of surfaces. However, when caught under close infrared (NIR) range, highlights of iris district could be seen all the more without any problem. It has been demonstrated by the iris research local area and ophthalmologists that in an individual the iris present morally justified and the left eyes are particular. In any event, for hereditarily indistinguishable twins iris textural highlights are supposed to be different, subsequently making it an ideal biometric attribute that ought to be utilized in iris acknowledgment framework [4]. During the third month of the embryo development, iris is supposed to be created, through a technique for tissue films tight framing and collapsing.

Iris structures helps in distinctive people are entirely framed during the gestational period's eighth month. Prior to labor, degeneration happens bringing about student opening and arrangement of the irregular and unmistakable iris textural designs [4]. At the point when the eye is seen from the front, it has two unmistakable areas: sclera and cornea. The sclera is white or pale white in shading with intently interlaced strands. The cornea is a straightforward film. The iris is an all-around secured inward eye organ, arranged behind the watery humor and the cornea. It is the hued segment of the natural eye and has particular examples or textural data. Cornea covers both student and iris, where the understudy is the focal opening of iris, by and large dim in shading when contrasted with iris [5]. The excellent obligation of an iris is to control the understudy's measurement size with the goal that the light going into retina is controlled. Dilator and sphincter are two muscles present in the iris, liable for changing understudy size to play out this capacity [4]. Figure 1.1 portrays the construction of the iris alongside its unmistakable textural highlights [20]. Despite the fact that the pigmentation and design of iris are hereditarily connected, it has in excess of 200 unmistakable component focuses, which could be utilized for ID or acknowledgment reason including rings, wrinkles, pupillary laces, sepulchers, spots, collaret, and so on Iris textural designs are profoundly particular and irregular, making between-class changeability crossing around 250 levels of-opportunity. These examples are clearly steady for the duration of the existence of an individual [5].

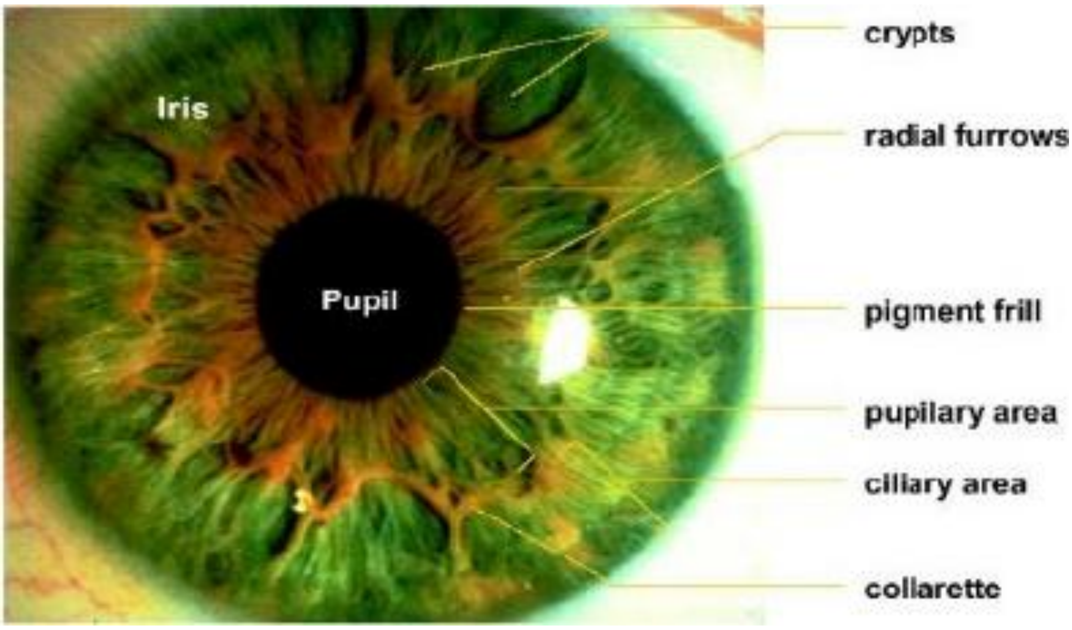


Fig. 1.1: Structure of an Iris.

Pupil is a dark opening (Fig: 1.1) situated in the focal point of the iris of the eye that permits light to strike the retina [23]. It seems dark since light beams entering the understudy are either consumed by the tissues inside the eye straightforwardly, or ingested after diffuse reflections inside the eye that generally miss leaving the tight student. The expression pupil was made by Gerard of Cremona [1]. In eye, the pupil is round, yet its shape fluctuates between species; a few felines, reptiles, and foxes have vertical cut understudies, goats have on a level plane arranged students, and some catfish have annular sorts [2]. In optical terms, the anatomical understudy is the eye's opening and the iris is the gap stop. The picture of the student as seen from outside the eye is the passageway understudy, which doesn't actually relate to the area and size of the actual student since it is amplified by the cornea. On the inward edge lies an unmistakable construction, the collarets, denoting the intersection of the early stage pupillary layer covering the undeveloped student [21].

In this research the author uses gray scale information's which are available in the space occupied by Iris and Pupil as well as Sclera. The gray scale values of the portion covered by the part sclera have more or less same gray scale value but it has some little differences in nearest to the iris. So the author gives more importance the gray scale information's presented in Iris and Pupil. The gray scale information's have many difference depends upon the structural patterns of Iris. So it is easy to differentiate an eye for different persons by using the gray scale information. And gray scale values in-between the area of iris and pupil has many differences. So the author concludes the gray scale values of Iris and pupil is very best for a secure biometric authentication system. Then the author find out the iris length by using the gray scale information's which are relevant to iris area and creates a number of templates by using the extracted gray scale information's from three middle rows and three middle columns. The author prefers to take the gray scale values of middle rows because of removing noises caused by eye lid and eye lashes then specific gray scale values only taken from the particular columns to reduce noises.

2. Literature Review

Vanaja Roselin.E.Chirchi et al. [9] proposed a strategy to upgrade a calculation for iris acknowledgment with more speed and precision. The creator utilizes CASIA information base for input eye picture. What's more, the creator gives biometric examination rundown to acquire information on biometric validation. In this exploration the preprocessing incorporates iris discovery, right iris division and finding iris. In preprocessing the creator utilizes wavelet calculation and decreases the commotions. Subsequent to preprocessing the necessary highlights are extricated. In iris confinement the pupillary fringe and iris fringe are identified by utilizing Integro – differential administrator. The Daugman elastic sheet model is utilized in iris standardization here the roundabout zone of iris is changed over into rectangular locale. Gabor channel and Wavelet change are regularly utilized for extra element extraction. Lastly Binary coding plan and Hamming Distance are utilized for design coordinating and the creator gives one extra significant data is the diverse state of irises. Some of iris pictures have oval shape rather than circle and all iris areas are not wonderful circle shape, it is demonstrated by given pictures. The creator had accomplished the proposed work with 99.9% exactness.

Gafar Zen Alabdeen Salh et al. [10] presents an iris distinguishing proof method by utilizing a Linear Discriminant Analysis (LDA) Algorithm. The creator maintains a strategic distance from the regular techniques utilized for iris acknowledgment which were all the more computationally costly by presenting the proposed calculation. By utilizing the strategy of LDA the creator structure a gathering of pictures then the necessary example is intended for existing gathering of iris picture. After that the creator demonstrates the high effectiveness of the proposed framework. The creator utilizes MMV information base which have 450 iris pictures. From past days the Daugman elastic sheet model utilized for standardization in iris acknowledgment. Furthermore, Daugman Integro – Differential administrator utilized for confinement. Be that as it may, in this paper the creator proposed new methodology as opposed to utilizing those ordinary strategies which are likewise computationally costly. At last the creator effectively perceives the iris picture with exactness of 74%, bogus acknowledgment rate is 5% and bogus oddball rate is 15%. The LDA calculation lessens substantially more numerical estimation then the customary strategies utilized in iris acknowledgment.

Abikoye Oluwakemic et al. [11] propose another calculation by bearing the procedure Fast Wavelet Transform (FWT) to recover the iris textural designs for individual ID. The creator utilizes CASIA information base for input iris picture. In iris confinement the creator identify focus arrange of an iris and furthermore distinguish other two finishes by utilizing these focuses the creator register sweep of iris just as utilize similar strategy to discover the limits of student. After iris restriction the iris standardization is completed by utilizing ordinary Daugman elastic sheet model [17]. By utilizing this model the roundabout region is moved in to rectangular locale. After the standardization interaction iris underlying example extraction is completed. Consequently the surfaces of irises are separated. What's more, the creator examinations that there are two strategies called Gabor channel and wavelet change adaptable to recover the textural design [18, 19] and utilizing Fast Wavelet Transform (FWT). At last the creator inferred that the proposed calculation is quick and has less computationally costly to extricate the textural highlights of iris. What's more, the creator produces 2048 pieces iris organized code.

Lokesh Sharma et al. [12] proposed another strategy to perceive iris highlights utilizing Discrete Cosine Transform (DCT). The creator utilized UBIRIS variant 4.1 data sets for input iris picture which incorporates 990 pictures of 198 unique eyes. While preprocessing the pupillary fringe and iris fringe are distinguished by shrewd edge identifier and roundabout Hough change. The two strategies are functions admirably in picture division. At that point the standardization interaction is done by Daugman elastic sheet model. At that point the necessary highlights are separated by utilizing Discrete Cosine Transform (DCT) framework. The necessary lattice is size of 4*4. After the nitty gritty data of framework is changed over to double information the coordinating cycle is finished by Hamming distance. At last the creator gives 99.9% precision with FAR at 0.01%.

Dr Sanjay R.Ganorkar et al. [13] presents another technique for iris ID utilizing Neural Network. As ordinary cycle the iris restricted at that point standardized and afterward the necessary highlights are extricated. After that the Neural Network order is applied at that point Back Propagation Neural Network is applied for coordinating interaction. By utilizing these strategies the creator expands the exactness level. Shrewd edge discovery and Hough Transform procedures are utilized for commotion decrease just as iris limitation. Consequently the commotion decrease and iris limitation are performed well. Gabor channel used to give more goals in component extraction; it gives best outcome than the Fast Fourier Transform. In this examination the creator executed the element extraction procedure by parting of two – dimensional iris structure in to one – dimensional wavelet changes. Here the Gabor – Wavelet utilized for better outcome. The coefficients of obvious huge number of individuals are saved as a singular framework. The single worth rot is applied to these coefficients for connection with find the best presentation. Accordingly a neural association mechanical assembly is used to calculate the best endorsement execution and plot an outline of mean square missteps versus number of edges. At last the groupings utilizing Neural Network gives the outcome with more exactness.

Daouk et al. [14] proposed iris affirmation plans which incorporate a blend segment of both a Canny Edge Identification plot and a Circular Hough Transform, to recognize as far as possible in automated image of an eye. By then Haar wavelet is used to pull out the deterministic plans in a person's iris as a component vector. Wavelet tree was utilized for picture coefficient's arranging where a data base of 60 pictures was used and typical right affirmation rate is 93%. The requirement of this work is that this framework doesn't perform well in case of horrible lighting, hindrance by eyelids, uproars or inappropriate eye arranging.

Xu et al. [15] presents an improved iris affirmation system which deals with the eyelids and eyelashes recognizable proof and an elective picture improvement procedure. The standard explanation behind considering eyelids and eyelashes revelation is that the presence of these impacts the iris picture and produce upheaval that results in the degradation of structure execution. Sub square of eyelids/eyelashes models took a gander at for acknowledgment reason. For redesign of iris picture derivation of establishment was done. Isolating is performed by histogram evening out and vainer isolating. For eyelids/eyelashes acknowledgment rundown derivate was used. The iris zone finding rate is 98.42% if there ought to be an event of CASIA data base.

Poulami Das et al [6] proposed another biometric-based Iris highlight extraction framework. The framework consequently secures the biometric information in mathematical arrangement (Iris Images) by utilizing a bunch of appropriately found sensors. We are thinking about camera as a great sensor. Iris Images are ordinarily shading pictures that are handled to dark scale pictures. At that point the Feature extraction calculation is utilized to identify "IRIS Effective Region (IER)" and afterward separate highlights from "IRIS Effective Region (IER)" that are mathematical portrayal of the basic biometrics. Later on this work will assist with recognizing a person by contrasting the element acquired from the component extraction calculation with the recently put away element by delivering a similitude score. This score will show the level of likeness between couples of biometrics information viable. Contingent upon level of likeness, individual can be recognized. Verification is additionally a significant concern territory of this theory. By considering Biological attributes of IRIS Pattern we utilize Statistical Correlation Coefficient for this 'IRIS Pattern' acknowledgment where Statistical Estimation Theory can assume a major part.

Chengqiang Liu Mei Xie, proposed [7] Direct Linear Discriminant Analysis (DLDA) which joins with wavelet change to remove iris highlight. In their technique, right off the bat, they apply wavelet deterioration to the standardized iris picture whose size is 64×256 and simply pick the coefficients of the guess part of the second level wavelet disintegration to address the iris picture since this part contains fundamental component of the first iris picture however the size of this part is just 16×64. And afterward utilize DLDA to remove the iris highlight from this guess part. During characterization, the Euclidean distance is applied to quantify the similitude level of two iris classes.

Azizi et al. [16] proposed a work which oversees using features extraction and subset assurance. Iris features were isolated using form let change; it gets the inborn numerical designs of iris picture. Iris picture was furthermore broken down into sub-discourages that contain all surface information. This technique utilizes Support Vector Machine (SVM) for organizing the iris designs. Gabor channel and Haar wavelet were used in this work for coding reason. Iris vector was made using Principal

Component Investigation (PCA). The introduction of the proposed system was checked against CASIA picture data base.

Rajasundaram P et al [8] proposed a new algorithm for biometric authentication using the gray scale and binary information's of Iris and Pupil. The author did not use any mathematically expensive techniques in the proposed research work so the biometric recognition rate is high. Iris length and pupil chord lengths are calculated using Euclidean distance formula. Certain middle row gray scale values are used for additional security. The gray scale values are taken from the middle row so no need to worry about the noises made by eye lids and eye lashes. Finally the author successfully recognizes an exact eye image with 99.92% of accuracy from the datasets which are having 1227 unique eye images.

3. Problem Identification

Most of the previously available Iris recognition systems are more expensive in computation. The Iris recognition task is completed without using any mathematically expensive techniques with the accuracy of 99.92% [8]. The execution time of the previous work [8] is 0.032760 seconds. The proposed system tries to increase the performance by reducing the execution time with more accuracy than the previous work. Furthermore the proposed system used only mathematically less expensive techniques like Euclidean distance. Some more new techniques are employed in the proposed algorithm.

4. Proposed System

The problem described in the problem identification section will overcome by this proposed system. The proposed system works on gray scale information's and any other mathematically expensive techniques are not used hence the performance of proposed system will be high than the previous systems. The iris length is find out by using the concept of repetition of gray scale information's less than or equal to 165 in the interlayer area of sclera and iris then required templates are created in the size of 3×3 matrixes by using gray scale information's presented in specific row and column. In this work the required biometric authentication is done by iris length matching and then template matching.

4.1 Image Acquisition

The necessary eye pictures are obtained from the prepared informational database CASIA (Chinese Academy of Science and Institute of Automation) and IITD (Indian Institute of Technology Delhi) dataset. Absolutely 1227 pictures are gained from all the classes of the portrayed dataset. One of the images from the described databases is treated as an input image and the other images are used as test images. In this research the author creates stored templates by extracting the required information's from all the images acquired from the described databases. After creating stored templates the author used stored templates for testing and databases are used for getting different input images. The gathered data about the two examined databases are momentarily clarified in the accompanying table.

Attributes/Database	**CASIA-V4-Iris-Interval (Left Eye)**	**CASIA-V4-Iris-Interval (Right Eye)**	**CASIA-V4-Iris-Twins (Left Eye)**	**CASIA-V4-Iris-Twins (Right Eye)**	**IITD (Left Eye)**	**IITD (Right Eye)**
Image Dimension	320×280	320×280	640×480	640×480	320×240	320×240
Image Memory Size	Varied depend on image	Varied depend on image	Varied depend on image	Varied depend on image	225 KB	225 KB
Gray Scale Image	Yes	Yes	Yes	Yes	No	No
Image Format	JPEG	JPEG	JPEG	JPEG	BMP	BMP
Number of Classes	249	249	200	200	224	224

Number of Sub Classes	Varied depend on Classes	Varied depend on Classes	Varied depend on Classes	Varied depend on Classes	Varied depend on Classes	Varied depend on Classes
Total Number of Images	1310	1384	1509	1666	1188	1052

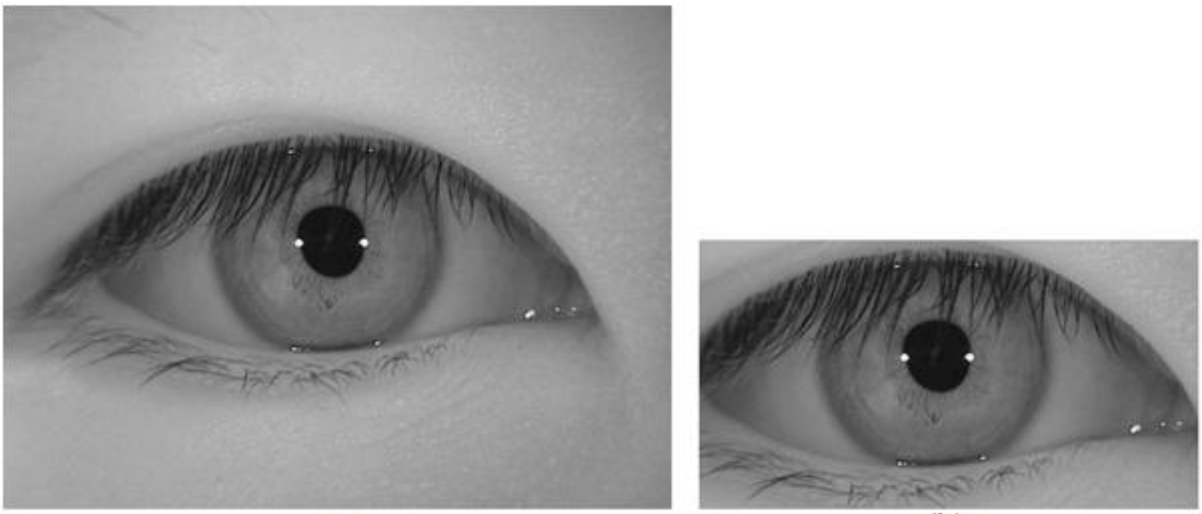
Table 4.1: Information's of Database's.

4.2 Preprocessing

Preprocessing is an important factor in image processing. It will increase the performance and helpful for giving more accuracy. The following preprocessing steps are used in this research.

4.2.1 Cropping

The unwanted spaces available in an eye image are removed by cropping process. The CASIA-Iris-Interval and IITD databases have no additional white spaces in huge level. But CASIA-Iris-Twins database has additional area around the eye which has the unwanted information's for Iris recognition. So the unwanted area is removed and large volume of memory will be saved by cropping process. The cropping process is explained in the following figure.



(a) (b)

Fig. 4.1: (a) Before cropping and (b) After cropping.

4.2.2 Converting to gray scale and Resizing of acquired images

Acquired eye images from CASIA database are in gray scale but IITD database eye images are colored images. Therefore the IITD database images are converted as gray scale images. After cropping and gray scale conversion all the images are resized into 100×100 and then all the images are stored into separate directory for further process. The resizing process helps to avoid occupies more memory and avoid some more calculation for finding the middle rows. So it will increase the speed while comparing the input images with stored templates.

4.2.3 Removing Noise

In this research the author used trained databases CASIA and IITD. So there is no availability of impulse noises like salt and pepper noise and the acquired images are not captured by using x-ray so no availability of thermal noises. Generally noises in an eye images are created by eye lashes and eye lids. Noises created by eye lids and eye lashes are easily removed by taking the middle rows (49-51) of 100×100 resized eye images. And required gray scale information of Columns is also taken from 49-51 columns below 52^{nd} row for avoiding noises created by eye lids and eye lashes.

4.2.4 Image Enhancement

All the images are acquired from trained databases CASIA and IITD. There is no availability of poor quality images so image enhancement is no need in this research.

4.3 Finding Iris length

Finding an Iris length is the primary factor in this research. The author finds the iris length by using the gray scale information’s occurred in the interfacial layer of sclera and iris. Because the gray scale information’s of this area indicates the starting point of iris. The following figure shows the gray scale information of an acquired eye image and required gray scale information of starting point of iris is circulated in the given figure.

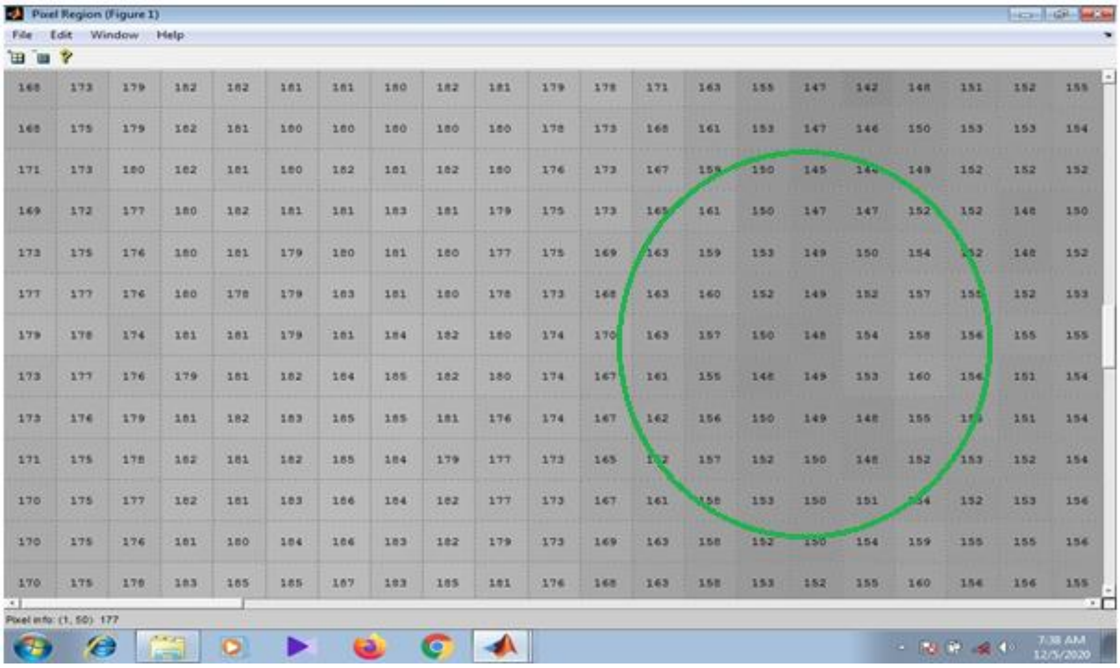


Fig. 4.2: Gray scale information’s of an eye image (Iris starting area is circulated).

From the circulated area of given Figure 4.2 it is clear that the gray scale information’s of iris lies in the range of less than or equal to 165 and the values are repeated with this range in the starting point of iris and end point of iris also. If gray scale information’s are repeated within the range of less than or equal to 165 then it is concluded that an iris area. Hence the author checks the repetition of the values within given range from the first column of 49th row for at least five times. If the condition satisfies then the position of first gray scale information which is less than or equal to 165 is taken as a starting position (x_1, y_1) of iris. Similarly after end of iris the gray scale information’s are greater than 165. The repetition of gray scale information which is greater than 165 conforms an ending of iris and starting of sclera. If the ending condition satisfies then position of the first gray scale information which is greater than 165 is taken as an ending position (x_2, y_2). After extracting the position the distance between the two points is calculated by using the Euclidean distance formulae which is given below.

$$\text{Distance}=\text{Sqrt}((x_2-x_1)^2+(y_2-y_1)^2)$$

Similarly the iris length for 50th row and 51st row calculated. Finally the maximum iris length from these three rows is considered as an iris length. Because the maximum one is treated as available

4.4 Creating Templates

The required templates are created in the size of 3×3 by using the gray scale information’s of specific rows and columns of resized 100×100 eye image. The author suggested to take the gray scale information’s from the rows 49-51 and from 8th column to 94th column of an eye image for creating templates. Because the gray scale information’s from the specified rows and columns are not having eye lashes and eye lids noises. At the same time the gray scale information's from these rows are more enough to differentiate the structural feature of eye for different persons. After creating the templates extracting data from specified rows then the templates are created by extracting the gray scale information's from 52nd to 81st row for 49-51 columns. The specified row and columns for avoiding eye lids and eye lashes noises. Totally 39 templates are created for a single person. The following pictures depict the Row wise gray scale values of an eye image.

173	175	176	180	181	179	180	181	180	177	175	169	163	159	153	149	150	154	152	148	152
177	177	176	180	178	179	183	181	180	178	173	168	163	160	152	149	152	157	155	152	153
179	178	174	181	181	179	181	184	182	180	174	170	163	157	150	148	154	158	156	155	155

(a) Row 49-51 Column 1-21

152	154	150	151	155	155	145	136	151	171	158	139	111	56	54	55	55	55	55	55	55
153	152	150	152	154	157	156	151	152	170	164	137	104	53	55	55	55	55	55	55	55
155	150	150	156	156	158	156	156	152	157	152	148	99	53	55	55	55	55	55	55	55

(b) Row 49-51 Column 21-41

55	55	55	55	55	55	55	55	55	55	55	55	55	55	53	110	163	162	162	164	169
55	55	55	55	55	55	55	55	55	55	55	55	55	55	52	93	140	147	153	156	166
55	55	55	55	55	55	55	55	55	55	55	55	55	55	53	87	142	164	168	166	153

(c) Row 49-51 Column 42-62

162	160	152	165	159	152	146	142	140	140	141	145	142	140	146	157	166	173	178	178	179
169	166	160	165	165	160	153	149	143	146	147	148	143	144	147	158	165	174	178	180	181
150	159	166	165	165	161	157	148	146	149	152	147	147	144	149	159	166	174	177	177	181

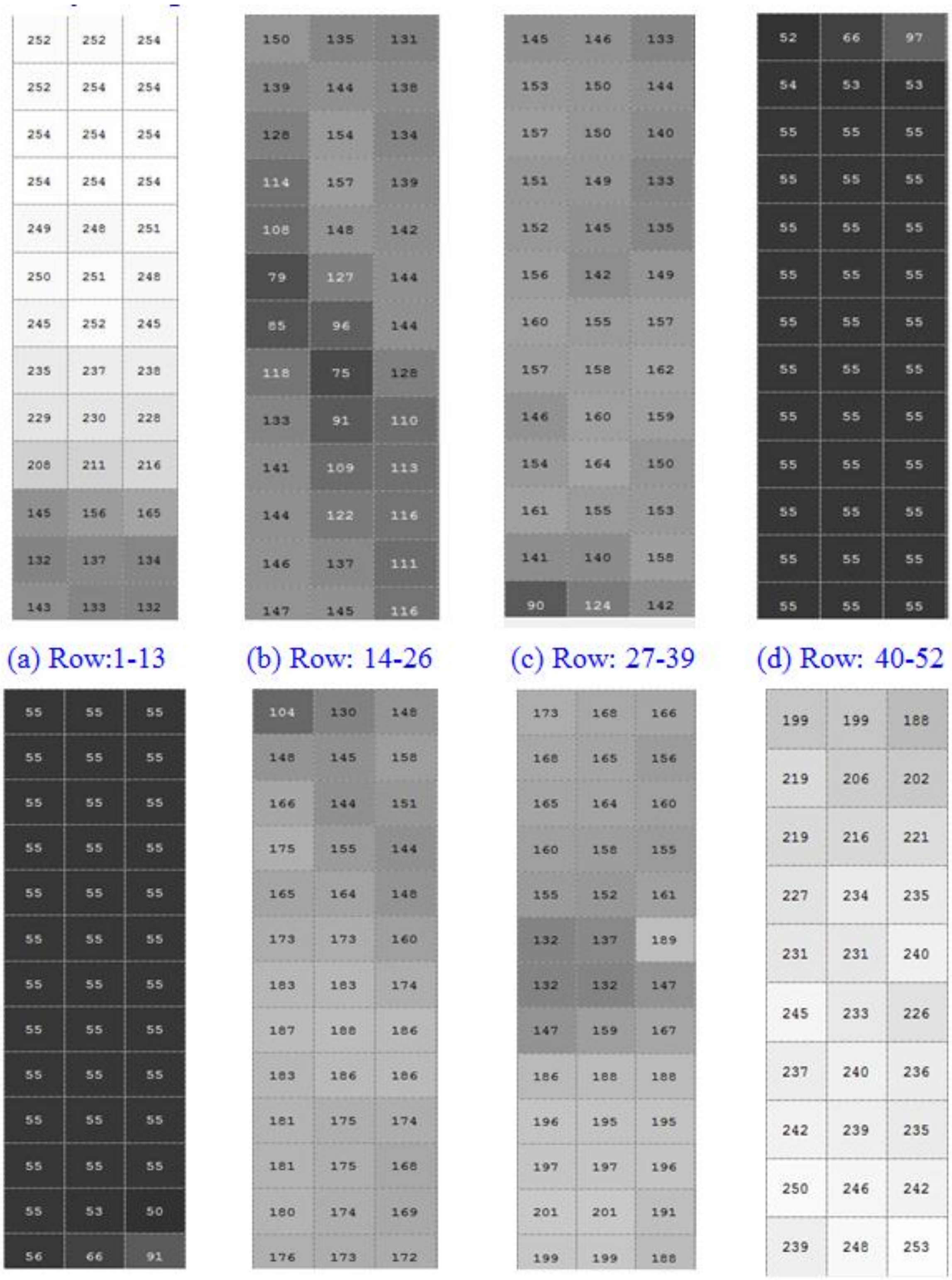
(d) Row 49-51 Column 62-82

178	179	179	180	179	180	182	181	180	180	174	172	168	165	161	157	153	150	145
180	181	179	180	180	179	180	182	181	180	177	172	170	166	161	157	154	149	148
177	181	181	180	181	181	181	180	182	180	179	174	171	166	163	158	154	150	148

(e) Row 49-51 Column 82-100

Fig. 4.3: (a) – (e) Row wise gray scale values.

The following pictures depict the column wise gray scale values of an eye image for column 49-51.



252	252	254
252	254	254
254	254	254
254	254	254
249	248	251
250	251	248
245	252	245
235	237	238
229	230	228
208	211	216
145	156	165
132	137	134
143	133	132

(a) Row:1-13

150	135	131
139	144	138
128	154	134
114	157	139
108	148	142
79	127	144
85	96	144
118	75	128
133	91	110
141	109	113
144	122	116
146	137	111
147	145	116

(b) Row: 14-26

145	146	133
153	150	144
157	150	140
151	149	133
152	145	135
156	142	149
160	155	157
157	158	162
146	160	159
154	164	150
161	155	153
141	140	158
90	124	142

(c) Row: 27-39

52	66	97
54	53	53
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55

(d) Row: 40-52

55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	55	55
55	53	50
56	66	91

(e) Row: 53-65

104	130	148
148	145	158
166	144	151
175	155	144
165	164	148
173	173	160
183	183	174
187	188	186
183	186	186
181	175	174
181	175	168
180	174	169
176	173	172

(f) Row: 66-78

173	168	166
168	165	156
165	164	160
160	158	155
155	152	161
132	137	189
132	132	147
147	159	167
186	188	188
196	195	195
197	197	196
201	201	191
199	199	188

(g) Row: 79-91

199	199	188
219	206	202
219	216	221
227	234	235
231	231	240
245	233	226
237	240	236
242	239	235
250	246	242
239	248	253

(h) Row: 92-100

Fig. 4.4: a-h represents the gray scale values column wise.

From the discussed figures the created templates are shown below.

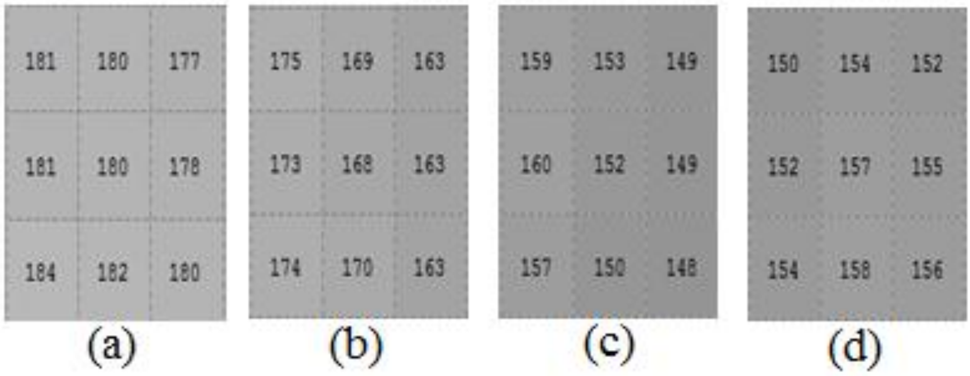


Fig. 4.5: (a), (b), (c) and (d) are some of the created templates.

4.5 Creating stored templates

The detected Iris length and created templates for each image are stored as templates. Creating stored templates will increase the performance of the proposed work because the image preprocessing, finding iris length, and creating templates done for every image earlier and stored as templates before matching. At that point put away formats are just enough for the coordinating cycle no compelling reason to get to the data set pictures in the wake of making put away layouts and no compelling reason to perform required assignments for all the pictures in an information base at the hour of coordinating. It will build the presentation and saves time. At last, one layout is kept up for a solitary eye picture.

4.6 Feature Matching

Image preprocessing, finding iris length and creating stored templates are performed for an input image. Then the extracted features are matched with stored templates from the initial. The iris length of input image is compared with the iris length first stored template, if the comparison gets success then the templates of input image and templates in a first stored templates are compared, if it is matched well then the access will be granted. Otherwise the comparison continues from the second stored templates and so on. The comparison process will be continued till the match is found. If the match is not found till the end of stored templates means the access will be denied. The following pictured explains the comparison for input image with the stored templates.

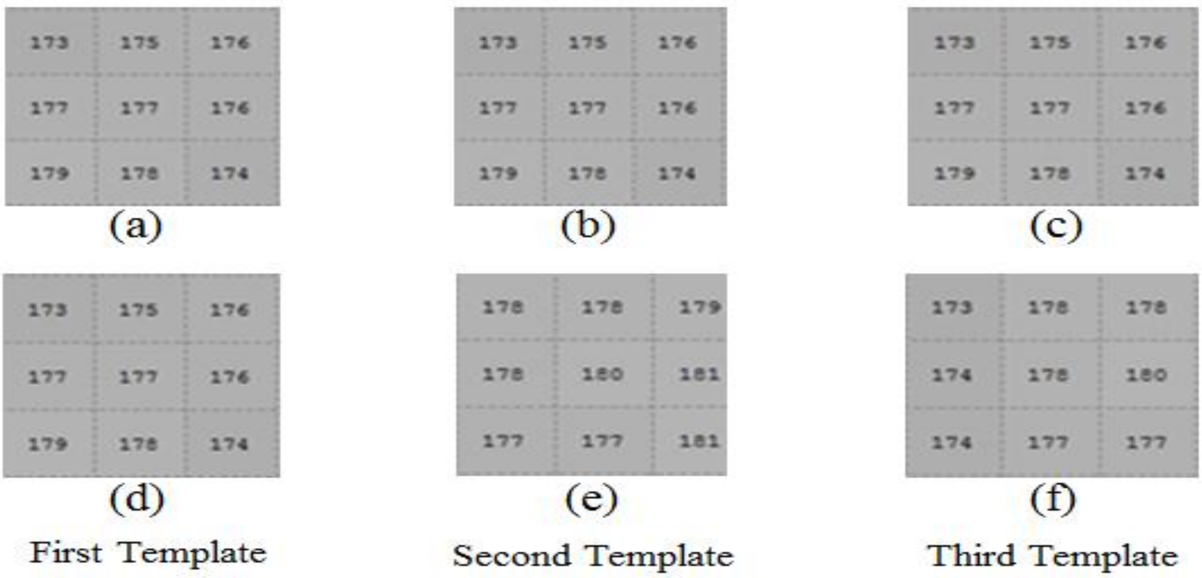


Fig. 4.6: (a), (b), and (c) represents stored templates and (d), (e) and (f) are templates of an acquired image.

In the previous figure (a), (b) and (c) are templates of stored templates and (d), (e) and (f) are templates of an acquired image. And it is clear that the first template only matched, the second and third templates are not matched. Hence no need to check all the templates after the second templates while doing the templates matching then the comparison process will be moved for next set of stored templates and so on. The matching is done when all the stored templates matched with Templates of an acquired image.

5. Proposed system workflow

5.1 Proposed system workflow for creating stored templates

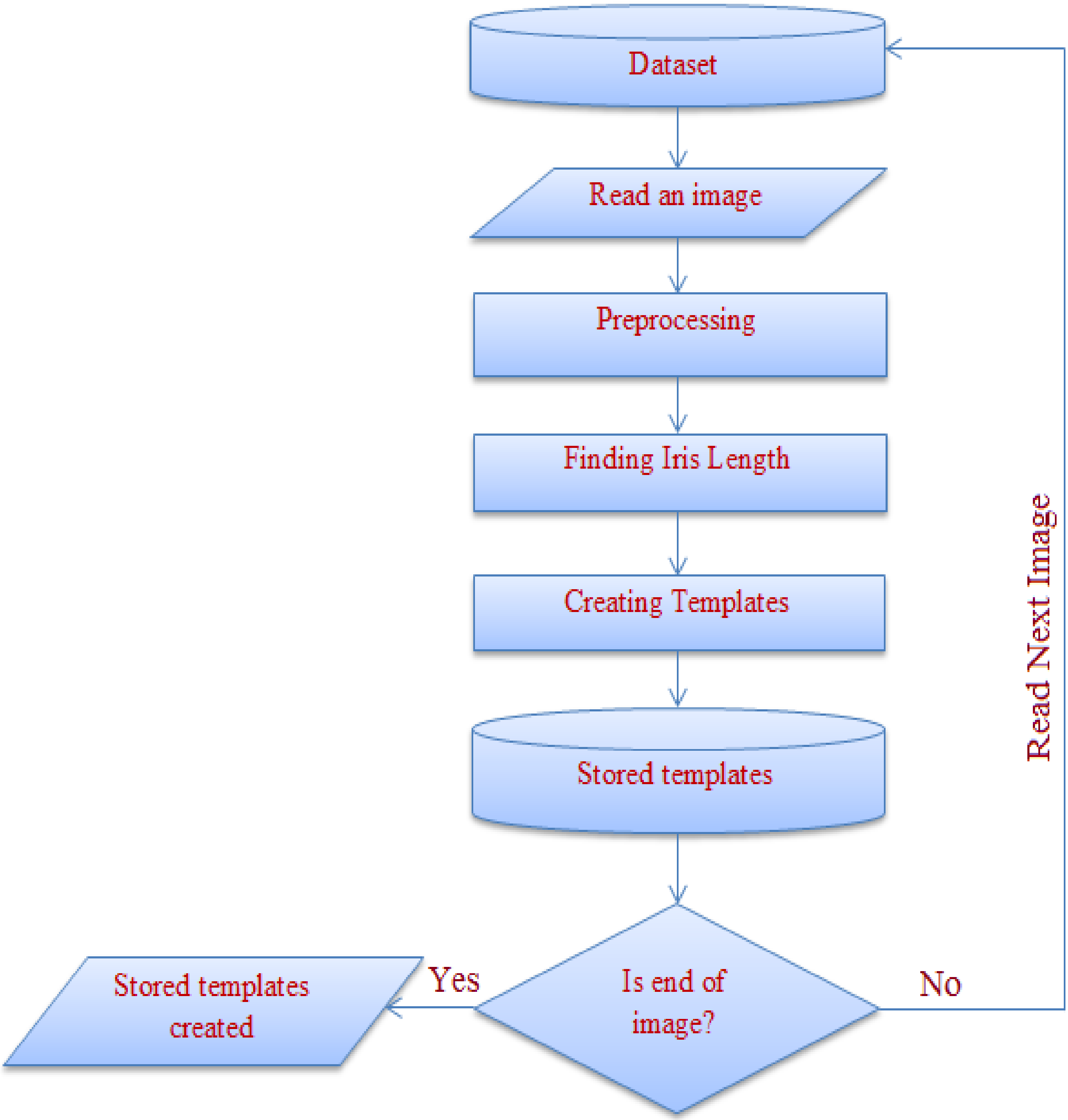


Fig. 5.1: work flow for creating stored templates.

5.2 Proposed system workflow for feature matching

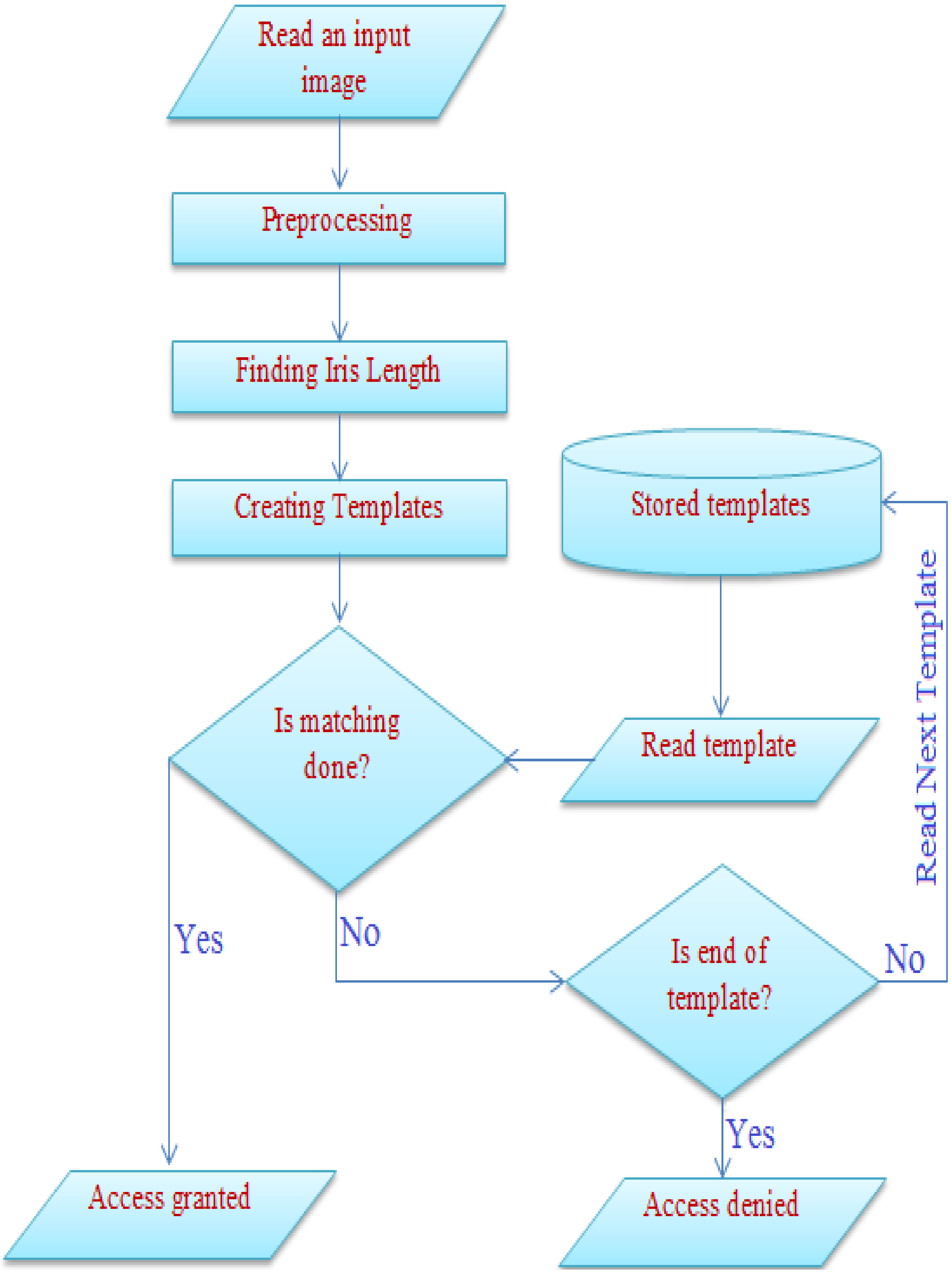


Fig. 5.2: Work flow for feature matching

6. Proposed algorithm

6.1 proposed algorithm for Global functions

Step 1: function IrisChordLength(img, Row)

```
        Col = 1;
        IrisAttempt = 0, ScleraAttempt = 0, IrisStarting = 0, IrisEnd = 0, IrisLength = 0;
        while(IrisAttempt < 5)
                if(img(Row , Col) <= 165)
                        IrisAttempt = IrisAttempt+1;
                else if(IrisAttempt = = 1)
                IrisAttempt = 0;
                else if(IrisAttempt = = 2)
                        IrisAttempt = 0;
        else if(IrisAttempt = = 3)
                        IrisAttempt = 0;
                end
        end
                end
                end
                Col = Col + 1;
        end
        IrisStarting = Col - 5;
        x1=row;
        y1=IrisStarting;
        while(ScleraAttempt < 5)
                if(img(Row , Col) >= 165)
                ScleraAttempt = ScleraAttempt + 1;
                else if(ScleraAttempt = = 1)
                        ScleraAttempt = 0;
        else if(ScleraAttempt = = 2)
                        ScleraAttempt = 0;
                else if(ScleraAttempt = = 3)
                ScleraAttempt = 0;
                end
                end
        end
                end
                Col = Col + 1;
        end
        IrisEnd = Col - 5;
        x2 = Row;
        y2 = Col;
        diff1=x2-x1; diff2=y2-y1;
        Length=sqrt((diff1^2) + (diff2^2));
        return Length;
    end
```

Step 2: function RowWiseTemplates(img)

```
        TotalRowTemplates = 29;
        Template=1;
        SC = 8; // SC -> Starting Column
        while(Template <= TotalRowTemplates)
                RowTemplate{Template}=[3;3];
                tempSC=SC;
                SR=49; //SR -> Starting Row
```

```
            for i=1:3
              for j=1:3
        RowTemplate{Template}(i,j) = ResizedImg(SR,SC);
        SC=SC+1;
              end
              SR=SR+1;
              SC=tempSC;
            end
           Template=Template+1;
            SC=SC+3;
    end
    return RowTemplate;
End
```

Step 3: function ColWiseTemplates(img)

```
    TotalColTemplates = 10;
    SR=52; //Column wise templates
    SC=49;
    Template=1;
    while(Template <= TotalColTemplates)
      ColTemplate{Template}=[3;3];
      for i=1:3
        for j=1:3
    ColTemplate{Template}(i,j)=ResizedImg(SR,SC);
    SC=SC+1;
        end
        SR=SR+1;
        SC=49;
      end
      Template=Template+1;
    end
    return ColTemplate;
End
```

6.2 Proposed algorithm to creating stored templates

Step 1: Start execution.
Step 2: Acquire the images from the dataset then perform cropping.

Step 3: Convert cropped images to grayscale if colored.

Step 4: Make a new directory for dataset images.
Step 5: Path="Path of a new directory";

Step 6: if(is not directory of path)

```
        Print "Folder does not exist";
        return;
    end;
```

Step 7: files = Reading all images from path;

Step 8: for Count=1to length(files)

```
        filename=allocate i^th file name;
       img=imread(filename);
        ResizedImg=resize(img,[100,100]);
```

```
                Length1= IrisChordLength(img, 49);
                Length2= IrisChordLength(img, 50);
                Length3= IrischordLength(img, 51);
                if(Length1 > Length2 and Length1 > Length3)
                        IrisLength = Length1;
                else if (Length2 > Length3)
                        IrisLength = Length2;
                else
                        IrisLength = Length3;
                end
                end
                RowTemplates = RowWiseTemplates(img);
                ColTemplates = ColWiseTemplates(img);
                StoredTemplates{count}={IrisLength, RowTemplates,
                ColumnTemplates}
        end
```

Step 9: print ‘Stored Templates Created Successfully’;

Step 10: End of Execution.

6.3 Proposed algorithm for feature matching

Step 1: Start Execution

Step 2: img = ‘Read an Input Image from a new directory’;

Step 3: ResizedImg=resize(img,[100,100]);

Step 4: Length1= IrisChordLength(img, 49);

```
        Length2= IrisChordLength(img, 50);
        Length3= IrischordLength(img, 51);
        if(Length1 > Length2 and Length1 > Length3)
                IrisLengthOfInput = Length1;
        else if (Length2 > Length3)
                IrisLengthOfInput = Length2;
        else
                IrisLengthOfInput = Length3;
        end
        end
```

Step 5: InputRowTemplates = RowWiseTemplates(img);

Step 6: InputColTemplates = ColWiseTemplates(img);

Step 7: for i=1 to length(StoredTemplates)

```
                if(IrisLengthOfInput = = StoredTemplates{i}.IrisLength)
                        if(InputRowTemplates = = StoredTemplates{i}.RowTemplates)
                                if(InputColTemplates = = StoredTemplates{i}.ColTemplates)
                                        Access=’Granted’;
                                else
                                        Access=’Denied’;
```

Step 8: print (Access);

Step 9: End of execution

7. Implementation

The proposed work is implemented by using the image processing software Matlab R2013a. The Matlab software has lot of inbuilt modules to perform image processing operations. Performances analysis is easily done by using this software. The results acquired from implementing the proposed work using this software is described in result and discussions section.

8. Results and Discussion

The following table briefly explains the results obtained from implementation.

S. No	Dataset	No of Images Used for Recognition	No of Images Recognized Correctly	Accuracy in %
1)	CASIA-V4-Iris-Interval (Left Eye)	197	197	100%
2)	CASIA-V4-iris-Interval (Right Eye)	195	195	100%
3)	CASIA-V4-Iris-Twins (Left Eye)	200	200	100%
4)	CASIA-V4-Iris-Twins (Right Eye)	200	199	99.5%
5)	IITD (Left Eye)	224	224	100%
6)	IITD (Right Eye)	211	211	100%
7)	Total	1227	1226	99.92%

Table 8.1 Results and Discussion

9. Conclusion

The proposed system purely works on Grayscale values and it didn't used binary conversion. So rate of recognition will be high. The Euclidean distance formula only used for finding the distance; it is the easy method and doesn't have any difficult calculation. The proposed system didn't use any mathematically expensive techniques those are used in the conventional recognition models. And stored templates plays a vital role in this research which leads the proposed system to saving so much of time during the matching process and it will increase the performance of the proposed system. After calculating the distance for finding iris length the required templates are created and matched well using the concept of array. Obviously the calculation speed of array is high when comparing with structures. Finally the proposed system gives 99.92% accuracy with high performance. Execution is time greater (0.022960 Seconds) than the previous work (0.032760 Seconds).

10. Future Enhancement

The proposed system accomplished the requirements with more performance than the previous work. Hence proposed system can be enhanced by creating the new eye structure for every person. The required new eye structure can be created by combining the structural patterns of left and right eye of a single person. By doing this the Iris recognition will reach the next level of the biometric authentication using Iris recognition.

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