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Detection of Age Related Macular Degeneration

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Abstract: - A component of the eye called the retina converts light into electrical impulses. The brain then transforms these impulses into pictures, which gives us the ability to see. When AMD (Age Related Macular Degeneration), a serious condition of the retina, initially appears, cells begin to disintegrate in the macular. One's ability to read, write, and perform several other daily tasks is thereby permanently reduced. A Matlab-based decision-making system is required to diagnose AMD and assess its state fast and easily. Rapid results and less physical labour on the side of the doctor are advantages. This can be done by segmenting the blood vessels of the retinal fundus images and visually identifying AMD and even observing the difference among Wet and Dry AMD.

Keywords: Matlab, Age Related Macular Degeneration, Retinal Fundus Images, Image Processing

I. Introduction

Around the world, 2.2 billion people suffer from blindness and vision impairment, with over half having a untreated or avoidable ailment (WHO, 2020). Age-related macular degeneration (AMD) is the primary cause of blindness in the industrialized world. 170 million individuals globally and one in seven Australians over 50 are affected. It is a global vision crisis. Fig. 1 shows the difference between the two types of AMD along with the comparison with the normal eye.

Age-related macular degeneration (AMD) is the leading cause of blindness among the elderly on a global scale. Unfortunately, this degenerative disease is incurable in around 90% of cases. Based on whether blood vessels have disruptingly penetrated the retina, wet and dry types of AMD are distinguished from one another. By the time, a person is 80 years old, AMD, which currently affects 2% of the population, will affect one in four people. Women and those with light skin tones are more susceptible to develop AMD for unknown reasons. There are currently no FDA-approved treatments for AMD, with the exception of a very small number of patients with end-stage illness. (Ambati et al. [11]). In Western countries, age-related macular degeneration is a common eye disorder that mostly affects elderly individuals (AMD). Along with the development of drusen in the macula, there may also be geographic atrophy or choroidal neovascularization (CNV). (Gheorghe et al. [12]). In clinical terms, AMD primarily impacts the macula, which is the central region of the retina. There are two stages of the disease: early and advanced AMD. Advanced AMD can be categorized into two forms: exudative or neovascular form (wet AMD) that exudes, and nonexudative or atrophic form (dry AMD).The wet kind is frequently associated with more serious visual loss. Various genetic factors, lipid metabolism, oxidative stress, and ageing all have an impact in AMD. (Yanhui Deng et al. [13]).

Since AMD causes persistent and permanent vision loss, early detection of the condition is essential. When it comes to investigating the retina, color fundus photography is the most inexpensive imaging method available. Recently, advanced algorithms based on deep learning were developed to automatically detect AMD from images of the fundus. Large annotated datasets and consistent evaluation standards are still missing, though. Each B-scan slice in the OCT volume must be inspected by a professional to detect the presence of fluid in order to diagnose AMD using OCT (Optical Coherence Tomography). It takes a long time and is unpleasant.

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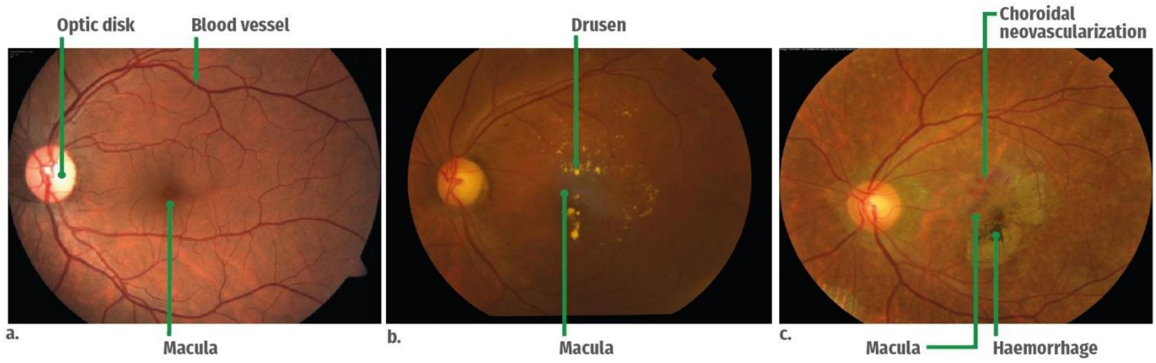

Figure 1. Fundus photographs a) Normal, b) Dry AMD, and c) Wet AMD [17]

It is hence important to identify and classify AMD in adults as early and quickly as possible . This can be done by detecting AMD , by using the retinal fundus images . The fundus images can be processed , by using the Matlab software. The physician can then visually see the difference between a normal human eye , and an eye affected by AMD . The classification of AMD (Dry/Wet), can then be an easy task , as in Wet AMD there is an abnormal growth of blood vessels below the retinal layer ; which can be easily observed in the final colorized image.

II. Literature Survey

Serener et el. [1] demonstrated that dry vision impairment may be detected with more accuracy using deep neural network performance data than wet vision impairment. Their research also demonstrates that, in terms of classification accuracy, the 18-layer ResNet model surpasses the AlexNet model. Particularly, at each stage of AMD, the ResNet model shows an area under the receiver operating characteristic curve of 94% and 63%, respectively.

Using OCT images, Sharif et al. [2] automatically categorised and distinguished AMD. The process of extracting the Retinal Pigment Epithelium layer, which is a layer of the retina, involves first enhancing the quality of the OCT image using the Wiener filter, and then utilizing Graph Theory Dynamic Programming. The differential inner and outer segment signals of the RPE's inner and outer segment layers was used, to create a specific feature set. The feature set also contains the resulting difference signal's approximation coefficient, entropy, and spectrum energy.

Arabi et al. [3] suggested that an automatic screening method for dry and wet macular degeneration can be based on the ratio of white pixels to the rest of the pixels in the corresponding eye image. The proposed strategy is evaluated using 30 photographs of eyes, 10 from each of the three categories of healthy eyes, wet macular degeneration, and dry macular degeneration.

Krishna et al. [4] used a collection of pictures taken from 20 different persons, the two imaging methods for AMD identification in this study—extracting blood vessels from fundus photos and extracting the RPE layer from OCT images—are assessed. The remaining 10 individuals were in good health, while the remaining 10 people developed AMD. On these pictures, OCT and fundus imaging were examined.

Optical coherence tomography (OCT) scans were used by Kaymak et al. [5] to quickly identify diabetic macular edoema (DME) and AMD. They divided the OCT pictures into four categories using a deep learning system: healthy, dry AMD, wet AMD, and DME. For categorising OCT pictures into DME and AMD groups, the proposed technique performed better than a prior transfer learning-based strategy that was suggested in the literature.

Using their innovative framework, Lu et al. [6] automatically identify the B-scan frames with fluid areas to assist in the diagnosis of AMD. For B-scan classification, a method of multiple instance learning was suggested. This method involves turning each slice into a collection of features. Cross-validation testing showed that this method, which used a multiple instance random forest, performed better than the most recent state-of-the-art algorithms. This approach produced reasonable classification accuracy, with an F-measure over 0.85.

Govindaiah et al. [7] have shown that utilising a pre-trained network is inferior to using a large number of images to explicitly train a deep neural network, especially in the diagnosis and screening of AMD, where accuracy varies from 83% to 92.5%. For similar studies, the deeper neural network, or VGG16, outperforms the other analogous shallower networks, like AlexNet.

Chen et al. [8] categorised the optical coherence tomography (OCT) pictures from AMD and DME, and chose the suitable hyperparameters. It is advised to employ a convolutional neural network (CNN) equipped with transfer learning capabilities. To accomplish transfer learning, this entails utilising a pre-trained CNN model as the foundation for a new CNN model that solves related issues. Experiments revealed that the VGG19, Resnet101, and Resnet50 models were very successful in classifying OCT pictures of AMD and DME when combined with the right algorithm hyperparameters.

A technique to supervised learning that makes use of a multi-layer perceptron neural network and a properly chosen feature vector was put out by Tamim et al. [9]. This technique assigns a 24- dimensional feature vector, which comprises local pixel intensity, morphological transformation, significant phases of phase congruency, Hessian value, and difference between Gaussian values, to each pixel in a retinal fundus picture. The segmentation is improved using a post-processing method based on mathematical morphological operators. In order for the feature vector that will be utilised to display the likelihood that blood vessels will operate effectively, the final binary map picture must be symmetrical.

To identify diabetic retinopathy, Matlab is utilised. Shamalay et al. [10] extracted the fundus picture for this suggested system from the patient's retina using a DR detection approach. Here, a MATLAB-based system has been used to analyse fundus images taken using a smartphone camera and a Peek retina device. This method's objective is to determine if the DR stage of the retinal disease is Proliferative or Non-Proliferative. To do this, the fundus picture will be divided into several sections, such as Exudates, Microaneurysm, Optical Disk, and Hemorrhage. This segmentation procedure enables a more precise identification of the kind of retinal illness and establishes the best course of action.

Amin et al. [14] proposed a decision-making system utilising Matlab software for angiography to swiftly and effectively examine various body sections. This approach has the advantages of being quick to produce results and requiring less physical work from the doctor.

The Automated Detection Challenge on Age-Related Macular Degeneration, a satellite event during the ISBI 2020 conference, was organised by H. Fang et al. (2020). (ADAM). The four unique goals for the ADAM challenge were to diagnose AMD, identify and segment the optic disc, locate and classify lesions, and identify the fovea. These steps were required for the accurate classification and detection of AMD utilising fundus pictures. The ADAM challenge includes a sizable dataset that includes 1200 fundus images with diagnostic labels for AMD, pixel-wise segmentation masks for the optic disc and various AMD-related lesions (such as drusen, exudates, haemorrhages, and scars), as well as coordinates identifying the macular fovea's location.

III. METHODOLOGY

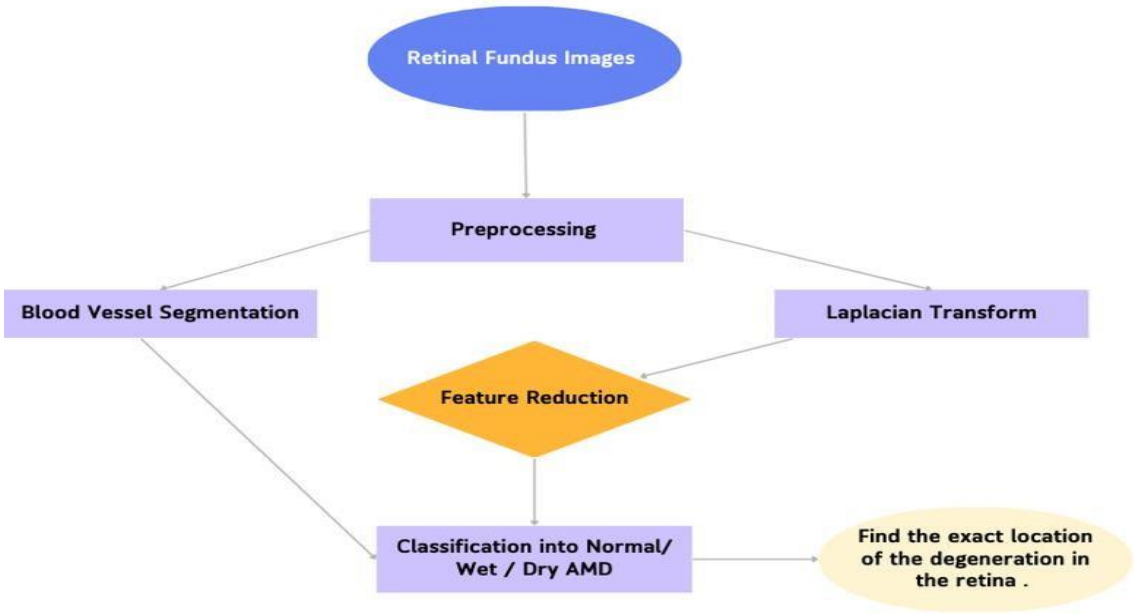

Figure 2a. Block Diagram for detecting AMD

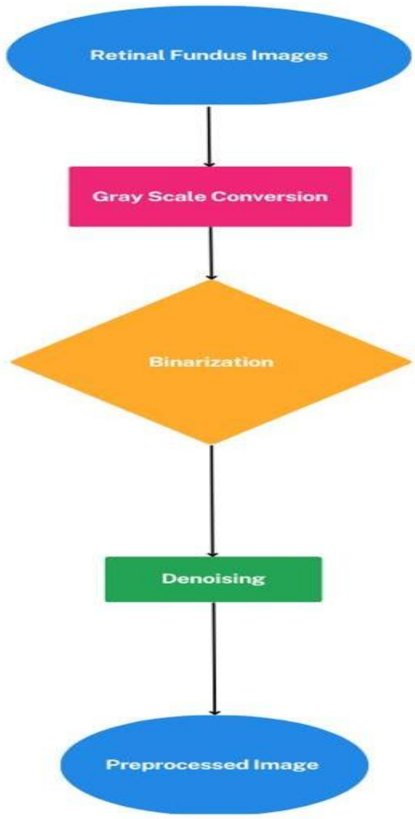

Figure 2b. Preprocessing Procedure

The Retinal Fundus Images Database, which has top-notch fundus pictures, was the database used in this investigation. A list of diagnosis codes and diagnoses is given for each of the 400 raw images. The text files include expert comments on the manifestations (features) that may be seen in each image. For a total of 44 potential manifestations in the database, the experts were contacted at various points during the data gathering procedure. These 44 manifestations were then split into 39 values throughout the encoding process. For the segmentation of the blood vessels, 40 photos were manually recognized. [16]. We used online Matlab software and retinal fundus images affected by both the types of AMD , namely Wet and Dry to get the results. The photographs can be saved to the computer before being imported into Matlab. Matlab starts by iteratively running the code instructions after obtaining the image as input. The picture has been changed from its original state in the filtered version. The filtered picture is then transformed into a second binary image, after which a complimentary image is produced. The final colourful image is created by transforming this complimentary image. Also, by modifying the colour parameters in the Matlab code, the final image's colour may be altered. Fig. 2 depicts the block diagram of the proposed methodology and Fig. 2b demonstrates the various preprocessing stages. By observing these images the doctor can easily conclude whether the patient has AMD or not , and further can also classify the type of AMD , based on the output colorized image. The final images can be seen in Fig. 3 , Fig. 4 and Fig. 5. The Laplacian of the image can be found , and it can be convolved with the mask. The Green Channel Extraction can be performed followed by a series of processes , namely Inversion , Contrast Enhancement , Gaussian Filtering , Median Filtering and Thresholding . Results can be seen in Fig. 6, Fig. 7 and Fig. 8 respectively. This enables doctors to find the exact location in the eye where there is macular degeneration in just a few seconds. Age-related macular degeneration (AMD) is characterized by drusen, and there is compelling evidence that the quantity of drusen and how they influence the retinal pigment epithelium serve as powerful predictors of AMD development and vision loss [19]. This can be detected in the eye at early stages to prevent the progression of AMD. The resultant image can be seen in Fig. 9.

IV. RESULTS & DISCUSSION

Normal Unaffected Eye:

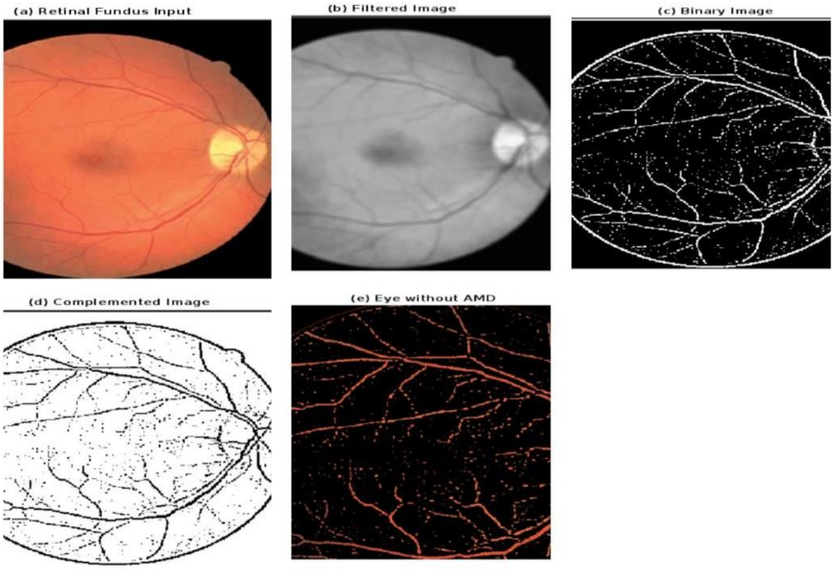

Figure 3. The image indicates that the patient is not suffering from AMD

Figure 3. By integrating all of the outputs produced while the code was being executed, the final image of the colored blood vessels that the Matlab software extracts from the retinal images of the eye was produced. The image indicates that the patient is not suffering from AMD.

Dry AMD :

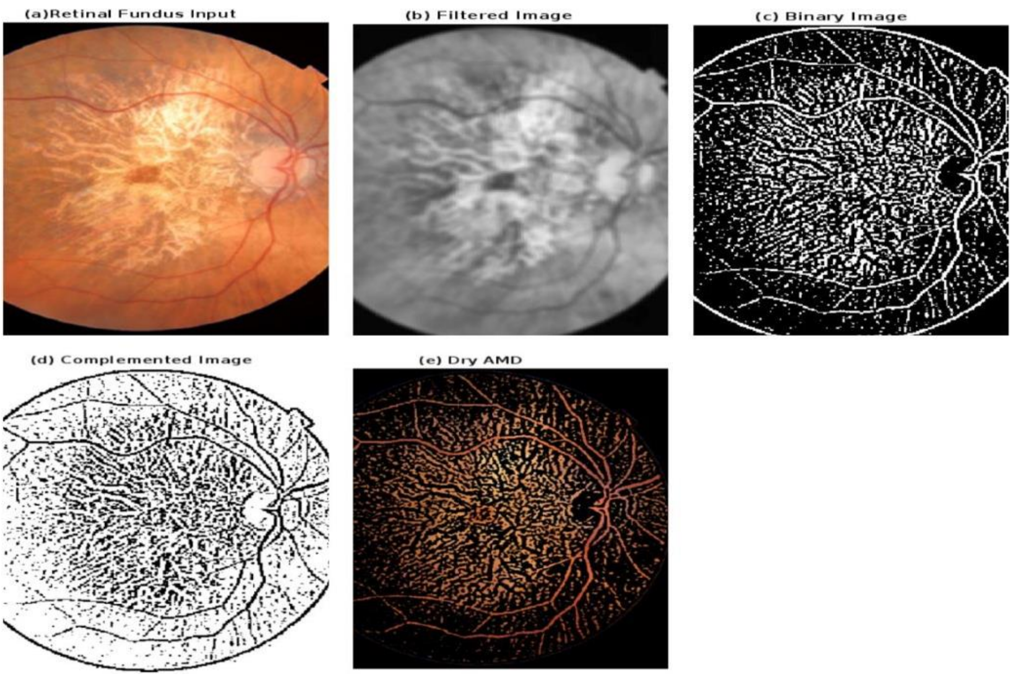

Figure 4. The image indicates that the patient is suffering from Dry AMD

Figure 4. By integrating all of the outputs produced while the code was being executed, the final image of the colored blood vessels that the Matlab software extracts from the retinal images of the Dry AMD-affected eye was produced. The image indicates that the patient is suffering from Dry AMD.

Wet AMD :

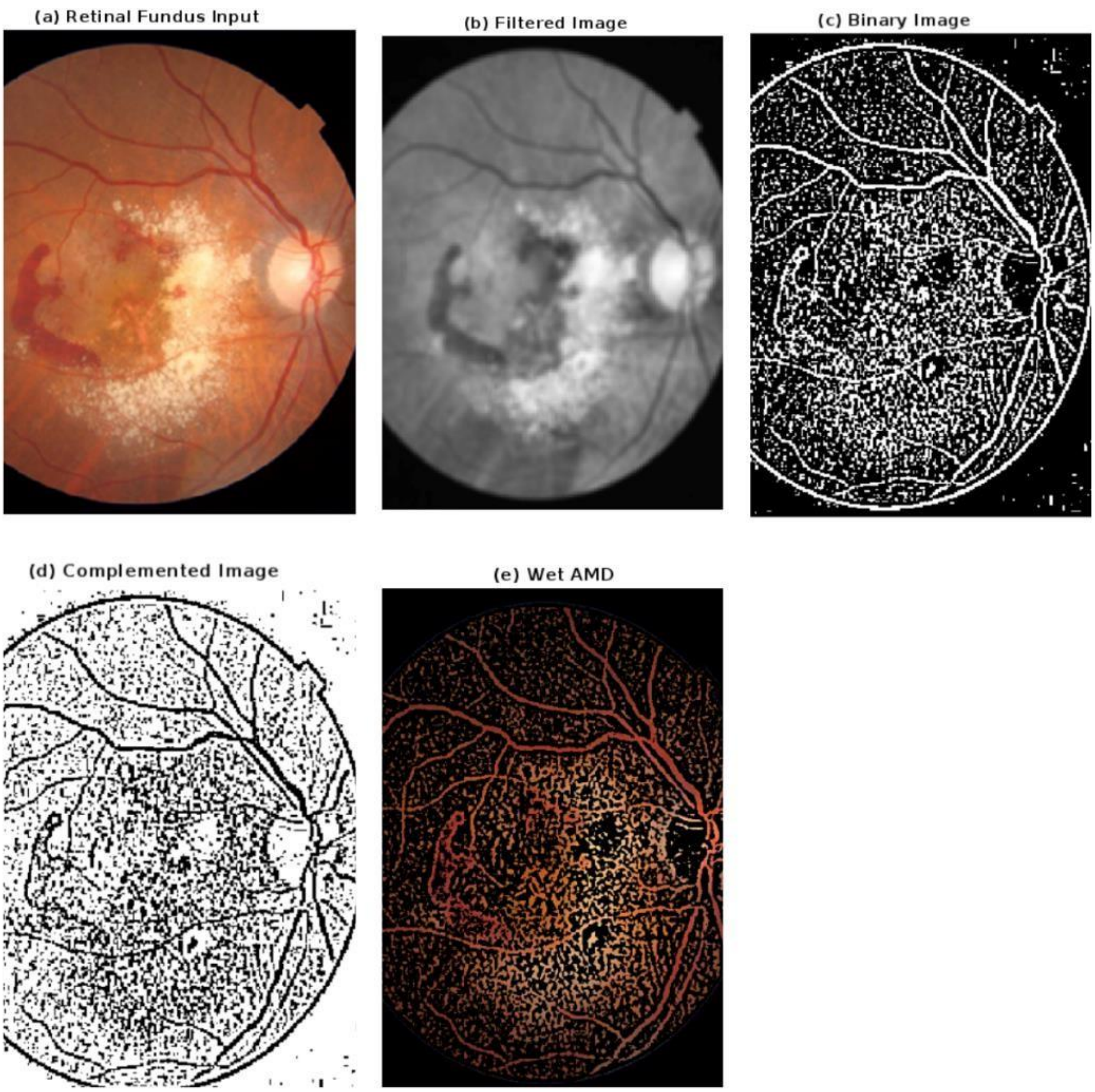

Figure 5. The image indicates that the patient is suffering from Wet AMD

Figure 5. By integrating all of the outputs produced while the code was being executed, the final image of the colored blood vessels that the Matlab software extracts from the retinal images of the Wet AMD-affected eye was produced. The image indicates that the patient is suffering from Wet AMD. The exact location of the degeneration can be found out .

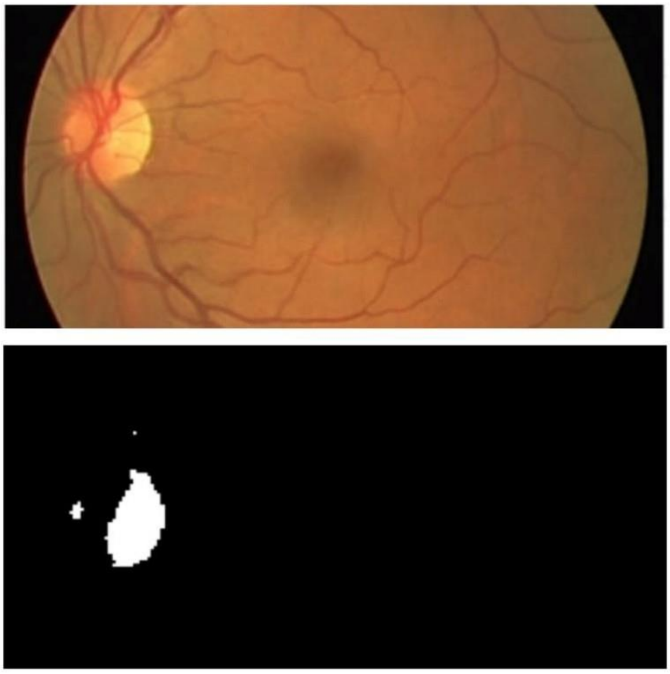

Figure 6. Unaffected Eye

Figure 7. Dry AMD

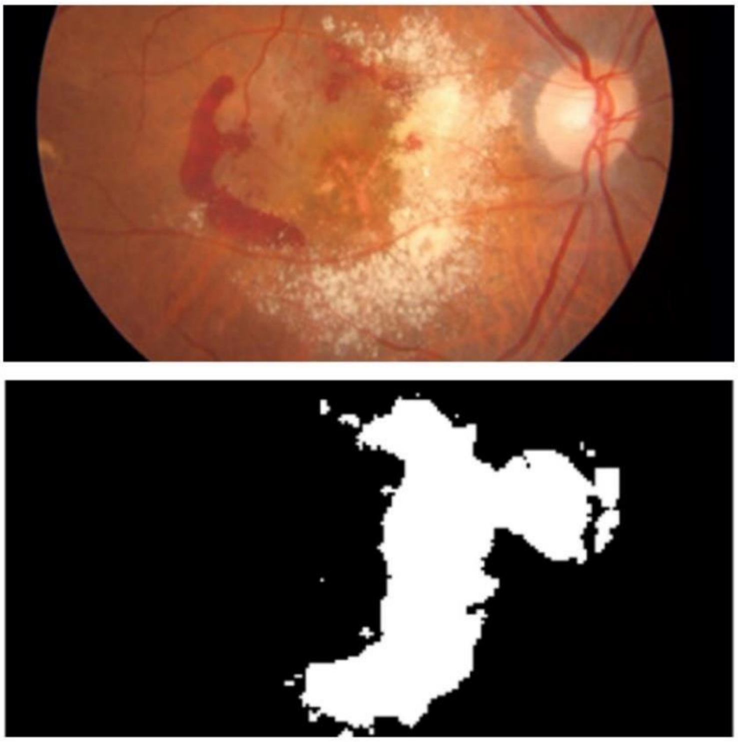

Figure 8. Wet AMD

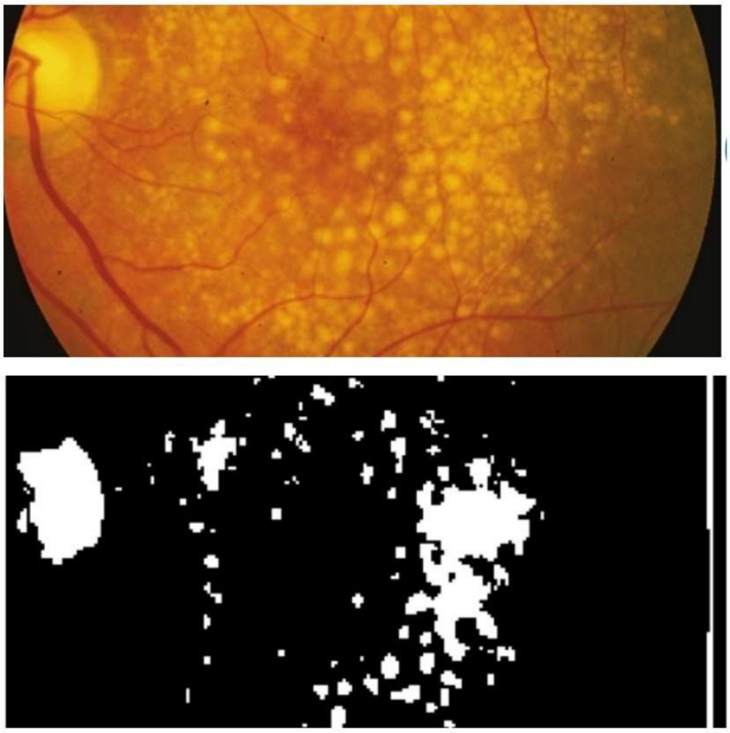

Figure 9. Drusen Detection

In their study, Garnier et al. [18] utilized a technique called multiresolution texture analysis along with color fundus images to explore the diagnosis of AMD. They divided the texture using wavelets and analyzed it at different scales to detect relevant texture patterns. Their final model, called Local Binary Patterns, uses both the sign and magnitude components to provide textural information.

Freeman et al. [19] , on the other hand, identified patients' drusen using either spectral domain optical coherence tomography or an image-stabilized scanning laser ophthalmoscope. Their objective was to establish a relationship between the volume and area of dry AMD drusen and the Age-Related Eye Disease Study (AREDS) grade.
Shamalay et al. [10] proposed a method for detecting diabetic retinopathy using Matlab. The method involves extracting a fundus image from the patient's retina and using a MATLAB-based system to analyze fundus images captured through a smartphone camera or a Peek retina device. The objective of this approach is to segment the fundus image into various components such as Exudates, Microaneurysms, Optical Disk, and Hemorrhages to determine whether the retinal disease is in the Non-Proliferative or Proliferative DR stage.
Amin et al. [14] also proposed a decision-making system based on Matlab for angiography, which allows for the rapid and effective analysis of various body parts. This system offers quick results and requires less physical effort on the part of the doctor.
Fang et al. [15] conducted the Automatic Detection Challenge on Age-Related Macular Degeneration (ADAM) as a satellite event at the ISBI 2020 conference. The challenge consisted of various tasks, such as locating and segmenting the optic disc, identifying the fovea, diagnosing AMD, and identifying and categorizing lesions. In order to achieve accurate AMD classification and detection through fundus images, completion of these tasks was necessary. The ADAM challenge dataset was substantial, containing 1200 fundus images with labels for AMD diagnosis, segmentation masks for AMD-related lesions (such as exudates, drusen, hemorrhages, and scars) and the optic disc on a pixel-wise basis, and coordinates that corresponded to the macular fovea's location.

V. CONCLUSION & FUTURE SCOPE

Matlab is a powerful tool that can be used to analyze the retinal fundus images to detect diseases like Age Related Macular Degeneration which can lead to life threatening situations if left undetected . It helps physicians to diagnose the AMD as soon as possible with minimal efforts , and is an alternative approach to the conventional Optical Coherence Tomography which is very tedious as the physician is required to check each slice patiently . Retinal Blood Vessel Segmentation can be enhanced and extensively used in the future to detect and diagnose complicated eye diseases like Diabetic Retinopathy.

The approach could change in the future to enhance the segmentation of the retinal fundus picture or to take various diseases of other body parts into consideration. In the near future, this technique may be used to analyze pictures of the fundus captured during imaging procedures in clinics. To increase the effectiveness and precision of the therapy, several researchers are investigating various features of retinal arteries. Machine learning-based solutions will be more accurate and effective with a greater understanding of the problem. In this situation, machine learning approaches are more likely to be successful. This approach takes longer since it only analyses one image at a time. The system could accept a range of images and the time for diagnosing the disease could be reduced further.

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