



Detection of Age-related Macular Degeneration using Open CV for Image Processing Applications

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Abstract— Age related macular degeneration is degeneration of the macula area and is commonly observed in people with age 50 and above, therefore called age related Macular degeneration, AMD. If AMD is diagnosed at an early stage degeneration laser treatment can help some people to prevent further deterioration of macula. The authors have developed a novel algorithm for automatic detection of AMD using image processing techniques. The algorithm locates disease affected pixels on macula and evaluates the degenerated area on the macula. Intel's Open CV Library is used to implement the algorithm. The aim of developing the algorithm on open CV is to embed the same on ARM based low power single board computer system. The algorithm is implemented on Linux- Ubuntu platform to test retinal images for the detection of AMD. The algorithm has been tested with 25 normal and 25 AMD clinical images and has yielded an accuracy of 94%.

Keywords— Age related macular degeneration, image processing, Open CV, hardware implementation.

I. INTRODUCTION

AMD is a common eye condition among people age 50 and older. The central area of the retina is known as the macula. The macula is responsible for central vision. AMD gradually destroys the macula that provides sharp, central vision needed to see the objects clearly. There are no symptoms for this disease, only by observing the loss of central vision one can predict AMD. The figure1 shows the difference between normal, AMD macula and figure2 shows normal vision, vision of a person having AMD. In India 70% of peoples are in villages and most of them suffer from eye diseases. There is a large deficit for the ophthalmologists in these areas. A simple instrumentation system which can acquire retinal images, process and analyze the retinal diseases solves this problem to some extent. A trained technician can operate the system and identify those patients who need treatment by the ophthalmologists, thereby improving the doctor to patient's ratio.

A large number of algorithms and image processing techniques have been developed for detection of AMD. Marryam Mubhashar et.al, proposed an algorithm to detect macula from distance estimation of Optical disc centre and blood vessels [1]. Shifeng Hu, proposed a driver fatigue eye features detection algorithm based on OpenCV,

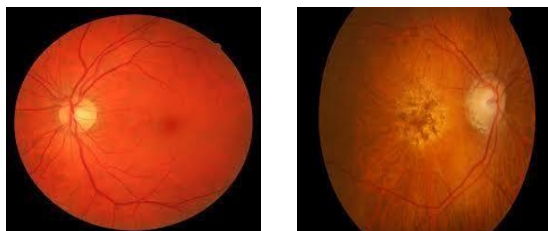


Figure1: (a) Normal Macula (b) Degenerated Macula

(a)

(b)



(a) (b)

Figure2: (a) Normal Vision (b) AMD Vision.

Hiroki Sugano in his paper, proposed a parallel implementation of morphological processing optimized for Cell Broadband Engine [3]. Cemal Kose et.al, proposed a simple inverse segmentation method to exploit the homogeneity of healthy areas of the macula rather than unhealthy areas [4]. Rapantzikos E et.al, proposed a novel segmentation algorithm for the automatic detection and mapping of drusen in retina images for the diagnosis of AMD [5]. Meindert Niemeijer et.al, implemented a fast method to detect the position of the optic disc and the fovea in retinal images [6]. Jaeyoung Kim et.al, implemented real- time image processing program using OpenCV library for Apple's iPhone4,smart mobile phone [7]. Sopharak et.al, implemented detection of OD based on entropy filter [8]. Rashid Jalal Qureshi et.al, implemented a combination of the different algorithms for the detection of OD and Macula [9]. Aby P.K et.al, implemented image processing algorithms on DM3730 for face detection applications [10].

II. METHODOLOGY

The objective of this work is to develop algorithm for detecting AMD and implementing on open CV with a future scope to implement the same on hardware.

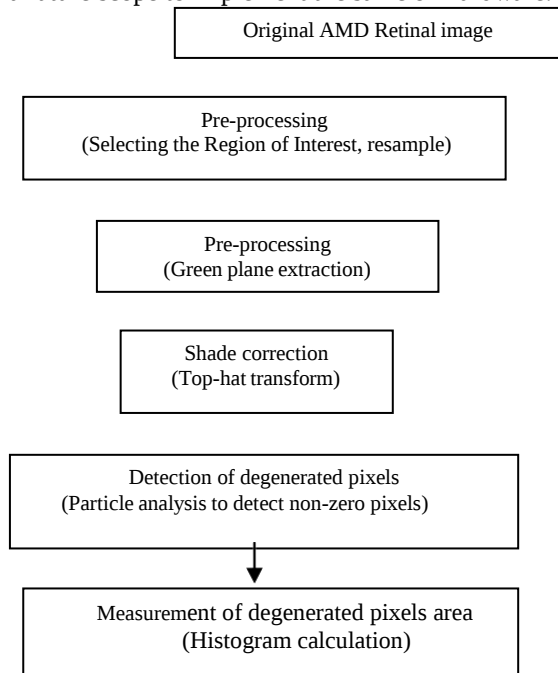


Figure 3:Flowchart for the proposed algorithm.

A. Software Development

The proposed algorithm by the authors detects AMD by identifying damaged pixels in the macula. The algorithm detects groups of damaged pixels in the macula region and evaluates the total damaged area in the macula from the colour retinal images. The flow chart for the algorithm is shown in figure3.

The retinal fundus images present structural and impulsive noise. The structural noise is caused due to anatomic shape of the retina, and impulsive noise is caused by the acquisitions tools. And another characteristic problem associated with of retinal images is that both the background and the vascular system have the same grey levels. In order to extract the desired retinal features from the retinal image, good image pre-processing is necessary. The original retinal image is first pre-processed and then particle analysis is performed.

Pre-processing

During pre-processing the image is cropped standard resolution of (256X256) pixels and re-sampled to perform the image processing operations in the region of interest (ROI). Green plane is extracted for gray level correction. To distinguish the gray level variations in the fore ground with reference to back ground

image in the gray scale, shade correction operator is employed.

The original retinal image is cropped to select the region of interest (ROI). Cropping refers to the removal of the outer parts of an image to improve framing, accentuate subjectmatter or change aspect ratio. This eliminates the unwanted areas from the image. A Region of Interest (ROI) is an area of an image, which is graphically selected from a window displaying that image. This area is used to concentrate further processing. Any ROI is used as a mask to remove pixels from the image. Removing pixels means setting their intensity to zero. The mask tool can remove pixels that are outside the selected ROI(s) and retain pixels that are inside the ROI(s). When dealing with logic operations on gray scale images pixel values are processed as string of binary numbers. The AND and OR operations are used for masking, that is for selecting sub-images in a main image.

Re-sampling is the mathematical technique used to create a new version of the image with a different width and/or height in pixels. Increasing the size of an image is called up sampling; reducing its size is called down sampling. When images are up sampled, the number of pixels increases, but, with reference to the original subject, new image details cannot be created that were not already present in the original image. As a result, an image normally become softer the more they are enlarged since the amount of information per pixel goes down. When images are down-sampled, information in the original image has to be discarded to make the image smaller. Thus, if Image is down-sampled and then up-sample an image, all the original image will get detail back. Down-sampling a soft image can make it appear sharper even though it contains less information than the original. Re-sampling in Picture Window is performed by the Resize transformation. The Resize dialog boxes display the input image width, height and dpi(dots per inch) setting and specify the output image width, height, dpi setting and re- sampling method. Note that changing the dpi setting (resolution) does not affect the image data in any way. It is simply a suggested scale factor that is associated with the image to expedite printing or document the size of the original subject.

The green component of the image shows a good variation between macula and background. Hence green plane is extracted and a series of morphological opening operations are applied. Opening is defined as an erosion followed by a dilation with a specific structuring element.

The erosion operator takes two pieces of data as inputs. The first is the image which is to be eroded. The second is (usually small) a set of coordinate points known as a structuring element (also known as a kernel). The structuring element determines the precise effect of the erosion on the input image. To compute the erosion of a binary input image by this structuring element, we considered each of the *foreground* pixels in the input image in turn. For each foreground pixel (the input pixel) the structuring element is superimposed on top of the input image so that the origin of the structuring element coincides with the input pixel coordinates. If for every pixel in the structuring element, the corresponding pixel in the image underneath is a foreground pixel, then the input pixel is left as it is. If any of the corresponding pixels in the image are background, however, the input pixel is also set to background value. In the present application a 3×3 structuring element is employed. The effect of this operation is to remove any foreground pixel that is not completely surrounded by other white pixels. Such pixels must lie at the edges of white regions, and so the practical upshot is that foreground regions shrink. Erosion is the *dual* of dilation, i.e. eroding foreground pixels is equivalent to dilating the background pixels. Most implementations of this operator expect the input image to be binary, usually with foreground pixels at pixel value 255, and background pixels at pixel value 0. Such an image is produced from a grayscale image using thresholding. The polarity of the input image is set up correctly for the dilation implementation being used. The structuring element is supplied as a small binary image, or in a special matrix format, or it may simply be hardwired into the implementation. The above procedure allowed us to smooth vessels, to break the narrow items and to eliminate the thin protrusions. The output image is subtracted from the green plane for the calculation of shade correction operator.

Shade correction

The macula is dark pattern and the gray level variations in this region are higher than in any other part of the image. Hence a shade correction operator is used to remove the slow background variations. Top-hat transform is employed for shade correction. In digital image processing, top-hat transform is an operation that extracts small elements and details from the given image. There exist two types of top-hat transforms: The white top-hat transform is defined as the difference between the input image and its opening by some structuring element; The black top-hat transform is defined dually as the difference between input image and its closing by structuring element. Top-hat transforms are used for various image processing tasks, such

as feature extraction, background equalization, image enhancement, and others.

The size, or width, of the elements that are extracted by the top-hat transforms are controlled by the choice of the structuring element. The bigger the structuring element, the larger the elements extracted. Both top-hat transforms are images that contain only non-negative values at all pixels. The main feature of the top-hat transform is to emphasize details in the presence of shadow (the background). Here white top-hat transform is applied.

Detection of degenerated region

To detect the degenerated region (dark pixels) particle analysis is performed. NI Vision Particle analysis tool is used to detect the connected regions or groups of pixels in an image. These regions are commonly referred to as particles. A particle is a contiguous region of non-zero pixels. These particles are extracted from a gray scale image by thresholding the image into background and foreground states. Zero-valued pixels are placed in the background state, and all non-zero valued pixels are placed in the foreground. Particle analysis consists of a series of processing operations and analysis functions that yield information about particles in an image.

Measurement of degenerated pixels area

To calculate the total degenerated area histogram is performed, that gives the number of non-zero pixels and zero-pixels. The number of non-zero pixels represents the degenerated area.

B. Implementation

The algorithm is initially developed in LabVIEW for simulation and testing purposes [11][12]. The algorithm is programmed using the functions in Open CV Library. The program is executed at the terminal of Linux-Ubuntu. The processed image at different stages of the algorithm are displayed on the screen. Figure 4 below shows the display of degenerated area at the output stage, on Ubuntu terminal.

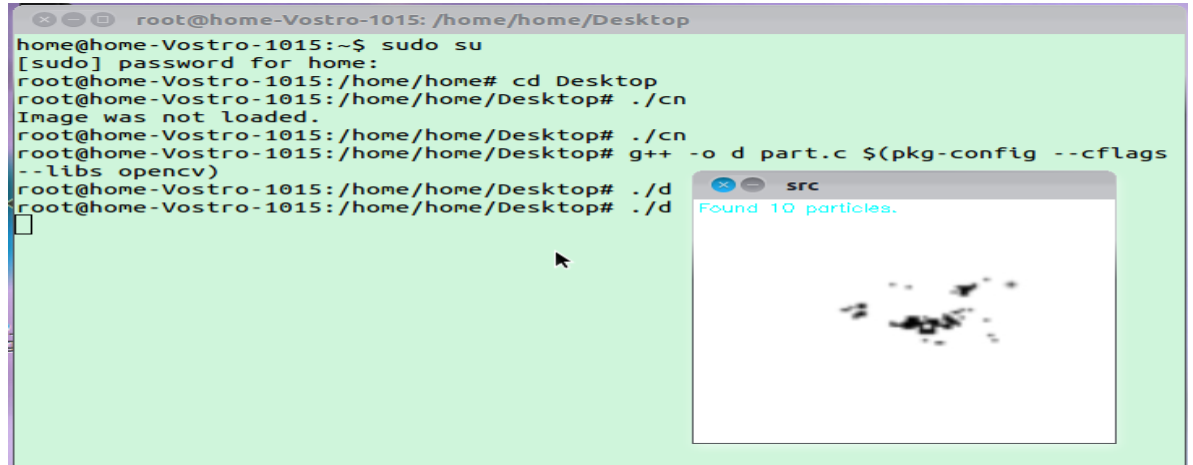


Figure 4: Display of degenerated macular area at the last stage of the proposed algorithm on Ubuntu terminal.

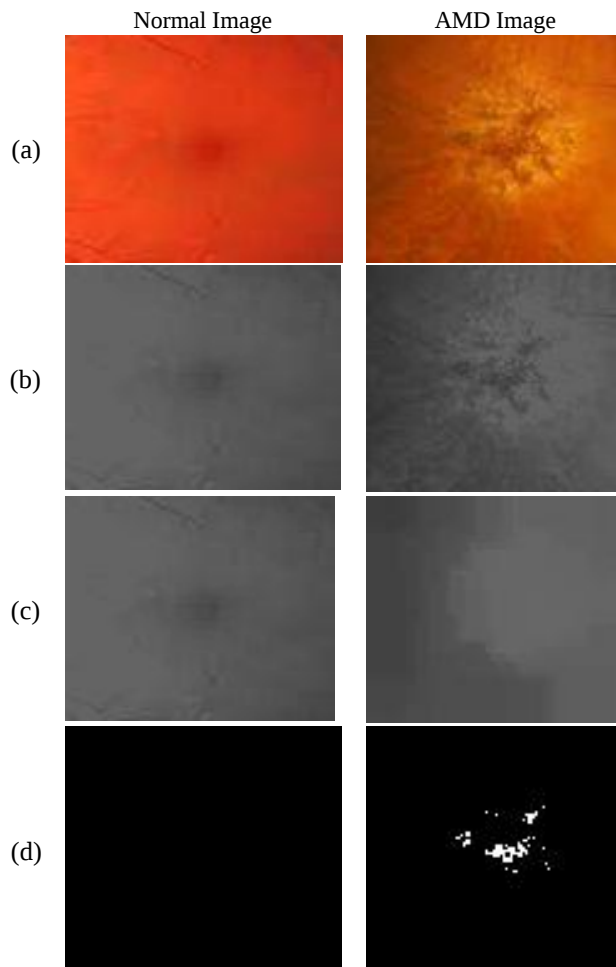


Table1: The total number of detected particles and damaged area in pixels.

Case	Number Of Particles Detected	Measured Area in Pixels
Case1	0	0
Case2	8	402
Case3	16	314
Case4	105	4175
Case5	89	3549
Case6	34	1486
Case7	86	2180
Case8	119	3758

Figure 5: Each step in the algorithm for normal image and AMD image; (a)Cropped Image (b)Green Plane Extracted ImageX (c)Morphological opened Image Y (d)output image (subtraction of X & Y)

III. RESULTS

The algorithm is tested with 25 clinical retinal images of AMD patients and 25 normal retinal images. The results are closely matching with the doctors reports. The output images at each step of the algorithm for normal image and AMD image is shown in figures5. Table1 shows the number of detected particles and damaged area in pixels for AMD images and normal images.

IV. CONCLUSION

The algorithm has been tested with DRIVE data set and clinical images. 94% of the images tested matched with the ophthalmologist's reports. The objective of developing this simple algorithm is to embed on hardware to provide screening system for identifying retinal diseases.

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