Extraction of Cotton Wool Spot using Multi Resolution Analysis and Classification using K-Means Clustering

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ABSTRACT
Diabetic is one of the leading disease all over in the world. The patient who is suffer with the diabetic, they may cause the diabetic retinopathy.Diabetic retinopathy categorize into the no of lesions such as microaneurysms, hemorrhages, cotton wool spots and exudates. Cotton wool spots are caused by retinal nerve fiber layer microinfarcts. Detonated retinal ganglion cell axons extrude their axoplasm like toothpaste.Proposed algorithm is develop for extraction of cotton wool spot lesion from the fundus images. For extraction of this lesion we apply multi resolution analysis by using symlet wavelet on fundus images databases. Like STARE, DRIVE, DiarectDB0, DiarectDB1 & SASWADE. After extraction of the lesion we apply K-Means clustering algorithm for the classification. The proposed algorithm is achieves 92% accuracy for lesions extraction.

General Terms
We apply K-Means clustering for classification the features of cotton wool spot.

Keywords
Multi Resolution Analysis, Cotton Wool Spot, K-Means Clustering

1. INTRODUCTION
According to world health organization (WHO), 347 million people worldwide have diabetes, more than 80% of diabetes deaths occur in different countries. WHO projects that diabetes will be the 7th leading cause of death in 2030. Diabetic Retinopathy produced by leakage of blood or fluid from the retinal blood vessels and that leakage will damage the retina.In proposed algorithm we mainly emphasize on cotton wool spot.

Cotton wool spots are an abnormal finding on fundoscopic exam of the retina of the eye. Cotton wool spot appear as fleecy white covers on the retina. Cotton wool spots are caused by damage to nerve fibers and are a consequence of accretions of axoplasmic material within the nerve fiber layer. cotton-wool spots do not represent the whole area of ischaemic inner retina but just reflect the obstruction of axoplasmic flow in axons crossing into much larger ischaemic areas [1].According to Haniza Yazid and et. al.There are several lesions that seem such as hemorrhages, cotton wool spots, microaneurysms and exudates. Exudates incline to form ring, around area of diseased vessel and appeared as yellowish-white deposits with well-defined edges. Cotton wool spots are grayish-white with poorly defined fluffy edges. Exudates can be emphasized from the background easier rather than cotton wool spots since it has well defined edge. To detect these diabetic retinopathy lesions, a proper technique is required to segment the cotton wool spots and exudates from the fundus image. This paper is proposed to sharpen the edge to make simpler the segmentationprocess for cotton wool spots and exudates through ramp width reduction [2].Usman M. Akram and et.al. have proposed a computer aided system for the early detection of DR. Blood vessels are enhanced and segmented by using Gabor wavelet and multilayered thresholding respectively. Then they localized optic disk using average filter and thresholding and detected the optic disk boundary using Hough transform and edge detection. Once blood vessels and optic disc (OD) are segmented out, dark and bright lesions are detected using hybrid fuzzy classifier [3].V. Vijaykumari and et.al. has developed a method for exudates detection in retinal image using image processing techniques. Here few methods are used for the detection and the performance of all techniques was compared[4].Tjandrasa, H. and et.al. classify the hard exudates in retinal fundus images which are active to the moderate and severe non-proliferative diabetic retinopathy. The lesions are segmented using mathematical morphology and the extracted features are classified by using soft margin support vector machine. The classification model achieves accuracy of 90.54% for 75 training data and 74 testing data of retinal fundus images [5].

Table 1. Fundus image database

Sr. No	Name of Fundus Database	Total images
1	SASWADE (Own Database)	500
2	STARE	402
3	DRIVE	40
4	Diarect DB0	130
5	Diarect DB1	89
6	HRF (Diabetic Retinopathy)	15
7	HRF (Glaucoma)	15
	Total	**1191**

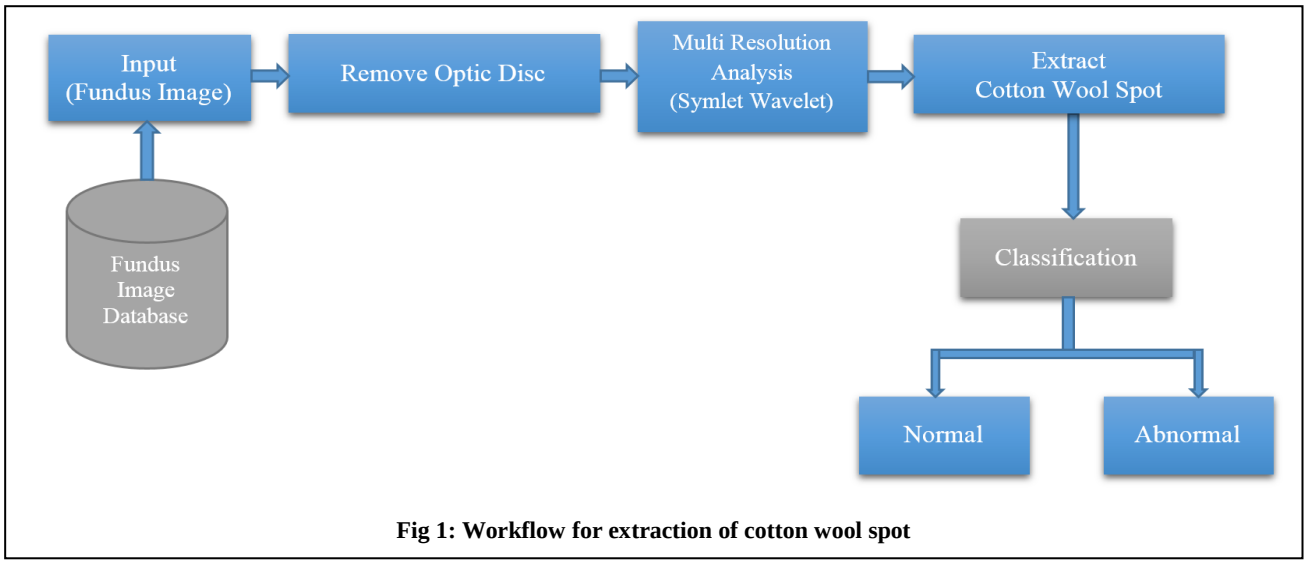


Fig 1: Workflow for extraction of cotton wool spot

2. METHODOLOGY

Proposed algorithm is design for extraction of retinal cotton wool spots. Firstly, read the fundus image from the fundus image database, then remove optic disc from all fundus images. Because optic disc is of yellow color and cotton wool spot also have the same color. For removing the optic disc we extract the green channel. Because green channel shows the high intensity image as compare to red and blue respectively. Then apply histogram equalization for enhancement of image. Afterwards apply complement function and intensity transformation. Then remove complemented image into intensity transformed image to remove the optic disc. After separation of optic disc we apply multi resolution analysis in the language of symlet wavelet. As we have known that the wavelet is mainly used for the reconstruction and compression of the image. Here we use the symlet wavelet 4 (sym4) for extraction of the cotton wool spot. After feature extraction, perform classification using K-Means clustering. As we have known, the K-means clustering algorithms are unsupervised techniques for sub-dividing a larger dataset into smaller groups.

2.1 Proposed Algorithm

I. Load the image from the database.

II. Remove optic disc using digital image processing techniques

III. Apply 2D DWT using symlet wavelet (sym4) over the image.

IV. Increase the level of symlet wavelet

V. Feature extraction

VI. K-Means clustering for classification the data into normal and abnormal.

2.2 Symlet Wavelet

A multiresolution analysis of $L^2(IR)$ is a sequence of closed subspaces $V_j \subset L^2(IR)$ such that

$$V_j \subset V_{j+1}, \qquad \bigcap_j V_j = \{0\}, \overline{\bigcup_j V_j} = L^2(IR) \quad (1)$$

$$f(x) \in V_0 \iff f(x \iff 1) \in V_0,$$

$$f(x) \in V_j \iff f(2x) \in V_{j+1} \quad (2)$$

A scaling function $\varphi \in V_0$ with unit integral exists such that $\{\varphi_{0,,k}(x) \equiv \varphi(x \iff k), k \in \mathbb{Z}\}$ is an orthonormal basis of V_0 and, consequently, the set of functions.

$$\varphi_{j,k}(x) = 2^{\frac{j}{2}} \varphi(2^j x \iff k) \quad (3)$$

is an orthonormal basis of the space V_j. Since $\varphi \in V_0 \subset V_1$, a sequence of complex-valued coefficients a_k exists such that $\sum a_k = 1$ and

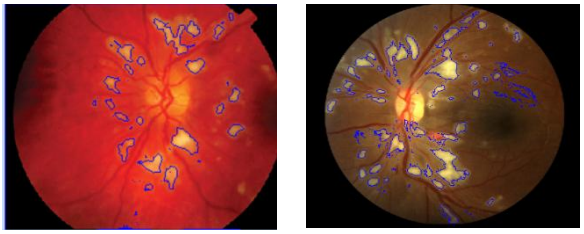
$$\varphi(x) = 2 \sum_k a_k \varphi(2x \iff k) \quad (4)$$

3. RESULT

Proposed algorithm we have design for extraction retinal cotton wool spots using digital image processing techniquesand multi resolution analysis (symlet wavelet). For extraction of cotton wool spots we have use online (STARE, DRIVE, DiarectDB0 & DiarectDB1) and local (SASWADE) fundus image databases. Firstly, preprocessing is done for separation of optic disc then extract cotton wool spots features like area, diameter, length and thickness.After extraction of the lesions we apply K-Means clustering to the extracted feature data. Below figure 2 shows the extraction of cotton wool spot using multi resolution analysis. And plot the extracted features to the original image by plotting the boundary function.

Original Image

Features



Features on Original Image

Fig 2: Extraction of cotton wool spots

Following table shows the features of the cotton wool spot.

Table 2. Features of cotton wool spots

Sr. No	Area	Diameter	Length	Thickness
1	9.54E+04	983	47723	2
2	4.01E+05	2016	200553	2
3	3.82E+05	1968	191189	2
4	3.79E+05	1959	189471	2
5	366586	1927	183293	2
6	3.91E+05	1991	195623	2
7	379303	1960	189652	2
8	3.82E+05	1968	191178	2
9	3.23E+05	1809	161494	2
10	8.24E+04	914	41180	2
11	3.95E+05	2001	197498	2
12	3.95E+05	2000	197306	2
13	3.74E+05	1946	186806	2
14	3.90E+05	1987	194784	2
15	4.13E+05	2023	202677	2
16	3.05E+05	2004	192306	2
17	3.94E+05	1942	182806	2
18	3.70E+05	1982	192784	2
19	4.33E+05	2025	221677	2
20	3.75E+05	2007	137306	2
21	381235.875	1965	190618	2
22	394124.125	1998	197062	2
23	405867.625	2028	202934	2
24	382321.375	1968	191161	2
25	396339.75	2004	198170	2
26	385919.75	1977	192960	2
27	393863.5	1998	196932	2
28	384575.5	1974	192288	2
29	386970.25	1980	193485	2
30	377317.875	1955	188659	2
31	394077.375	1998	197039	2
32	391714.875	1992	195857	2
33	391895.625	1993	195948	2
34	405751.5	2028	202876	2
35	386127.625	1978	193064	2
36	389152.125	1986	194576	2
37	403406.25	2022	201703	2
38	391707.25	1992	195854	2
39	381114.75	1965	190557	2
40	362583.25	1917	181292	2
41	400468.875	2014	200234	2

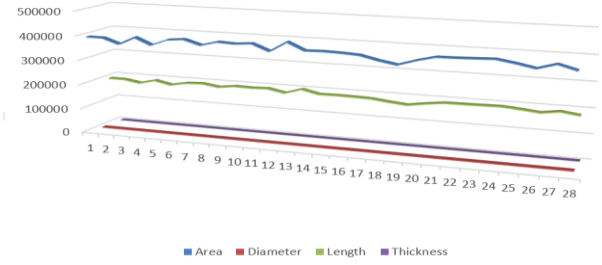


Fig 3: Features of cotton wool spots

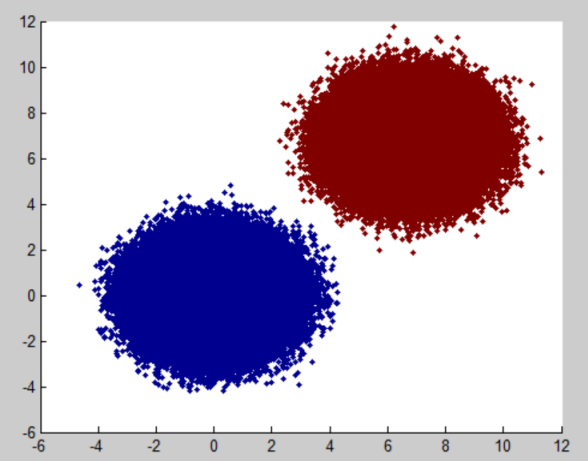


Fig 4: K-Means clustering

Figure 4 show the two clusters blue and red. Blue indicate the normal whereas red indicate abnormal.

4. CONCLUSION

Proposed algorithm is design for extraction of retinal cotton wool spots.This algorithm is tested on online fundus image databases and local (SASWADE) database. Total 1191 fundus images. Firstly, preprocessing is done for separation of optic disc. Then apply multi resolution analysis techniques using symlet wavelet (sym4) for extraction of lesion. Feature extraction is done by using area, diameter, length and thickness of cotton wool spots. After feature extraction K-Means clustering is apply for classification feature data. The proposed algorithm achieves 92% accuracy.

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