Design and Development of New Algorithm for Person Identification Based on Iris Statistical Features and Retinal Blood Vessels Bifurcation Points

ABSTRACT

Biometric identifiers are the trait, measurable features used to tag and describe persons. Physical characteristics are related to the shape of the body. Some common examples of biometric recognition are, face recognition, fingerprint, DNA, palm print, iris, and retina. We propose a new algorithm for the detection and measurement of iris statistical features and finding the bifurcation points of retinal blood vessels for person identification, by using digital image processing techniques. Iris algorithm is tested on CASIA database and local database collected from KVKR (Department of CS and IT, Dr. B.A.M.U, Aurangabad) research lab, total 100 iris image database. For localization and extraction of inner iris we have use digital image processing techniques. After extraction of inner iris, we have calculated the statistical features like area, diameter, length, thickness, and mean. For performance analysis, receiver operating characteristic curve is used. The proposed algorithm achieves sensitivity of 94.92 % and specificity of 100%. After extraction of iris features, retinal blood vessels bifurcations points are extracted. Retinal image database is collected by Dr. Manoj Saswade (Opthalmologist, Saswade Netra Rugnalaya, Aurangabad (MH)), total 500 retinal image database. After collection of database, apply digital image processing techniques, such as image enhancement and otsu’s method. For result analysis, receiver operating characteristic (ROC) curve is use this algorithm achieves a true positive rate of 98%, false positive rate of 20%, and accuracy score of 0.9702.

General Terms

Person identification based on statistical techniques of retina and iris.

Keywords

Iris, Person Identification, Statistical Features, Bifurcation Points.

1. INTRODUCTION

Iris recognition has become an important permitting technology in our society. While an iris pattern is naturally a supreme identifier, the development of a high-performance iris recognition algorithm and transferring it from research lab to practical applications is still a challenging task. Iris is a physical biometric feature. It contains distinctive texture and is complex ample to be used as a biometric signature. Associated with other biometric features such as fingerprint, face, iris patterns are more stable and consistent. It is inimitable to people and stable with age. Also, iris recognition systems can be non-invasive. For localization of inner iris we have collected the 40 Iris images from CASIA image dataset [1]. And KVKR iris database is having 1000 iris images.This database is collected in department of computer science and information technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Today's e-security are in severe need of finding accurate, secure and cost-effective replacements to passwords and personal identification numbers as financial damages increase intensely year

over year from computer-based scam such as computer hacking and identity theft [2]. Biometric solutions report thesefundamental problems, because aperson's biometric data is distinctive and cannot be moved. Biometrics which mentions to identifying an individual by his or her physiological or behavioral appearances has ability to distinguish between attributed user and an imposter. An advantage of using biometric authentication is that it cannot be lost or elapsed, as the person has to be physically present during at the point of identification process [3]. Biometrics is characteristically more reliable and accomplished than traditional information based and token based techniques. The commonly used biometric features include fingerprint, speech, iris, face, voice, hand geometry, retinal identification, and body smell identification [4].

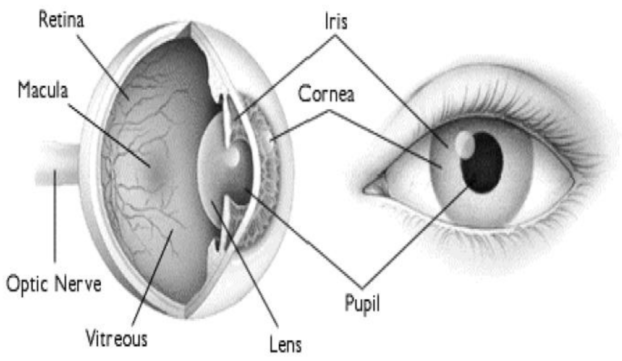


Fig 1: Structure of iris

2. METHODOLOGY

The proposed algorithm is design for localization of inner iris, shown in figure 2. In this algorithm firstly, preprocessing is done by renovating the image into gray. Afterwards apply histogram equalization for image enhancement. After image enhancement, image complement operation is done for highlighting the iris. Subsequently image adjustment is done by using contrast stretching method. After applying the contrast stretching function, some noise is get added, to remove that noise median filter is used. After removing the salt and pepper noise threshold operation is done for extraction of inner iris.In the figure 3, high resolution fundus image is taken then perform preprocessing operation on fundus image. Then perform image processing operation for enhancement of blood vessels. After enhancement of blood vessels perform threshold function for extraction of retinal blood vessels. Then perform

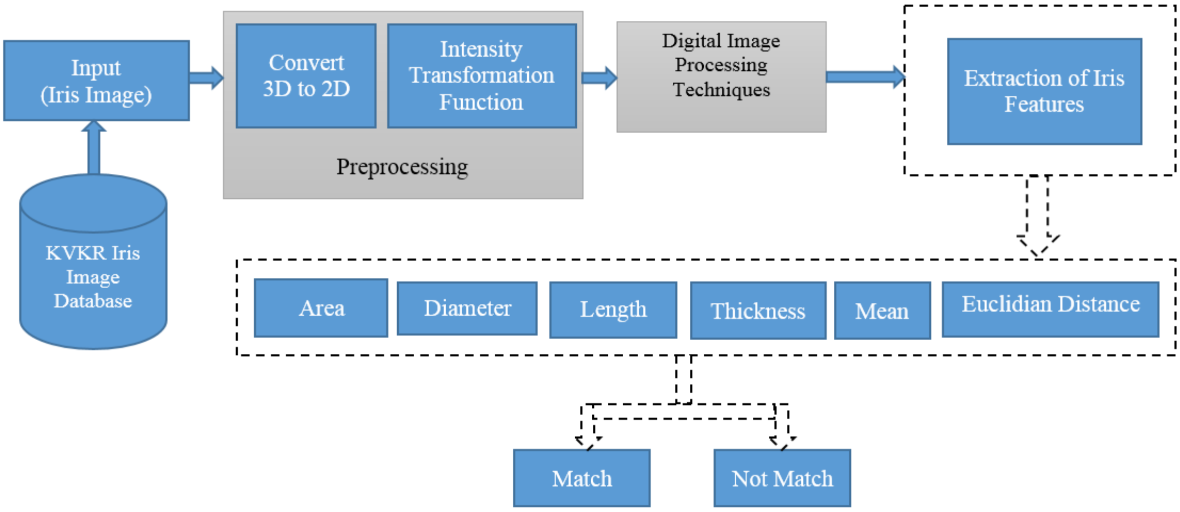


Fig 2: Workflow for inner iris extraction and localization

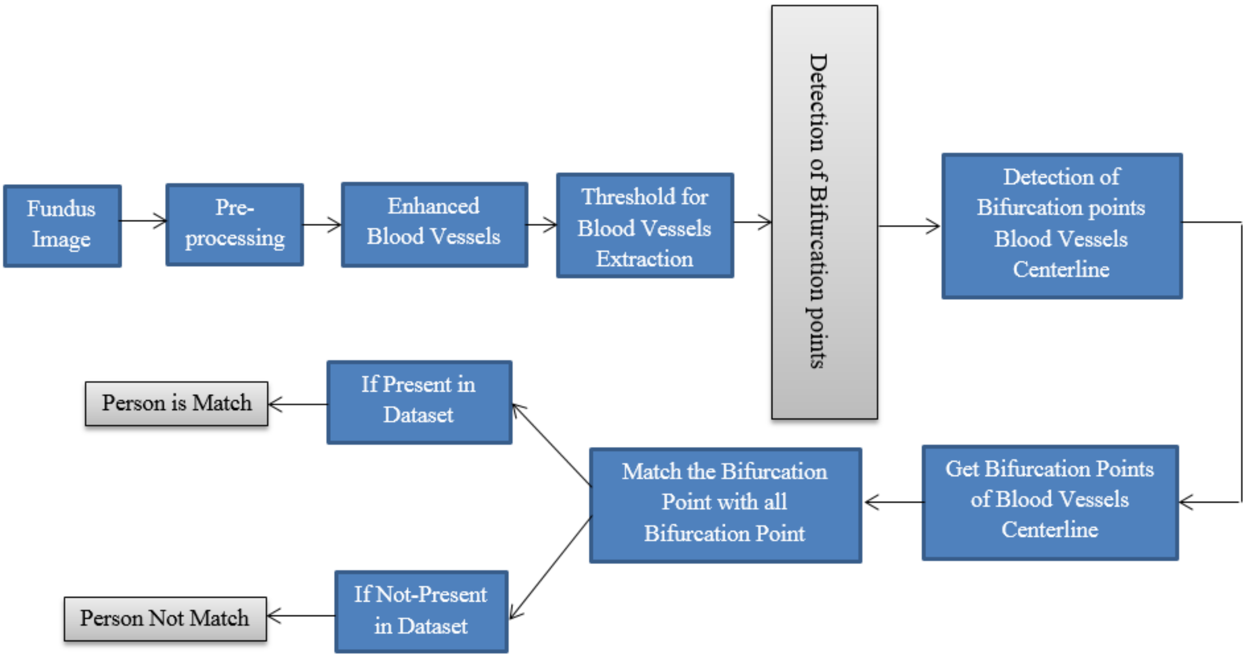


Fig 3: Workflow for retinal blood vessels extraction and calulating the bifurcation points

morphologicalskeletonozation for calculating the centerline of blood vessels.Then perform minutia technique for labeling the bifurcation points. For performing this techniquesdatabase is taken from Dr. Manoj Saswade and Dr. Neha Deshpande this database have the 300 hundred high resolution fundus images, we have calculate bifurcation points for all 300 hundred images and store in one dataset and when new image came then it will match its bifurcation points with this dataset and it will give the result as match or not match.

Following are the mathematical formulations is use for extraction and localizing of inner iris.

Histogram equalization function for enhancing the gray image:

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1)\right) \quad (1)$$

Here cdf_{min} is the minimum value of the cumulative distribution function, $M \times N$ gives the image's number of pixelsand L is the number of grey levels.2D median filter is use for removing the salt and pepper noise.

$$y[m,n] = \text{median}\{x[i,j], (i,j) \in \omega\} \quad (2)$$

Here ω Represents a neighborhood centered around location (m, n) in the image.

Threshold function for extracting the retinal blood vessels.

$$T = \frac{1}{2}(m1 + m2) \qquad (3)$$

Here m1 & m2 are the Intensity Values.

3. RESULT

By using digital image processing techniques we have extract the inner iris following figure 2 shows the output of inner iris localization. After extraction of inner iris we have calculated the statistical features like area, diameter, length, thickness and mean.

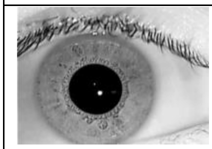
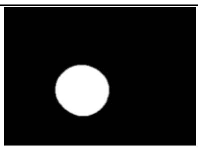
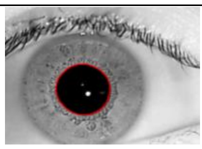
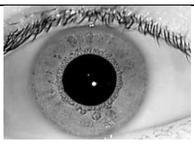
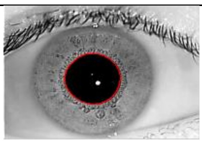
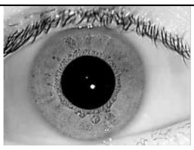
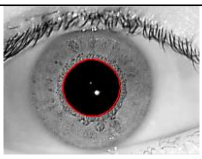
Original Image	**Extracted Inner Iris**	**Localization of Inner Iris**
		
		
		

Figure 4: Statistical Features of CASIA

Following table show the statistical features of CASIA Iris image database.

TABLE I. FEATURE DATA OF CASIA IRIS DATABSE

Sr. No	Image Name	Area	Diameter	Length	Thickness	Mean
1.	Image001	5999.88	247	3000	2	77.46
2.	Image002	6518.13	257	3259	2	80.73
3.	Image003	6746.38	261	3373	2	82.14
4.	Image004	6969.38	266	3485	2	83.48
5.	Image005	6963	266	3482	2	83.44
6.	Image006	10853.88	332	5427	2	104.18
7.	Image007	11487.38	341	5744	2	107.18
8.	Image008	11876.88	347	5938	2	108.98
9.	Image009	11448.63	341	5724	2	107
10.	Image010	9874.25	316	4937	2	99.37
11.	Image011	3877.38	198	1939	2	62.27
12.	Image012	3414.75	186	1707	2	58.44
13.	Image013	4174.13	206	2087	2	64.61
14.	Image014	4235.63	207	2118	2	65.08
15.	Image015	4418	212	2209	2	66.47
16.	Image016	10474.13	326	5237	2	102.34
17.	Image017	10492.5	326	5246	2	102.43
18.	Image018	10867.88	332	5434	2	104.25
19.	Image019	10971.75	333	5486	2	104.75
20.	Image020	10892.5	332	5446	2	104.37
21.	Image021	5999.88	247	3000	2	77.46
22.	Image022	6518.13	257	3259	2	80.73
23.	Image023	6746.38	261	3373	2	82.14
24.	Image024	6969.38	266	3485	2	83.48
25.	Image025	6963	266	3482	2	83.44
26.	Image026	10853.88	332	5427	2	104.18
27.	Image027	11487.38	341	5744	2	107.18
28.	Image028	11876.88	347	5938	2	108.98
29.	Image029	11448.63	341	5724	2	107
30.	Image030	9874.25	316	4937	2	99.37
31.	Image031	5999.88	247	3000	2	77.46
32.	Image032	9874.25	316	4937	2	99.37
33.	Image033	3877.38	198	1939	2	62.27
34.	Image034	3414.75	186	1707	2	58.44
35.	Image035	4174.13	206	2087	2	64.61
36.	Image036	4235.63	207	2118	2	65.08
37.	Image037	9874.25	316	4937	2	99.37
38.	Image038	11876.88	347	5938	2	108.98
39.	Image039	11448.63	341	5724	2	107
40.	Image040	9874.25	316	4937	2	99.37

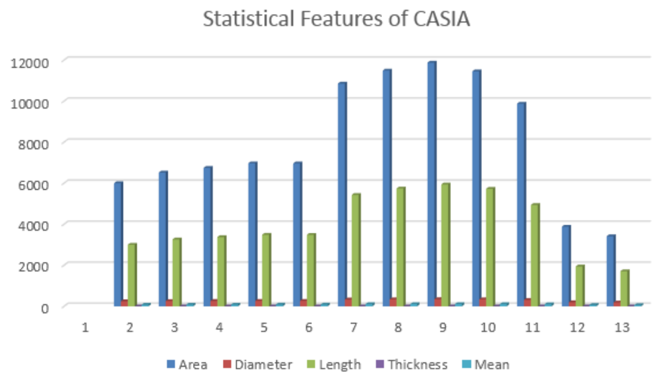


Figure 5: Statistical Features of CASIA

Following table show the statistical features of KVKR Iris image database.

TABLE II. FEATURE DATA OF KVKR IRIS DATABSE

Sr. No	Image Name	Area	Diameter	Length	Thickness	Mean
1.	Image001	9836.63	316	4918	2	99.18
2.	Image002	7222.88	271	3611	2	84.99
3.	Image003	9180	305	4590	2	95.81
4.	Image004	3152.75	179	1576	2	56.15
5.	Image005	1060.25	104	530	2	32.56
6.	Image006	1915.38	139	958	2	43.76
7.	Image007	4751	219	2376	2	68.93
8.	Image008	5636.5	239	2818	2	75.08
9.	Image009	4194.38	206	2097	2	64.76
10.	Image010	2980.88	174	1490	2	54.6
11.	Image011	2430.25	157	1215	2	49.3
12.	Image012	3044.75	176	1522	2	55.18
13.	Image013	2363.38	155	1182	2	48.61
14.	Image014	3309	183	1655	2	57.52
15.	Image015	2975.5	174	1488	2	54.55
16.	Image016	3110.88	178	1555	2	55.78
17.	Image017	1952.13	141	976	2	44.18
18.	Image018	3698	194	1849	2	60.81
19.	Image019	4228.13	207	2114	2	65.02
20.	Image020	4225.5	207	2113	2	65
21.	Image021	3711.75	194	1856	2	60.92
22.	Image022	2756	167	1378	2	52.5
23.	Image023	3767.63	195	1884	2	61.38
24.	Image024	3823.38	197	1912	2	61.83
25.	Image025	3825	197	1913	2	61.85
26.	Image026	6241.88	251	3121	2	79.01
27.	Image027	9836.63	316	4918	2	99.18
28.	Image028	7222.88	271	3611	2	84.99
29.	Image029	9180	305	4590	2	95.81
30.	Image030	3152.75	179	1576	2	56.15
31.	Image031	1060.25	104	530	2	32.56
32.	Image032	1915.38	139	958	2	43.76
33.	Image033	4751	219	2376	2	68.93
34.	Image034	5636.5	239	2818	2	75.08
35.	Image035	4194.38	206	2097	2	64.76
36.	Image036	2980.88	174	1490	2	54.6
37.	Image037	2430.25	157	1215	2	49.3
38.	Image038	3044.75	176	1522	2	55.18
39.	Image039	2363.38	155	1182	2	48.61
40.	Image040	3309	183	1655	2	57.52

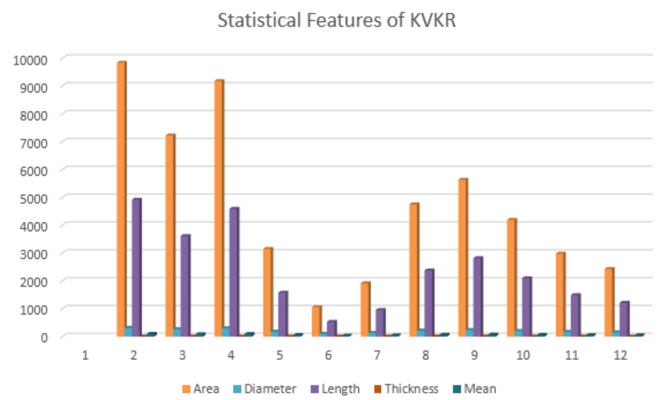


Figure 6: Statistical Features of KVKR

A. *Blood Vessels extraction :*

Use the complement function for enhancing the blood vessels of the retina. Following formula is the mathematical representation of Complement function.

$$A^c = \{\omega \mid \omega \notin A \} \qquad (4)$$

Here A^c is a complement, ω is the element of A, $\notin$ stands for not an element of A and A is set.

Then use Histogram equalization function for enhancing the complementary image to adjustment of contrast for better quality of an image. Histogram equalization is very important method for enhancement, the following mathematical equation elaborate the histogram equalization

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1)\right) \qquad (5)$$

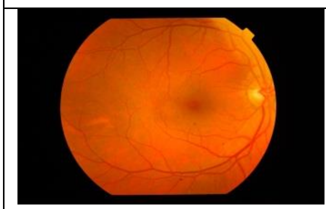
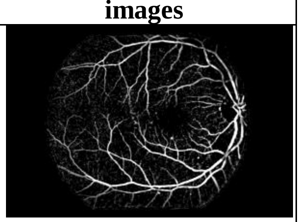
Here cdf_{min} is the minimum value of the cumulative distribution function, $M \times N$ gives the image's number of pixels and L is the number of grey levels.

After enhancement, use the Morphological structuring element for enhancing the blood vessels of the retina. The following mathematical formula shows the dilation and erosion function.

$$I_{dilated}(i,j) = \max_{f(n,m)=true} I(i+n, j+m) \qquad (6)$$

$$I_{eroded}(i,j) = \min_{f(n,m)=true} I(i+n, j+m) \qquad (7)$$

Perform erosion and dilation for joining the corrupted blood vessels. After performing these operations, the result is shown in figure 5.

Color Fundus Images	Blood Vessels extracted images
	

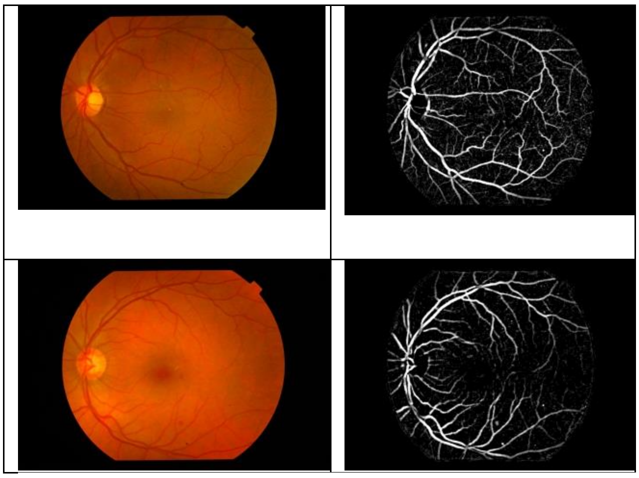


Figure 7: Fundus image and Blood vessels extracted images

TABLE III. BIFURCATION POINTS MANUALLY AND BY ALGORITHM

Sr. No	Name of High Resolution Fundus Image	Bifurcation Ground Truth	Bifurcation by proposed algorithm
1	1	605	605
2	2	944	944
3	3	304	304
4	5	649	649
5	7	1431	1431
6	8	675	675
7	10	147	147
8	12	306	306
9	14	616	616
10	16	500	500
11	18	187	187
12	19	405	405
13	21	930	930
14	1	203	203
15	3	421	421
16	5	903	903
17	7	415	415
18	9	605	605
19	11	944	944
20	27	500	500
21	29	187	187
22	31	405	405
23	33	930	930
24	35	203	203
25	37	421	421

4. CONCLUSION

For localization and extraction of inner iris we have use digital image processing techniques depicted in figure 2. For analysis of this techniques we have use online CASIA database and local database collected from KVKR research lab (Department of Computer Science & IT, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad).After extraction of inner iris, we have calculated the statistical features like area, diameter, length, thickness, and mean. For performance analysis, receiver operating characteristic curve is used. The proposed algorithm achieves sensitivity of 94.92 % and specificity of 100%. And for retinal blood vessels bifurcations points, design new algorithm. For result analysis, receiver operating characteristic (ROC) curve is use this algorithm achieves a true positive rate of 98%, false positive rate of 20%, and accuracy score of 0.9702.

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