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DETECTION AND SEGMENTATION OF DRUSEN IN THE HUMAN EYE IMAGE

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Abstract— ***Drusens are accumulation of lipid and other waste material from different layers of the retina. The main goal of this project is to detect the Drusen from the images of human eye containing Drusen disorder using different techniques. The results of the techniques are compared and the analysis has made.***

Keywords: Drusen, Active contour, Texture based, Model Based, Fundus.

I. INTRODUCTION

Drusens are the markers of age-related macular degeneration (ARMD) as their increasing numbers generally indicates risk for ARMD, a leading cause of blindness in people above the age of 50.

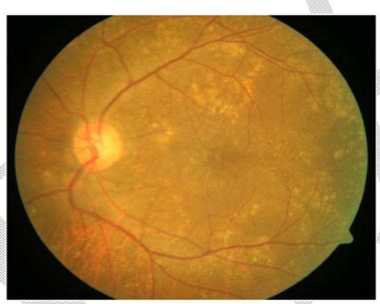

Fig 1: Drusens Image – Input Image

Drusen appear as yellowish cloudy blobs in a retinal image. They are deposists of cellular waste that accumulate beneath the retina and the primary cause of age-related

macular degeneration (ARMD). There are two types of Drusen. Optic Disk Drusen and Macula Drusen. The work is concentrated on the Drusen affected in the Macula region, which leads to the centre vision. An accurate count of drusen in a colour retinal image provides ample information about the extent of disease.

II. RELATED WORK

Brandon.L and Hoover.A [1] proposed Level Classification. Rapantzikos.K, Zervakis.M and Balas.K [2] proposed Histogram-based Adaptive local thresholding (HALT). Automatic Drusen Detection from colour retinal images is achieved by Texture and Hill-Based drusen detection method by [3] Saurabh Garg, Jayanthi Sivaswamy and Gopal Datt Joshi. Lee.N, Laine.A.F, and Smith.T.R [4] proposed the use of Non-homogeneous Texture Approach. Morphological approach is proposed by [5] Ageel F AQEEL and Subra Ganesan.

III. SEGMENTATION OF DRUSEN

3.1 Input Image

Drusen affected images of Human Eye is collected of any image type and size. Select a Drusen image as shown in Fig1, and change it to the dimension given below.

Properties:

- Image Type : JPG
- Dimension: 250/300
- Resolution: 72inch/pixel

3.2 Luminance

A multi-dimensional representation of the retinal image is necessary for better characterization and localization of the concerned Optic Disc (OD) region. In this step red color plane of the input image is taken for better characterization as the Optic Disc (OD) region is surrounded by blood vessels.

A color image is luminated into a black and white image with huge brightness in Fig 2.

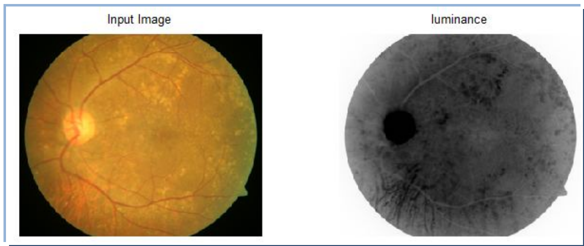

Fig2 : Image after Luminance process

3.3 Background Subtraction

Background Subtraction is correcting image defects that are associated with nonuniform brightness. Additional image enhancement technique must often be applied to the subtraction image in order to obtain a useful result.

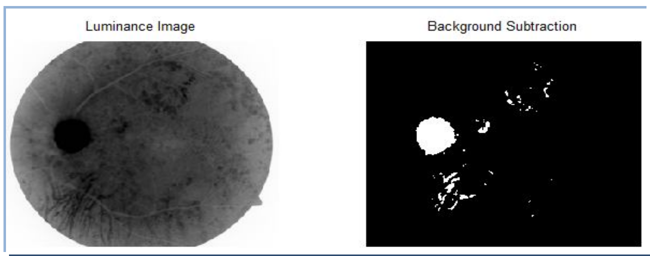

Fig3: Image after Background Subtraction process

It corrects the image defects that are associated with non uniform brightness. In Fig.3 gray image is converted into binary image.

3.4 Segmentation

The most basic morphological operations are dilation and erosion rule used to process the pixels defines the operation as dilation or erosion. Fig 4 shows the image after segmentation.

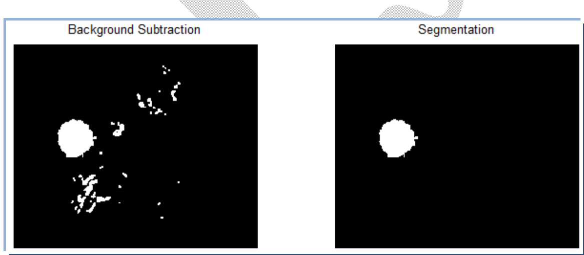

Fig 4 : Image after Segmentation process

Image segmentation is the process of assigning a label to every characteristic. The output of the Background subtraction process is the input for Segmentation process. As a result of segmentation, the Optic disk portion is segmented from all the other features of the fundus image.

3.5 Contour Based

Using this module the boundary (contour) of the Optic disk is detected using Edge Detection Method. Fig 5 show the image after contour detection

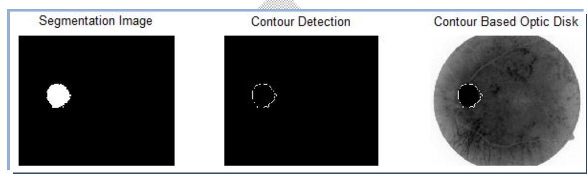

Fig 5 : Image after Contour detection

The Edge Detection Method used is the canny edge detection method.

3.6 Active Contour:

Fig 6. Image after Applying Region Based Active contour Method

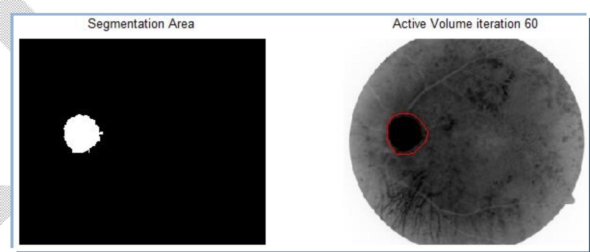

Fig 6: Region Based Active contour Method

It integrates the edge and region based information to detect OD. OD segmentation method based on region-based active contour model to improve the segmentation on the range of OD instances. This method is a good solution for OD segmentation, since this method does not impose any shape -constraint. The output image of Fig4 is given as the input, and after certain iteration

Algorithm:

The Algorithm of Region based Active Contour Technique to detect the OD is as follows.

Step 1: First Snake is placed over the image that include the OD region

Step 2: Gaussian filter is used to remove the unwanted noise

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Step 3: The external energy and the internal energy is used for the deformation of snake in every iteration
Step 4: Snake Deformation occurs in every iteration until two consecutive snakes difference is lower than threshold.
Step 5: Map the final snake to the original image.

The Optic disk is automatically segmented from the Fundus images by c-v model based method and region based active contour method. In Fig 7 the comparison of the output is made between the c-v model based method and region based active contour method.

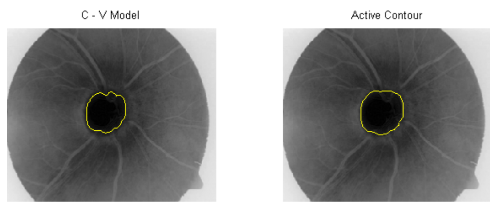

Fig 7 : Comparison of the OD Boundary by C-V method and the Region Based Active Contour Method

The results are compared and the analysis has been done. The conclusion obtained is that the region based Active Contour Technique is the good solution, since it:

- Provides high Accuracy Value i.e. F-score value is nearly
- Area Ration value is high.
- Boundary Distance value is low, this show it detects the exact OD boundary.

This Technique can be enhanced in future to detect several other diseases in the fundus images using texture information and the features can also be detected and analyzed.

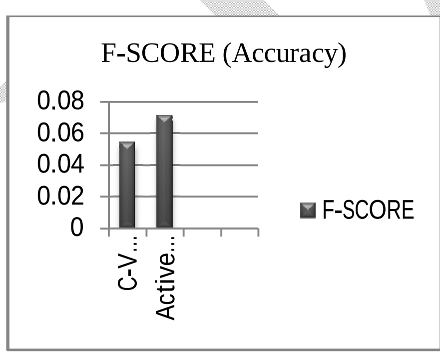

Fig 8: F- Score Analysis

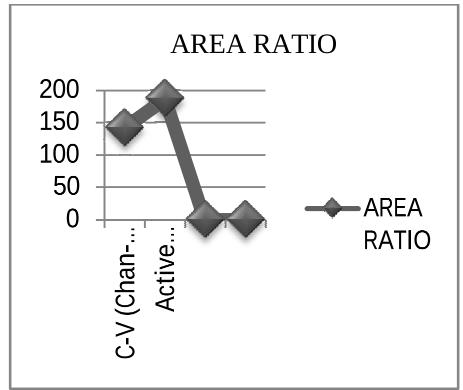

Fig 9: Area Ratio Analysis

3.7 Drusen Detection

From the input image, the Drusen Area is determined using Dilation which includes the Optic disk region and the Drusen region. Since the Optic disk region is not needed for further work, it is removed and only the Drusen portion is detected. The feature of eye like Optic Disk, Cup, nerve head and vessels are not considered in the process of work. So, they are removed and only the Drusen is focused and detected. Drusen Area shows the intensity variation in the entire gray image.

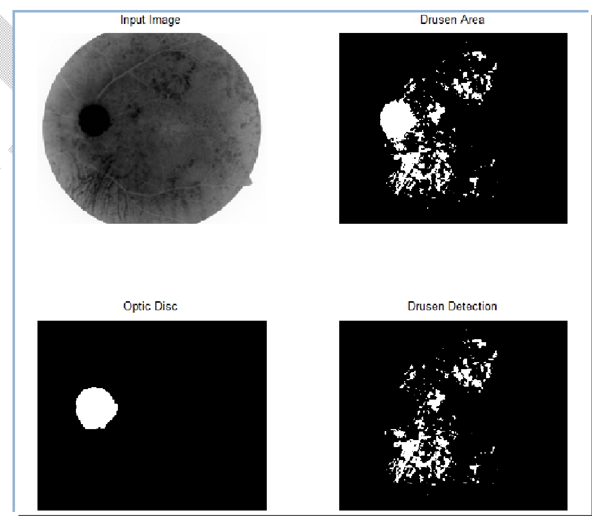

Fig 10. Drusen Detection

3.8 Optic Flow

The Optic flow of the input image is determined as show in Fig.12.

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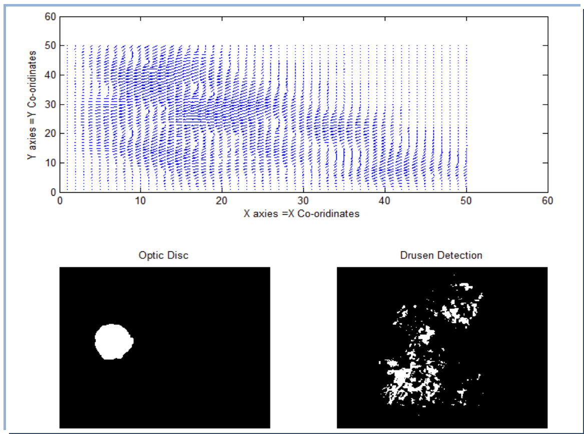

Fig 11 : Optic Flow

In the Optic flow, the gradient vectors and the pixel search directions are shown. The first step of the detection algorithm drusen amplitudes and locations. Considering the drusen are regional intensity maxima and that, in a gradient image, they have in its direction a confluence of several ascending paths.

A pixel level analysis, following a top-left to bottom-right direction is done. It starts assigning a new label to each pixel and determining its gradient azimuth using 3 x 3 Sobel operators which is the direction to an ascending intensity.

3.9 Drusen Modeling

In order to quantify drusen spots it is necessary to analytically characterize their shape and intensity. The intensity elevation shown on drusen areas on the tri-dimensional representation motivated the creation of a model of the image intensity as shown in fig.13.

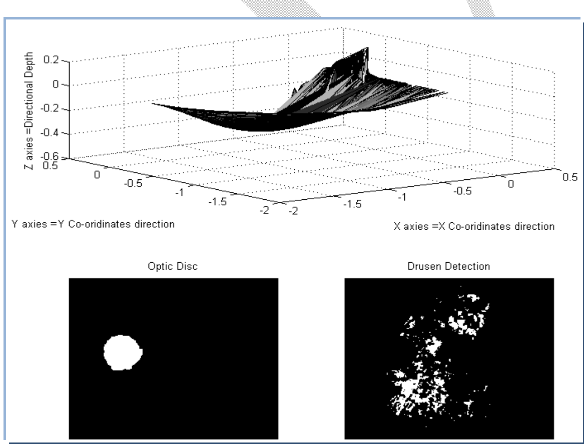

Fig 12 : Drusen Modeling

From this model the drusen dimensions and the total affected area are extracted. In a typical three-dimensional view of a drusen, it can be seen that it has a shape similar to a Gaussian function. Drusen Modeling reduces the computational time required to detect the Drusen.

3.10 Texture Based Drusen Detection

A texture –based approach is an attractive to the task of drusen segmentation. Futhermore, the texture of the drusen can be characterized in terms of the local energy. Our interest is to get an accurate count of the drusens and that will require further post processing of this result.

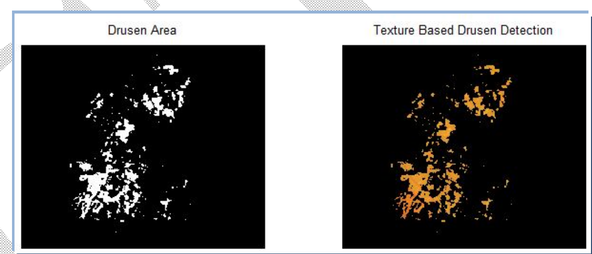

Fig 13 : Texture Based Drusen Detection

A possible solution is to extract a closed boundary for the drusens from the energy map and count each closed boundary as one drusen. However, the energy map indicates that obtaining a closed boundary will not be a simple task.

To, summarise, there appear to be two shortcomings with local energy based drusen detection, selection of parameter that will work well across a wide range of images and obtaining a reliable drusen count. We look towards a model based approach to overcome these shortcomings.

3.11 Model Based Drusen

Visualizing the 2D image function as a surface in 3D space leads to a different perspective of drusens as they have hilly profiles.

In order to detect such a profile, a useful property, is the curvature of the image surface. Curvature has been successfully used to detect ridges, valleys and thin nets and crest lines from images. In general, curvature can be used to detect features where the image surface bends sharply. Such features are characterized by points of maximal curvature on the image surface. The curvature at a point on the image surface is a measure of the bend in the surface along a particular direction.

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The task of grading drusen involves segmentation of entire drusen regions.

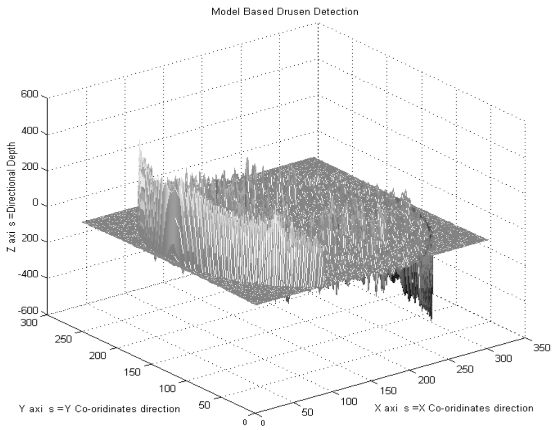

Fig 14: Model Based Drusen

3.12 Comparison

Drusen is automatically detected from the Fundus images by Texture based method and Model based method. In Fig16 the comparison of the output is made between the Texture Based Drusen Detection method and Model Based Drusen Detection method. Considering the Number of Drusen Objects in x-axis and the Object weight in y-axis, the amount of drusen determined by both the techniques is compared. Histogram for the two methods is used for comparison.

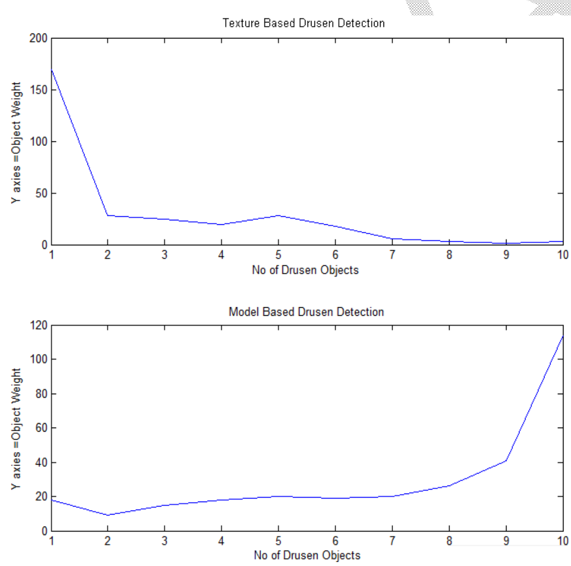

Fig15 : Comparison of the OD Boundary by C-V method and the Region Based Active Contour Method

IV. EXPERIMENTS AND RESULTS

The analysis is made for the final result got out of the Texture based drusen detection method and Model based drusen detection method.

The parameters used are

- Area
- Time-Taken
- Average of detection

The OD segmentation is the initial step in detection of macula Drusen, Region based active contour model achieve the effective segmentation of OD. To improve the texture information, preprocessing steps are performed. Here, if the input image is a noisy image, we cannot accurately detect the OD

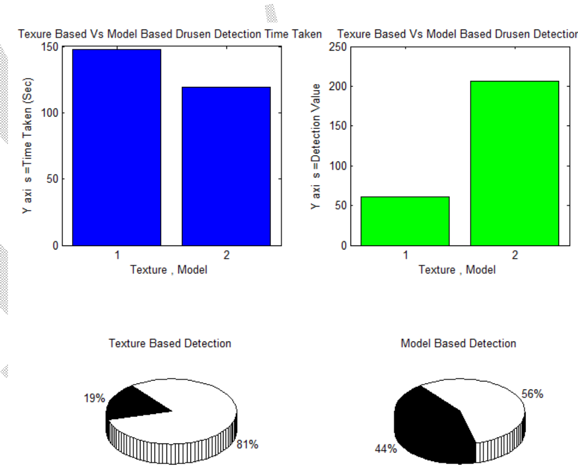

Fig 16: Analysis

To suppress the noise present in the image, we use the Gaussian filtering. The preprocessing steps include Luminance, Background subtraction and Segmentation in order to overcome the problem of atrophy and blood vessels occlusion.

In order to assess the strength of individual active contour models, curve initialization and preprocessing are kept same for each model. A common quantitative analysis is performed to assess overall performance of OD segmentation.

Optic Disc (OD) segmentation is done by a region-based active contour model by means of enhanced chan-Vese (C-V) model which is an improvement over the currently used Gradient Vector Flow (GVF) model. The major benefit of using enhanced Chan-Vese (C-V) model is the interior contour (here, we use the circle) can be placed anywhere in the image and there is no imposed shape constraint.

This method performs in a low computation time. The method was executed on a sample of images which contains fundus images. By analyzing the method, the single performance measure called traditional F-score which is the harmonic mean of precision and recall is derived. To assess the area overall pixel

- Area

Fig 18, Show the sample fundus images. Area Ratio is the amount of OD region detected in the entire image area.

- Time Taken

Time taken is the amount of time it takes to segment the OD boundary by both the methods.

- Average of detection

This gives the total average of the drusen area that is detected from a particular fundus image. Graph has been plotted for the ten images and is show in Fig8, 9.

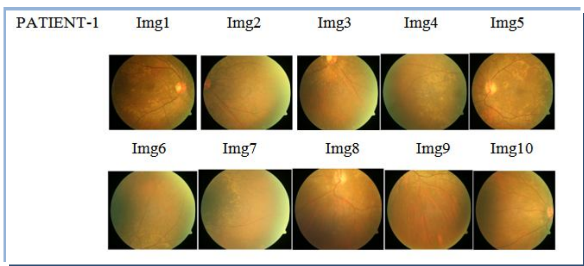

Fig17: Sample Input Images

Table1: Comparative Analysis of Statistical Report

Image		Texture Based Technique			Model Based Technique		
		Area	Time Taken In Seconds	Average Of the Detection	Area	Time Taken In Seconds	Average Of the Detection
P	Img1	66.72	9.85	16	278.25	7.36	45
A	Img2	60.39	8.96	18	207.82	6.53	44
T	Img3	65.08	11.04	21	186.47	8.00	43
I	Img4	64.33	12.91	17	256.53	9.56	44
E	Img5	61.22	15.75	19	206.32	11.28	44
N	Img6	66.17	11.72	17	256.12	9.01	44
T	Img7	63.23	12.54	18	221.92	8.70	44
	Img8	63.71	14.13	18	233.18	10.91	44
1	Img9	62.46	11.44	19	201.96	9.22	43
	Img10	63.35	11.66	18	227.07	8.36	44

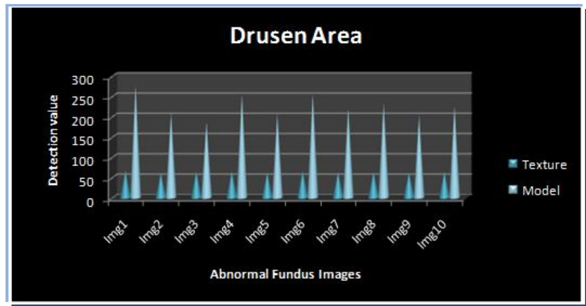

Fig 18 : Model Based Drusen Detection Technique has the larger Drusen Area Detected

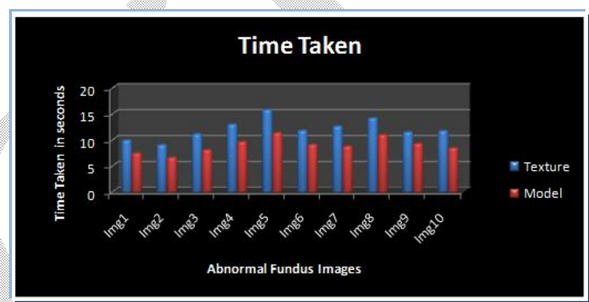

Fig 19 : Model Based Drusen Detection Technique takes less time in the entire Drusen detection process.

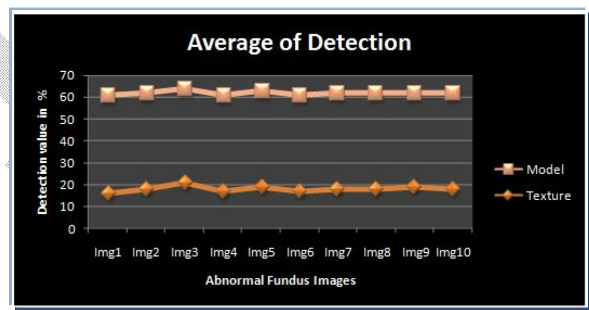

Fig 20 : Model Based Drusen Detection Technique shows highest Average of Detection in percentage.

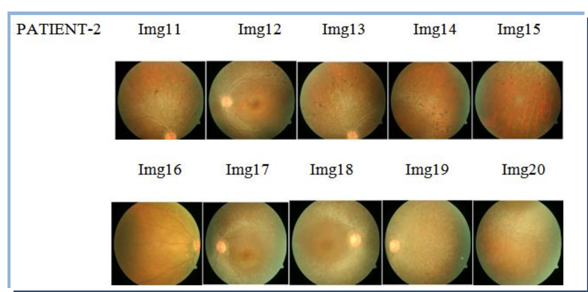

Fig 21: Sample Input Images 2

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Table 2: Comparative Analysis of Statistical Report

Image		Texture Based Technique			Model Based Technique		
		Area	Time Taken In Seconds	Average Of the Detection	Area	Time Taken In Seconds	Average Of the Detection
P	Img11	67.37	11.06	17	265.97	8.32	44
A	Img12	65.26	8.59	16	283.14	6.39	45
T	Img13	66.26	11.39	16	269.54	8.47	45
I	Img14	64.26	9.42	16	271.12	6.87	45
E	Img15	64.26	12.94	16	271.12	10.26	45
N	Img16	60.32	9.22	17	240.51	7.91	44
T	Img17	61.58	11.39	15	290.14	8.32	45
	Img18	61.51	11.22	15	294.18	8.24	45
2	Img19	60.64	13.96	15	284.17	10.26	45
	Img20	62.93	9.38	17	246.04	7.18	44

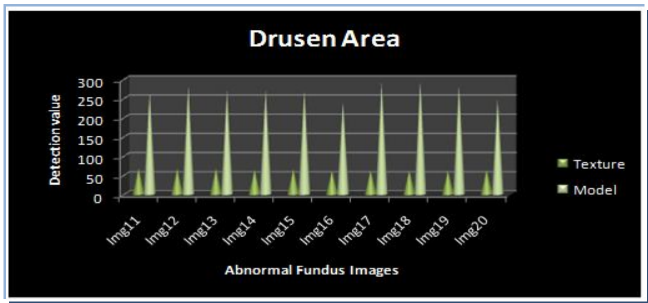

Fig 22 : Model Based Drusen Detection Technique has the larger Drusen Area Detected

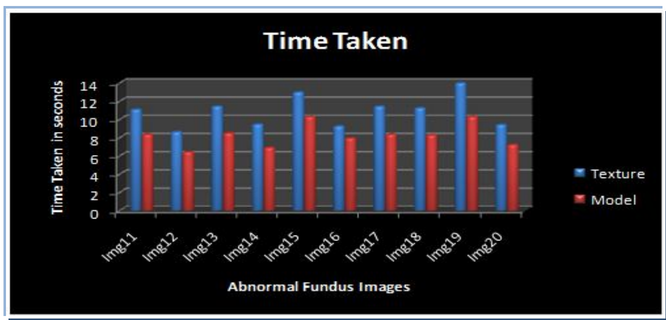

Fig 23 : Model Based Drusen Detection Technique takes less time in the entire Drusen detection process.

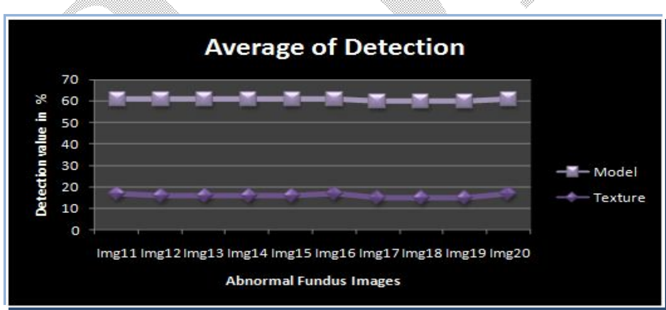

Fig 24 : Model Based Drusen Detection Technique shows highest Average of Detection in percentage.

IV. CONCLUSION

The conclusion is made that The Model based drusen detection technique (Hill- based drusen detection technique :

- Performs better and detects the drusen in a less computation time and high accuracy.
- Does not require any pre-processing (except Optic disk suppression) and hence will not affect the reliability of the results.
- Determines a large amount of drusen area when compared to the texture based drusen detection technique
- Has a highest percentage when the average of detection is calculated.
- Is reliable in picking up drusens of all sizes and types (bright or faint) in an image thus provides the accurate drusen count as well gives a promising grading(the task of segmenting entire drusen regions).

V. FUTURE ENHANCEMENT

In drusen detection, color features such lightness, saturation and hue followed by a likelihood ratio classification can be used. Other techniques like Histogram-based Adaptive local thresholding (HALT), Learning Non-Homogeneous Texture Approach, Morphological Approach and Level Classification can be used.

Further work in this area involves

- Increasing the sensitivity of the technique
- Improving the technique and extend it to characterize other retinal lesions
- Extending the technique for retinas with different background pigmentation
- Larger data sets that are more challenging with more evidence of AMD can be used.
- Image analysis techniques can be used to establish a standard progression rating.

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