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# Identification of Age-Related Macular Degeneration Using OCT Images

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**Abstract.**Age- related Macular Degeneration is the most leading retinal disease in the recent years. Macular degeneration occurs when the central portion of the retina, called macula deteriorates. As the deterioration occurs with the age, it is commonly referred as Age- related Macular Degeneration. This disease can be visualized by several imaging modalities such as Fundus imaging technique, Optical Coherence Tomography (OCT) technique and many other. Optical Coherence Tomography is the widely used technique for screening the Age- related Macular Degeneration disease, because it has an ability to detect the very minute changes in the retina. The Healthy and AMD affected OCT images are classified by extracting the Retinal Pigmented Epithelium (RPE) layer of the images using the image processing technique. The extracted layer is sampled, the no. of white pixels in each of the sample is counted and the mean value of the no. of pixels is calculated. The average mean value is calculated for both the Healthy and the AMD affected images and a threshold value is fixed and a decision rule is framed to classify the images of interest. The proposed method showed an accuracy of 75%.

**Keywords**-Age-Related Macular Degeneration(ARMD)-Retinal Pigmented Epithelium (RPE) - Optical Coherence Tomography (OCT) - No. of white pixels.

## 1. Introduction

Now-a-days age- related macular degeneration is the major visual disorder in the medical field. Vision loss is irreversible with AMD and even the legal blindness is caused in the individuals over the age of 50 and above. In the world, today about 5% of the people are blind because of AMD. When the disease reaches to certain outcome level it will have 8.7% of blindness prevalence. David G Birch et.al in their article summarized about the use of nanotechnology in the stressing potential applications of AMD's patho-physiology. [1].The recent study on Age-Related Eye Disease suggested that the disease progressing from intermediate stage to advanced stage can be reduced by certain dietary supplements. Hence it is necessary to find an individual with developing AMD to its advanced stage and the necessary dietary supplements can be chosen. With that the monitoring of advanced neurovascular stage of the AMD can begin.P.Burlina et.al in their paper demonstrated a potential method for detecting and classifying AMD called as, Deep Convolutional Neural Network (DCNNs) [2]. Age-related macular degeneration (AMD) is the major cause for a critical blindness and complete visions



loss. People more than 60 years of age usually become the victims of Age-related Macular Degeneration hence it is commonly referred as Age related Macular Degeneration. For this condition, the central part of retina, which is known as macula becomes progressively poor. SamraNaz et.al proposed an algorithm, which automatically segment the retinal pigment epithelium (RPE) layer of the eye using optical coherence tomography (OCT) images for the detection of drusen [3]. Age-related Macular Degeneration can be classified into Dry Age-related Macular Degeneration and Wet Age-related Macular Degeneration. In the Dry Age-related Macular Degeneration (DAMD), there will be existence of small yellow deposits in macula known as drusen, which will be present under the RPE layer and converts its smooth curve shape into a bumpy one. In the Wet Age-related Macular Degeneration (WAMD) there will an irregular growth of blood vessels under the layer of macula, this condition is known as choroidal neo vascularisation, where these blood vessels pours out the blood and fluid into retina, this results in vision deterioration, which may further lead to permanent blindness. Giovanni Gregori et.al proposed a novel algorithm which was used to quantitatively assess drusen area and its volume. For each of the eye, standard deviations in the drusen area and the volume measurements were calculated. Main Outcome of the method is to measure Drusen area and volume. [4]. Removal of interferences and noises is the major step before the detection of these retinal diseases for a better and accurate diagnosis. A novel algorithm was implemented to automatically extract the RPE layer [5]. Nimishal, Rana Gi et.al in this paper, they have proposed a method of the pre-processing and segmentation. Pre-processing is done on the original image using Gamma Normalization which brings the intensity value in a particular range. Then the segmentation is performed on the Gamma Normalized image. Segmentation is done by Super pixel method. This method was faster, to improve segmentation performance, memory efficient and straightforward to extent to Super pixel generation than other methods. Philippa war [6]. One of the main symptoms for AMD is the alteration in the central vision which is surrounded by the normal visual field, this is also known as a central scotoma, Huiying Liu et.al in their paper, presented a study on the detection AMD by considering the measurement of natural. In comparison with other AMD detection techniques, the natural and intuitive responsive eye movements are used as the natural trigger responses for the visual stimulus. The proposed system for the detection of AMD is called as AVIGA (Automated Vision Impairment detection through Gaze Analysis) [7]. Pratul P Srinivasan et.al presented a novel, fully automated algorithm for the detection of retinal diseases through optical coherence tomography (OCT) imaging. This algorithm utilized multiscale histograms of oriented gradient descriptors as feature vectors of a support vector machine based classifier. This algorithm was a potentially impactful tool for the remote diagnosis of ophthalmic diseases [8]. Jorge Oliveira et.al developed a method using 3 classes in classification, for the detection of drusen. The classification with more than 2 classes can identify the individual drusen accumulated [9]. Qiang Chen et.al described an automatic drusen segmentation method for SD-OCT retinal images, which leverages *a priori* knowledge of normal retinal morphology and anatomical features. The highly reflective and locally connected pixels located below the retinal nerve fibre layer (RNFL) are used to generate a segmentation of the retinal pigment epithelium (RPE) layer [10]. ItebeddineGhorbelet.al proposed that Optical coherence tomography (OCT) allows high-resolution and non-invasive imaging of the structure of the retina in humans. This technique revolutionized the diagnosis of retinal diseases in routine clinical practice. Nevertheless, quantitative analysis of OCT scans is yet limited to retinal thickness measurements. They proposed a novel automated method for the segmentation of eight retinal layers in these images. This approach is based on global segmentation algorithms, such as active contours and Markov random fields. Moreover, a Kalman filter is designed in order to model the approximate parallelism between the photoreceptor segments and detect them [11]. Florence Rossantet.al proposed an automated method for the segmentation of eight retinal layers in high resolution OCT images. It has been evaluated based on comparison with manual segmentation performed by five different experts. The method has been successfully applied on a database of 72 images. Quantitative measures are then derived as an aid to ophthalmic diagnosis. A good agreement with measures derived from manual segmentation is obtained which allows us to use the proposed method for retinal variability studies. Finally, a distance between

the manually traced curves and the ones obtained by the proposed method was calculated. The distance varies from 1.8 pixels for the RNFL/GCL+IPL interface, to 4 pixels for the OPL/ONL, which is again very accurate [12]. Jingjing Deng et.al proposed early identification of AMD can allow for mitigation (but not cure). One of the first symptoms of AMD is the presence of fatty deposits, called drusen, on the retina. The presence of drusen may be identified through inspection of retina images. Given the aging global population, the prevalence of AMD is increasing. Many health authorities therefore run screening programmes. The automation, or at least partial automation, of retina image screening is therefore seen as beneficial [13]. Age-Related Eye Disease Study Research Group et al proposed a statistics that shows only 10 % of the AMD patients suffer from the wet form. This paper is specifically focused towards the dry form of AMD that is affecting the 90 % of AMD victims [14]. Mona K Garvin et.al specifically focused towards the dry form of AMD that is affecting the 90 % of AMD victims. Drusen detection can be made with Colour Fundus Photographs (CPFs) [15].

## 2. Methodology

In the proposed method, two sets (sixteen images in total) of healthy OCT and OCT images of Age related Macular degeneration images are taken for experimentation. The algorithm of the proposed method is as shown below

Step1: Consider a RGB healthy and AMD image.

Step2: Acquired image is converted from RGB to grey.

Step3: The grey image is filtered using Gaussian filter and enhanced using contrast stretching

Step4: The enhanced image is converted to binary image by thresholding to partition the image into a foreground and background

Step5: RPE layer which is of higher value pixels i.e, the white pixels are extracted.

Step6: The extracted RPE layer is divided into eight sub images(quadrants) and number of white pixels in each of the eight sub images are counted and the mean pixel value is calculated using the formula –

$$\text{Mean pixel value} = \frac{q1+q2+q3+q4+q5+q6+q7+q8}{8}$$

Step7: The mean pixel value is calculated for both the healthy set and the AMD set of images, and named as m1 and m2 respectively. Using these mean pixel values the average mean value M, is calculated to fix a threshold as,

$$\text{Average mean, } M = \frac{m1+m2}{2}$$

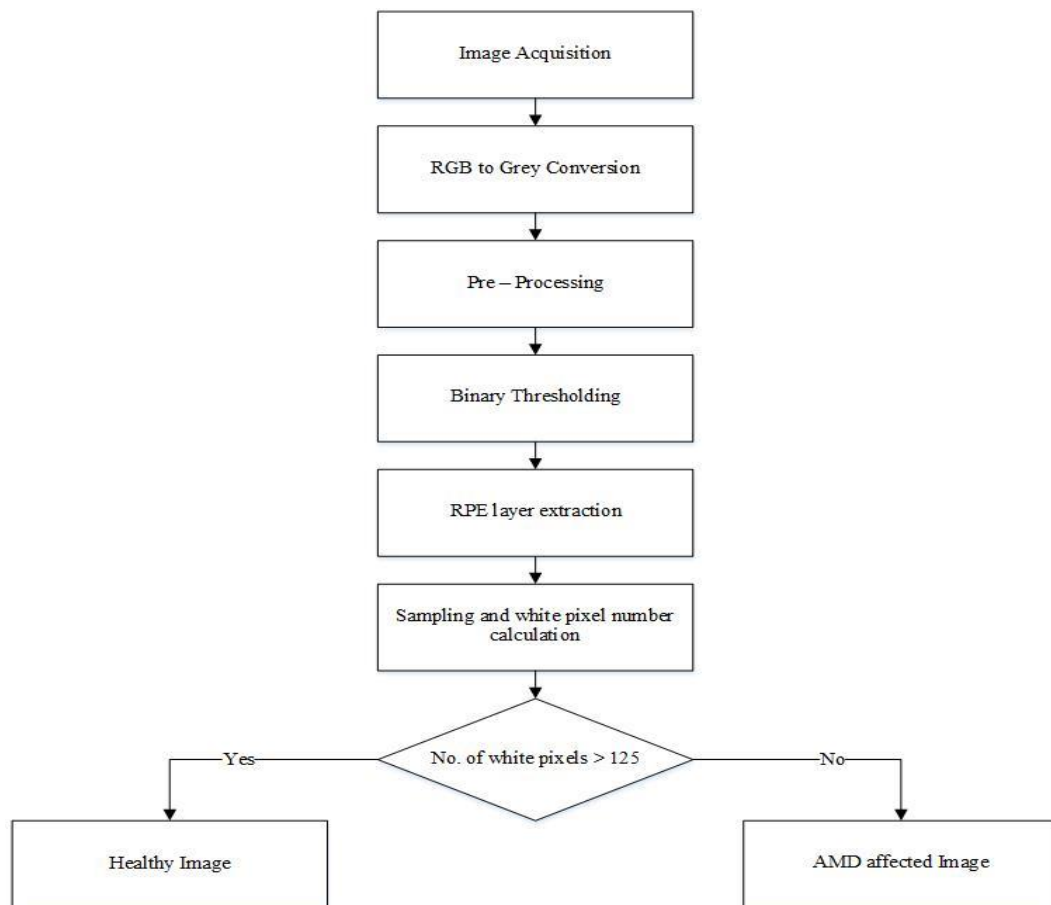
Step8: Using this threshold value, a decision rule is made in order to classify healthy images and AMD affected images.

### 2.1 Decision rule

If the mean pixel value of the control image is lesser than the fixed threshold value, the image of interest is classified as AMD affected one and if the mean pixel value is greater than the fixed threshold values it is classified as a normal image i.e.

$M > 125$ , the image is a healthy image

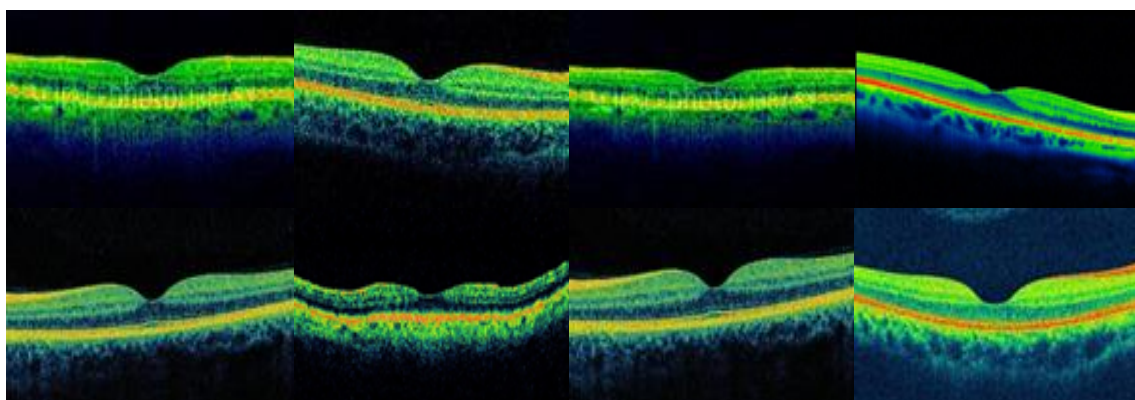
$M < 125$ , the image is AMD affected image



**Figure 1.** Flow diagram

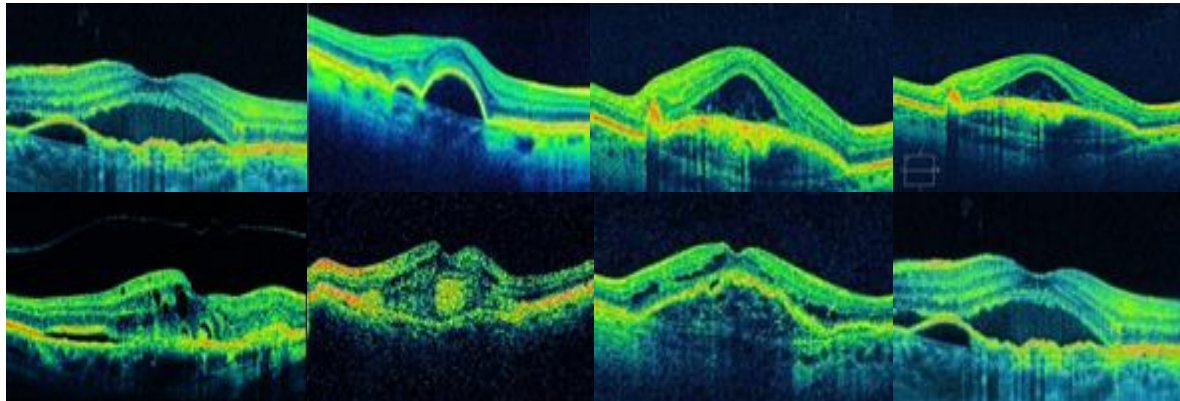
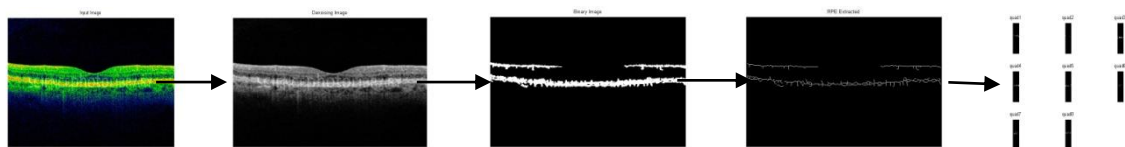
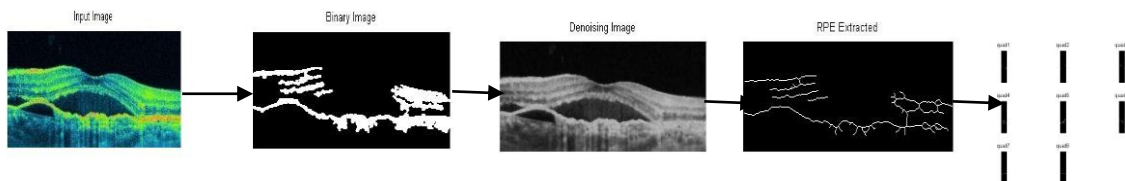
Figure 1. Shows the flow diagram of the proposed method

### 3. Results



**Figure 2a.** Set of Healthy OCT images



**Figure 2b.** Set of AMD -OCT images**Figure 2c.** Process involved for healthy OCT image1**Figure 2d.** Process involved for AMD OCT image1**Table 1.**Mean Pixel numbers of Healthy OCT images

No. of Images	q1	q2	q3	q4	q5	q6	q7	q8	Mean
1	137	112	166	124	142	149	177	138	143.1250
2	116	113	117	91	96	76	81	68	97.7500
3	100	106	123	122	122	135	139	126	121.6250
4	124	174	177	227	202	247	251	198	200
5	125	171	252	216	263	237	191	159	201.7500
6	168	162	166	242	226	170	172	88	174.2500
7.	124	177	228	127	260	221	201	157	186.8750
8	97	143	75	92	112	49	53	76	87.1250
Mean pixel number (m1)= 151.1875									

**Table 2.**Mean Pixel numbers of AMD OCT images

No. of Images	q1	q2	q3	q4	q5	q6	q7	q8	Mean
1	107	129	116	228	236	206	91	76	148.6250
2	80	98	62	65	62	82	84	63	74.5000
3	111	91	74	124	123	97	91	92	100.3750
4	133	133	158	78	51	37	37	60	85.8750
5	0	83	134	126	144	78	0	30	70.6250
6	76	58	58	69	80	67	82	55	68.1250
7	123	138	163	99	57	37	37	56	88.7500
8	63	85	108	80	91	73	62	43	75.6250
Mean pixel number (m2)= 100.5625									

Figure 2a and Figure 2b show the two sets of healthy OCT images and AMD OCT images

Figure 2c and Figure 2d show the process involved for healthy OCT image1 and AMD OCT image1

Table.1 and Table.2 show the mean pixel numbers of healthy OCT images and AMD OCT images

$$\text{Mean pixel value} = \frac{\text{quad1} + \text{quad2} + \text{quad3} + \text{quad4} + \text{quad5} + \text{quad6} + \text{quad7} + \text{quad8}}{8}$$

$$m1 \text{ (Table.1)} = 151.1875$$

$$m2 \text{ (Table.2)} = 100.5625$$

$$\begin{aligned} \text{Average mean, } M &= \frac{m1 + m2}{2} \\ &= \frac{151.1875 + 100.5625}{2} \end{aligned}$$

$$\text{Threshold value} \approx 125$$

#### 4. Discussion

Two sets of healthy and AMD images, 8 images in each group are taken for experimentation. The images undergo pre-processing step of noise removal and image enhancement, mostly the Gaussian noise present in the OCT images is removed using the Gaussian filter, which is one of the bilateral filter which even preserves the edges while removing the noise and in enhancement stage the contrast stretching of the image is done to improve the quality of the image. After the pre-processing stage, binary thresholding is done to extract the RPE layer. The RPE layer is extracted to check the thickness and the continuity of the layer, which is the disease mark to classify the AMD affected images. Binary thresholding is applied to extract the RPE because as the RPE layer contains high pixels it can be easily differentiated with the other pixels present in the image. The extracted RPE layer is then divided into 8 quadrants. It is sampled to 8 quadrants, so that the continuity of the RPE layer can be checked

and also the thickness of the layer can be found. More no. of samples can be obtained so that the accuracy of the result can be obtained. To sample the images even better segmentation methods can be implemented to increase the result accuracy. If thickness and continuity of the images are detected, it helps in developing a machine vision for classification of AMD affected images based on the no of white pixels, which is also a feasible technique in detecting the early stage of the detecting AMD. The no. of white pixels in each quadrant is calculated and the results are tabulated for healthy and AMD images respectively. For every image, the mean value of the pixels present in all the eight samples is calculated and tabulated; the grand average of all the mean value of the pixels present in all the images is then calculated for healthy as well as for AMD affected images and termed as  $m_1$  and  $m_2$  respectively. From these values average value  $M$  is calculated as  $\frac{m_1+m_2}{2}$ .

From the results obtained,  $M$  is found equal to be 125. Hence the decision rule is framed that if mean value of any image is greater than 125 then the image is said to be normal and if the mean value is lesser than 125 then the image is said to AMD images since value of mean pixel number of healthy OCT images  $m_1$  is greater than 125 and value of mean pixel number of AMD OCT images  $m_2$  is lesser than 125. Here in this experimentation out of 16 images taken 8 healthy images are taken out of which 5 images were found to be having the average greater than the threshold. Similarly, out of 8 AMD images were taken out of which 7 are found to be lesser than the threshold value. In total out of 16 images taken 12 images answered the decision rule whereas 4 of the images failed leading to 3 false positive and 1 false negative. This leads to an accuracy of 75%.

## 5. Conclusion

A set of 16 healthy and AMD images are taken for experimentation. In the proposed method the no of white pixels present in the samples is calculated, based on this a decision rule is framed. A total accuracy of 75% is obtained with false positive of 62.5% and false negative of 87.5%. However carrying out the analysis for more number of samples and also analysing the intra sample relation between the number of white pixels, by applying better segmentation methods and by increasing the number of samples and clinical trials the overall accuracy may be improved.

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