

Microaneurysm (MA) Detection with Smart Mobile Notification

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ABSTRACT

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A new improved method was introduced for the development of microaneurysm detection. The health dictionary explains the meaning of microaneurysm is the saccular enlargement at the end of the vein of the capillary retina associated primarily with the retinopathy of diabetes (DR). Microaneurysm (Ma) usually caused by high blood pressure can contribute to microaneurysm (Ma) in the retinal, but the main cause of microaneurysm formation is diabetes. Automatic microaneurysm (Ma) detection on retinal framework can decrease the work of ophthalmologists in order to determine the disease. In this project, the proposed method is been apply Contrast Limited Adaptive Histogram Equalization (CLAHE), Pillbox Circular Average Filter, Thresholding and Dilate of Morphology. A few image quality assessment was obtained such as sensitivity and accuracy in order to evaluate the performance. The development of microaneurysm (Ma) automatic detection on retinal images using Mathematical Laboratory (MATLAB) and sending messages to phones with Mobile System Communications (GSM) modems is implemented with the aim of allowing doctors to know the level of microaneurysm (Ma) disease in the retinal by the ease in a convenient manner. Message notification is a message that pops up on a mobile device. This message can send the receiver any time, users only insert telephone number to send their message.

Keywords:

Microaneurysm (Ma), diabetes
retinopathy (DR), mobile system
communication, retinal image

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1. Introduction

Malaysia is the fourth most elevated in Asia with diabetes. The 2.5 million people with diabetes in Malaysia, those aged 18 and above. According to NADI records, statistics suggest that almost half of Malaysians do not know that they have diabetes. NADI is National diabetes institute Malaysia. Microaneurysm is the earliest sign of Diabetic Retinopathy that appears as a small red dot on the surface of the retinal [1]. The problem is increasing in its scale, with diabetes having been identified

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as a significant growing global public health problem [2]. This project is to apply the new method that involved in the study of microaneurysm detection on the retinal image using a MATLAB software and displays in a smartphone. The system also will be able to display efficiency retinal database. In this undertaking, the smartphone will be utilized to show picture quality examination by utilizing Arduino Uno and Mobile Communications (GSM) to send a notice to the smartphone. Smartphones are compact and more important contrasted with alternate interfaces.

2. Methodology

Figure 1 shown a block diagram of the whole process. A total of 10 images of 1080x720 pixels have been tested with the proposed method. Imagery is inserted fundus image read by MATLAB as RGB images that do not represent the brightness value as the most important information of an image. The initial step of the process is getting the black and white image is called as grayscale. It can remove noise from the background and enhance the image. The grayscale technique is a take out a green channel because green channel can show high intensity compared to red and blue. It can remove noise from the background and enhance the image. The utilization of CLAHE administrator to accomplish a local contrast enhanced to the improved retinal image.

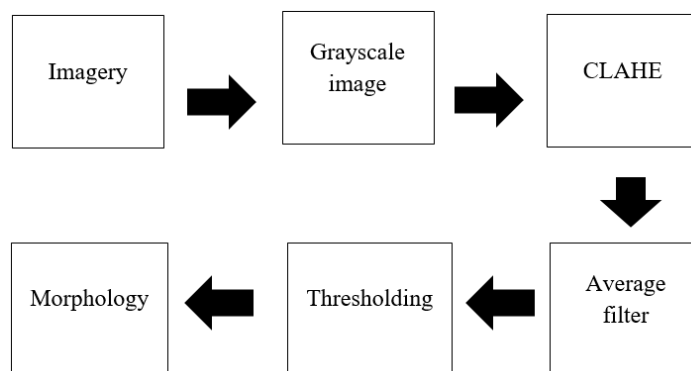


Fig. 1. Block Diagram of the whole process

The histogram of the original image is examined to determine the lowest and highest values currently present in the image in the modified image. The average filter is a simple sliding-window spatial filter that replaces the center value in the window with the average (mean) of all the pixel values in the window but the circular averaging filter is a value of each pixel is replace by mean of the value of all pixel inside a circle around this pixel. Global thresholding is the most important element because this stage of the image processing object is extracted from a scene for subsequent recognition and analysis. The structure of boundaries can display exactly by detection of the mask. The algorithm of thresholding used is as follow

$$T = \frac{1}{2(m1+m2)} \quad (1)$$

where $m1$ and $m2$ are an intensity values.

The basic morphology is used in this method is dilation because it enlarges a region. This operator enlarges the boundary of foreground pixels, hence holes inside pixels become smaller. The mathematical of morphology used is

$$A \oplus B = \{z \mid (B)z \cap A \neq \Phi\} \tag{2}$$

where dilation of a set A by structuring element B, all z in A such that B hits A when the origin of B=z.

2.1 Graphical User Interface (GUI)

The GUI is a short form for Graphical User Interface, allows the use of icons or other visual indicators to interact with electronic devices, rather than using only text via the command line [4]. The function of the GUI simplifies the process [3]. MATLAB as a based to create a GUI and it can establish the connection between MATLAB and GSM module. It also can show the whole process of detection of microaneurysm by use and visual indicator to easily understand. The GUI can send a mobile notification with IQA analysis via SMS. Figure 2 shows the design of a GUI for the mobile notification system.

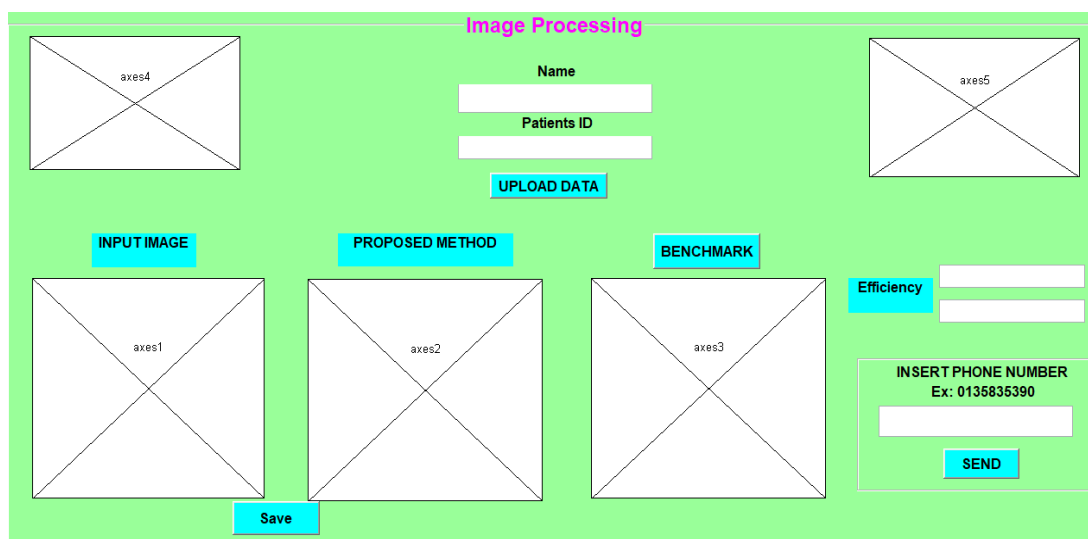


Fig. 2. Design of GUI for Mobile Notification System

2.2 Global System for Mobile Communication (GSM) Module

Global System for Mobile communication (GSM) SIM900A Modem is worked with Dual-Band GSM or GPRS based SIM900A modem from SIMCOM. Its functions at frequencies 900 until 1800 MHz. SIM900A can look through these two bands automatically [5].

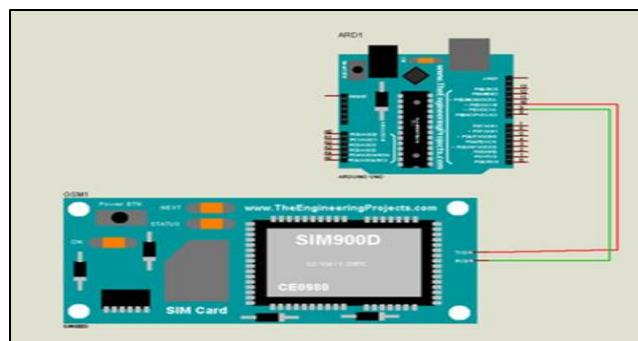


Fig. 3. Schematic Diagram of GSM Simulation

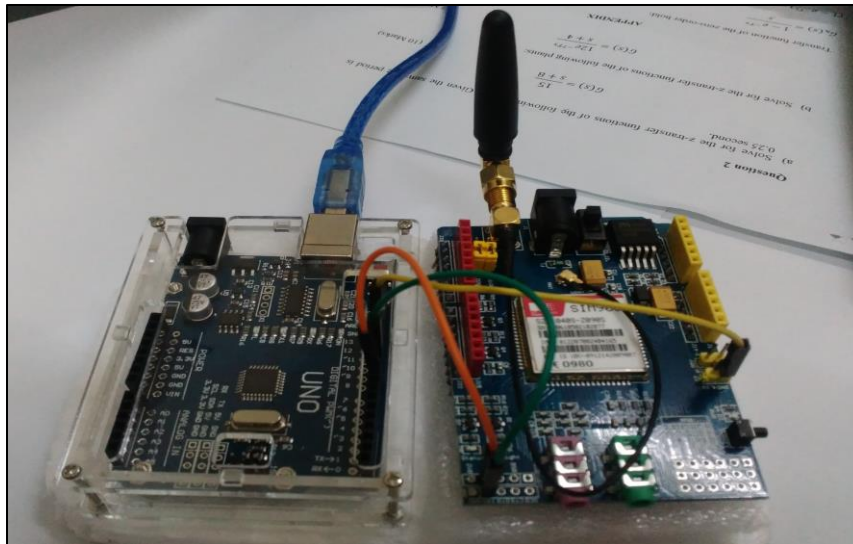


Fig. 4. Circuit Connection of Arduino Uno and GSM

The frequency band can likewise be set by AT Commands. The baud rate is configurable from 1200-115200 through AT command. The GSM or GPRS Modem is having inward TCP/IP stack to empower to interface with the web by means of GPRS. SIM900A is an ultra-compact and dependable remote module. The part of the hardware is operated without Arduino IDE programming since it straightforwardly direction from MATLAB. The guidance to control the GSM modem utilized AT direction on MATLAB. The order from MATLAB straightforwardly to work without Arduino programming.

Send message notification to need Arduino UNO as a medium between GUI to GSM. Global system for mobile communication (GSM) is for the process of sending data output of multiple images to the smartphone. Port 10 at Arduino connect port TX at GSM and port 9 at Arduino as port RX. Ground GSM is connected to ground Arduino. Figure 3 shows a schematic diagram and figure 4 is actual hardware connection.

3. Results and Discussion

Digital image processing deals with the influence of digital images over a digital computer. The result of segmentation shows as a figure 4 is the original image will be converted to a grayscale image to remove the color in images. Next, applied CHALE to stretch the contrast level of an image. This image must apply an average filter (Circular averaging filter (pillbox)) to clear and focus on the image. The circular averaging filter is calculated based on radius. The thresholding technique is used to separate background and object. Lastly, the dilated morphological to enlarge a region. This operator enlarges the boundary of foreground pixels, hence holes inside pixels become smaller.

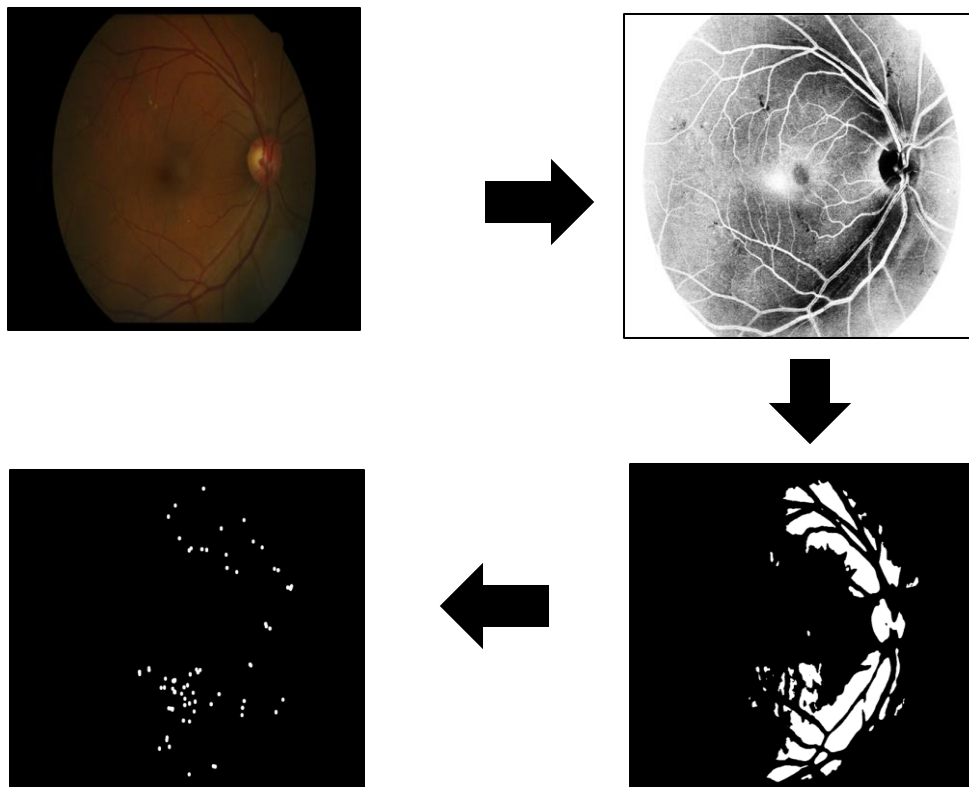


Fig. 5. Result of segmentation

The GUI is medium to show information of build up a discovery microaneurysm dependent on retinal image. Second, GUI likewise sending an SMS Image Quality Analysis (IQA) through GSM utilizing MATLAB programming to the smartphone. The framework can be used by a click on each button and it can make GUI entire process easier. In view of figure 6 until figure 10 show as the initial step is composed name and ID patient. Click upload data button to upload a retinal image. After that, the GUI is shown input image and proposed method image. In addition, there can save the proposed image or directly upload benchmark image to obtain the IQA results. Next, IQA results are acquired, a window that prompt the user to enter their mobile phone number will pop up and they can upload it to send SMS to the phone number. The SMS portable notice is utilized for the IQA results delivery medium, as it is more helpful and simple. SMS receiver does not need an internet connection but SMS just receiver user to have one SIM card for them receive and send an SMS. Next, the Send button on GUI is clicked, a mobile notification in the type of SMS will be sent to the devoted telephone number. As a result of receiver SMS appeared in Figure 10 comprises of two diverse IQA parameters which are accuracy and sensitivity. From the SMS, the receiver will know the efficiency of the proposed technique connected to their retinal image.

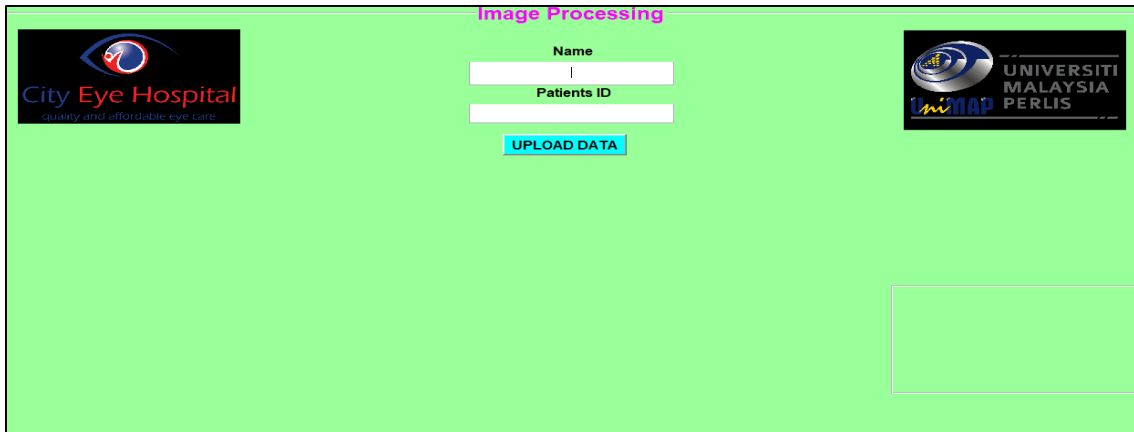


Fig. 6. Insert name and ID patient

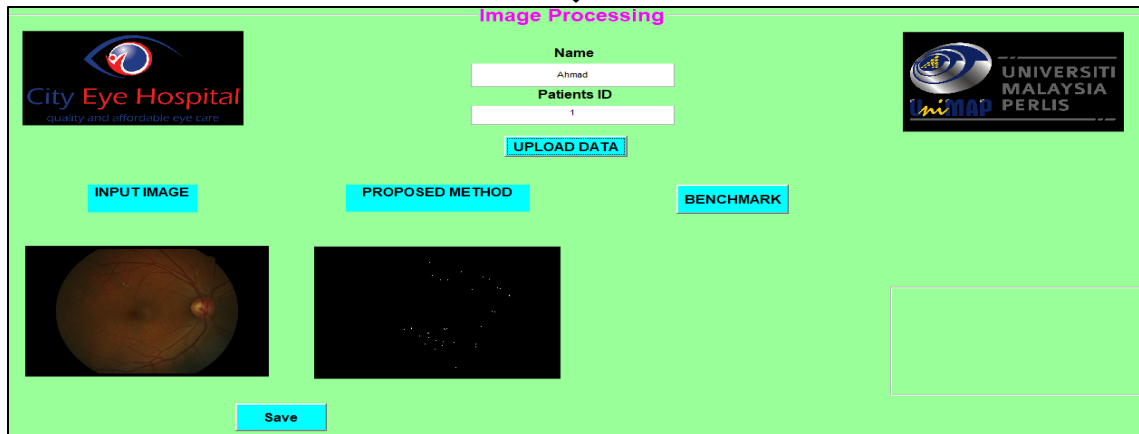


Fig. 7. Upload Data

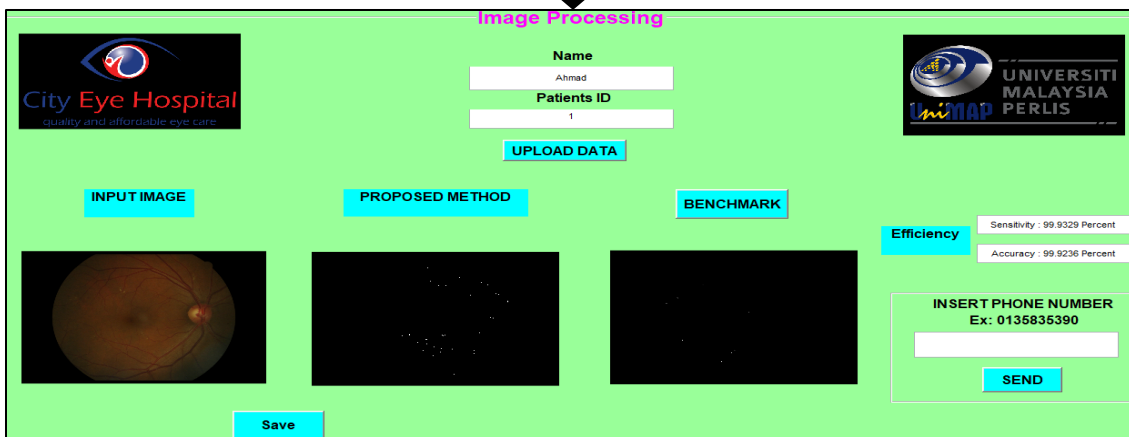


Fig. 8. Display Sensitivity and Accuracy

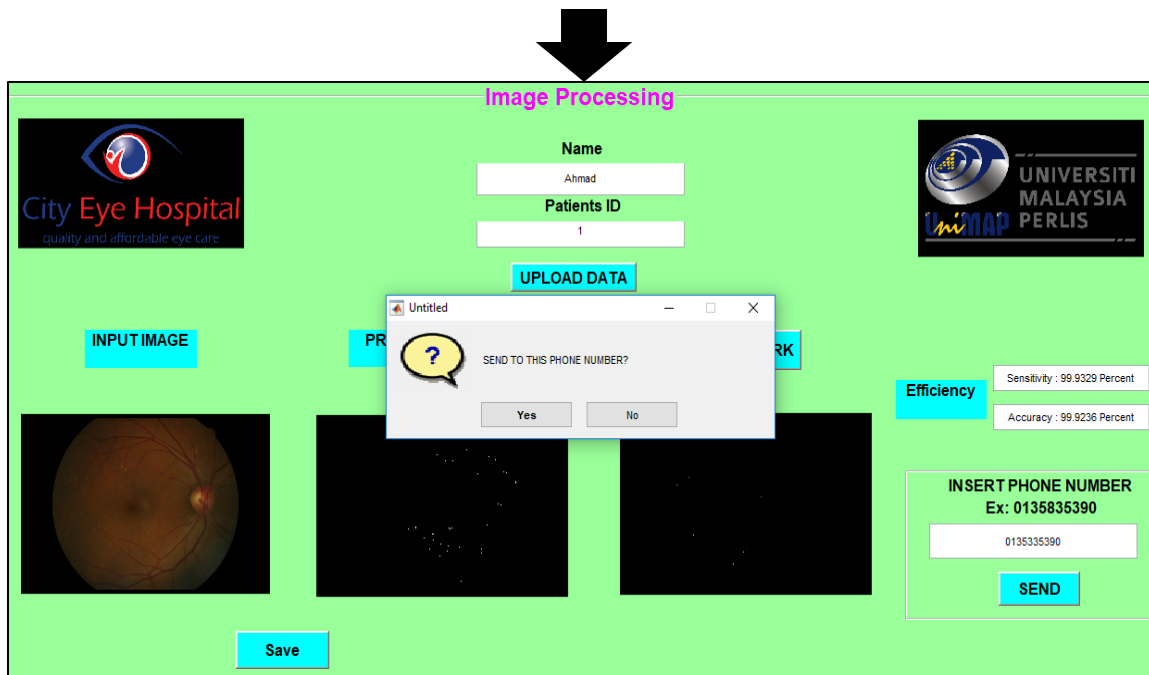


Fig. 9. Send Message to Mobile Phone

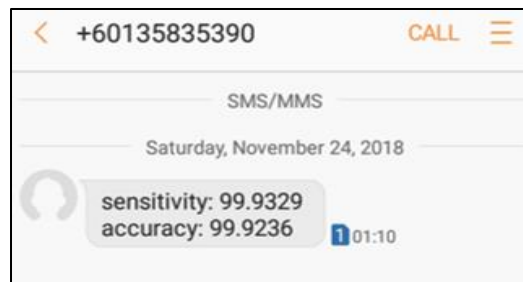


Fig. 10. Result on Smartphone using GUI Display

The result of sensitivity and accuracy is shown in Table 1.

Table 1
 The result of sensitivity and accuracy

Image	Sensitivity	Accuracy
1	99.9329	99.9236
2	99.9394	99.9344
3	99.8850	99.8349
4	99.9138	99.8947
5	99.9267	99.9090
6	99.9868	99.9610
7	99.8602	99.8373
8	99.9353	99.9266
9	99.9271	99.9044
10	99.9188	99.8981
Average	99.9088	99.8842

The results presented may facilitate improvements in the evaluation mechanism accurate in detection. The highest result of IQA for a total average of sensitivity is 99.9088% and accuracy is 99.8842%. The sensitivity and accuracy must be higher to the better-segmented image. The result is almost perfect because sensitivity and accuracy is nearly one hundred percent.

4. Conclusion

It was a process of detection microaneurysm in the retinal image. In this proposed method, it was designed to detect a microaneurysm using dilate morphologically. Dilate morphologically is enlarge the microaneurysm image. The Image Quality Analysis (IQA) which consists of accuracy and sensitivity. The proposed method is displayed in the GUI. It also performed for sending an SMS using a GSM and Arduino hardware. The Arduino is medium between MATLAB and GSM. Set a command in MATLAB to send Image Quality Analysis (IQA).

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