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Earlier Detection of Optic Neuritis Disease Using Cup-To-Disc Ratio in Fundus Images

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ABSTRACT: Early diagnosis of Optic Neuritis, which is a major indicator of Multiple Sclerosis, can halt or slow down the progression of the disease. Earlier works were based on algorithms like Entropy, super-pixel clustering etc. This paper describes an automated method for detecting the disease using cup-to-disc ratio (CDR) measurements. The intention of using Fundus Photography as the imaging modality is to allow the automated and quick analysis of the image with effective results. The CDR is one of the important parameter for indicating Optic cupping, which occurs in the optic disc for patients suffering from Optic Neuritis. Preprocessing technique such as Principal Component Analysis (PCA) has been applied. The optic disc and cup segmentation are performed using stochastic watershed segmentation and Threshold level set approach respectively. The testing was carried out with 20 samples. The methods used in the work results in comparatively faster and time saving process. Keywords: CDR, Optic Neuritis, Principal Component Analysis, Fundus image

I. INTRODUCTION

Optic neuritis (ON) is the most common cause of acute independent visual loss in young adults having a prevalence of 1–5 in 100,000 per year. Women are more often affected than men with peak materialization between the ages of 15 and 49. In this paper, we propose a method that uses Medical Image Processing in the form of MATLAB program to detect the presence of Optic Neuritis disease from Fundus images of the patients. Here, the Optic disc and Optic cup are segmented individually. The Cup-to-Disc Ratio (CDR) is then calculated. CDR remains the primary feature for analysing the images and detecting the presence of the disease. CDR values of above 0.4 are considered to be diseased to be exact, Optic Neuritis Condition.

II. LITERATURE SURVEY

"Measurement of optical cup-to-disc ratio in fundus images for glaucoma screening", Hanan Alghmdi, Hongying Lilian Tang, Morten Hansen, Arrianne O'Shea, Lutfiah Al turk, Tunde Peto, IEEE Publication, 2015 IWCIM October 2015

In this paper, superpixels clustering algorithm; simple linear iterative clustering (SLIC) and a feed-forward neural network classifier have been utilized. A set of superpixels features are extracted and then used for training the classifier.

To detect the optic disc and cup boundaries, the classifier is used to classify the superpixels in the region of interest.

"Application of Principal Component Analysis in Automatic Localization of Optic Disc and Fovea in Retinal Images" Asloob Ahmad Mudassar and Saira Butt, Hindawi Publishing Corporation Journal of Medical Imaging, Volume 2013, Article ID 989712

Principal component analysis (PCA) is one of the techniques that have been applied to segment the optic disc, but only a limited work has been reported. The PCA was trained on optic discs and foveae using ten retinal images and then applied on seventy retinal images with a success rate of 97% in case of optic discs and 94.3% in case of fovea. Results are presented to validate our idea.

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"Segmentation of the Blood Vessels and Optic Disk in Retinal Images",Ana Salazar-Gonzalez, Djibril Kaba, Yongmin Li, and Xiaohui Liu, IEEE Journal of Biomedical and Health Information, Vol.18 No.6, November 2014

In this paper, we present a novel method to segment blood vessels and optic disk in the fundus retinal images. Our method takes as first step the extraction of the retina vascular tree using the graph cut technique. The blood vessel information is then used to estimate the location of the optic disk. The optic disk segmentation is performed using two alternative methods.

III. METHODOLOGIES AND APPROACH

1. FUNDUS PHOTOGRAPH

The fundus is the back of the eye and includes the vessels. Fundus photography involves photographing the rear of an eye; also known as the fundus. Fundus photography is the process of taking serial photographs of the interior of your eye through the pupil Specialized fundus cameras consisting of an intricate microscope attached to a flash enabled camera are used in fundus photography. The main structures that can be visualized on a fundus photo are the central and peripheral retina, optic disc and macula. Fundus photography can be performed with colored filters, or with specialized dyes including fluorescein and indocyanine green. The models and technology of fundus photography have advanced and evolved rapidly over the last century. Fundus photography documents the retina, the neurosensory tissue in our eyes which translates the optical images we see into the electrical impulses our brain understands.

Fig. fundus image of right eye

2. FUNDUS CAMERA

The optical design of fundus cameras is based on the principle of monocular indirect ophthalmoscopy. A fundus camera provides an upright, magnified view of the fundus. A typical camera views 30 to 50° of retinal area, with a magnification of 2.5x, and allows some modification of this relationship through zoom or auxiliary lenses from 15°, which provides 5x magnification, to 140° with a wide angle lens, which minifies the image by half.

Fig. Fundus Camera

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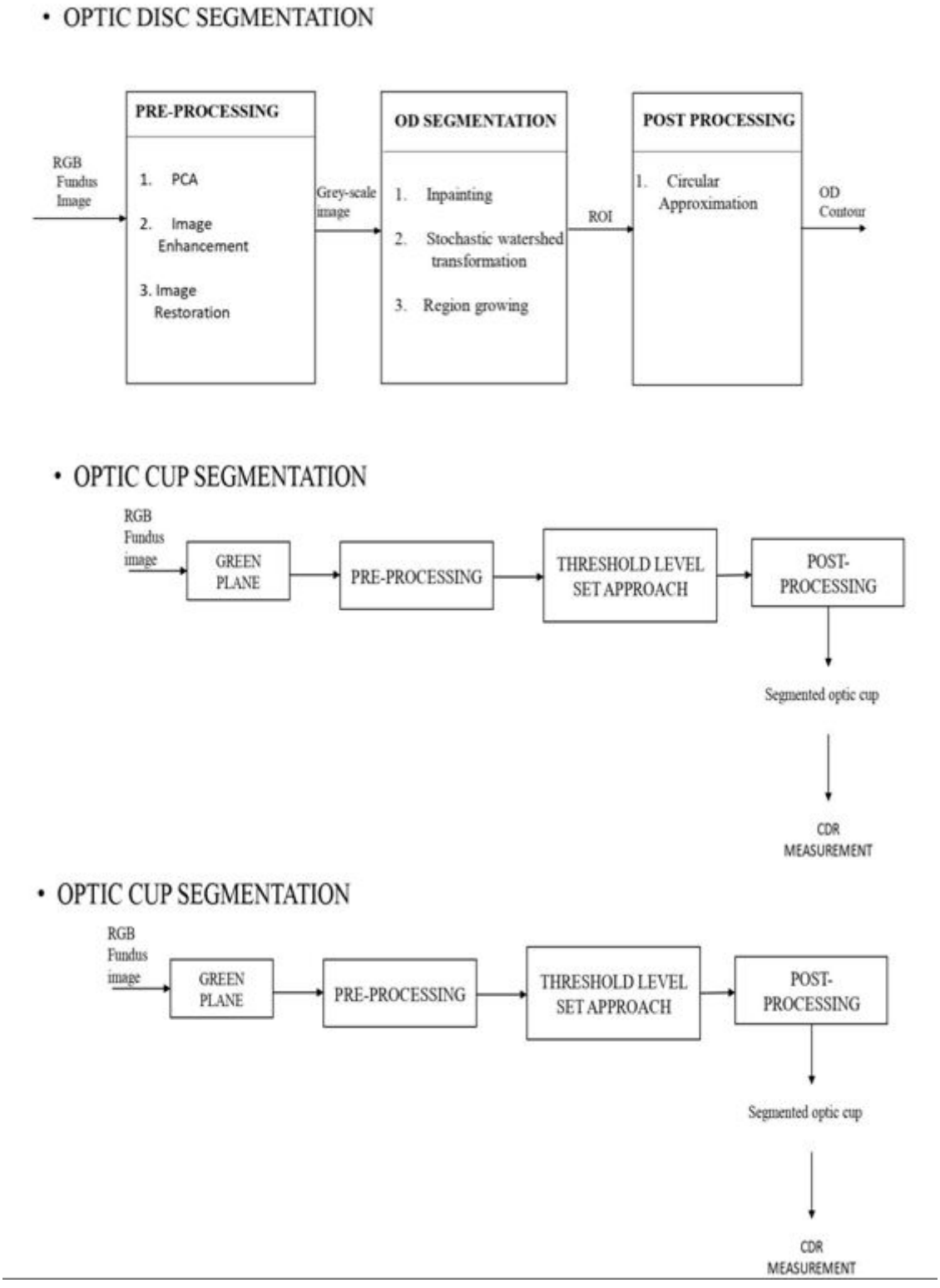
3. PROPOSED BLOCK DIAGRAM



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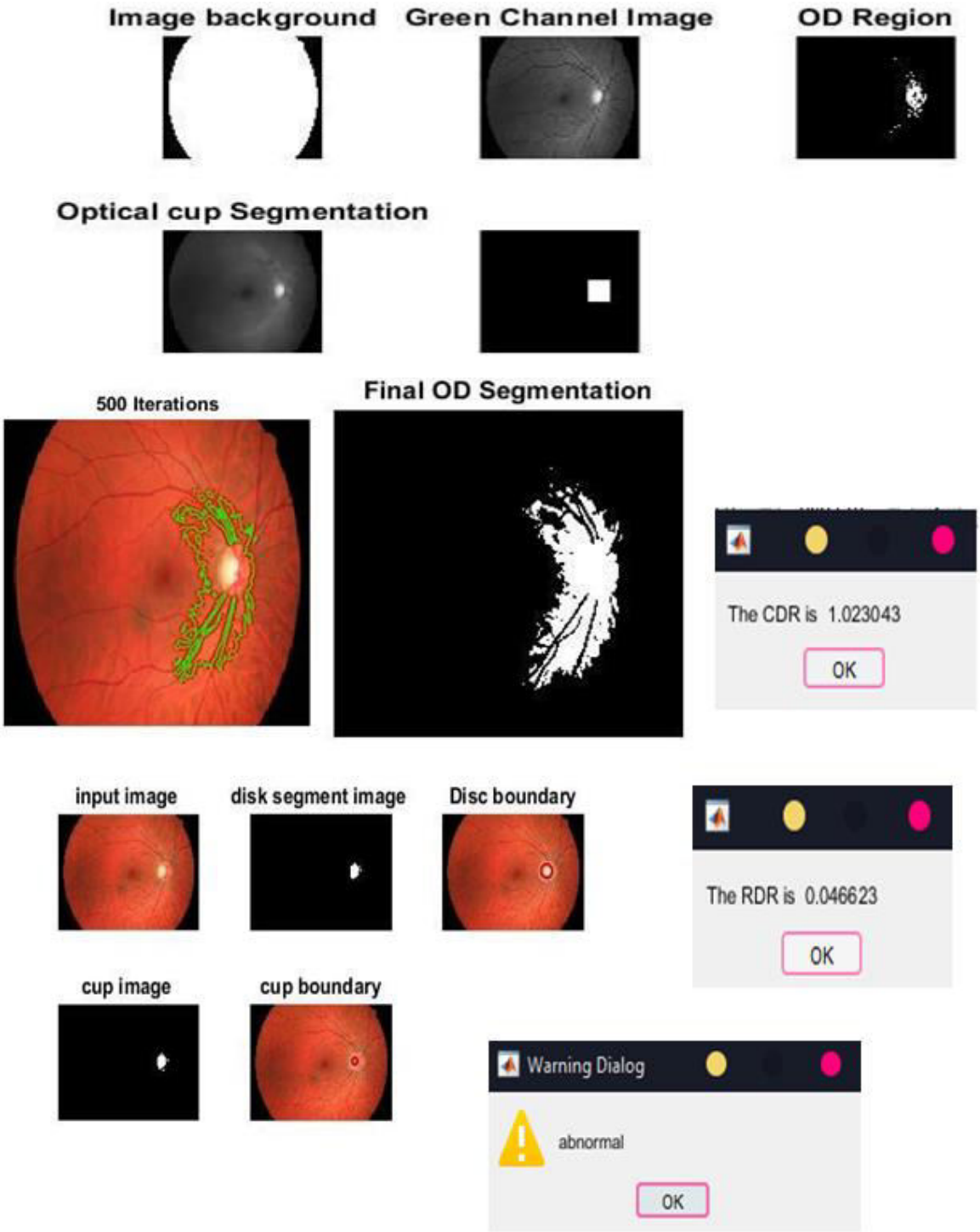
IV. RESULTS & DISCUSSION

OUTPUT FOR OPTIC NEURITIS CONDITION



The results presented in this paper show that the proposed methodology offers a reliable and robust solution for Optic disk and Optic Cup Segmentation. The algorithm had been trained for about 50 healthy and diseased samples. After successful training, 20 sample fundus images were given as input to the algorithm in the DICOM format. DICOM standard provided better resolution than normal JPEG format. The CDR and RDR were calculated for every sample and the resulting output showed abnormality, if any. According to the values obtained, they are classified as Normal or

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Abnormal. The disease is detected if the conditional output is 'Abnormal'.

V. CONCLUSION AND FUTURE WORK

The algorithm has been validated on five different public databases obtaining promising results and improving the results of other methods of the literature. The final goal of the proposed method is to make easier the early detection of diseases related to the fundus. Its main advantage is the full automation of the algorithm since it does not require any intervention by clinicians, which releases necessary resources (specialists) and reduces the consultation time, hence its use in primary care is facilitated. This work has been mainly focused on the use of Cup-to-disc ratio (CDR) primarily for classifying the images into healthy or diseased. The future work can be focused on using Rim-to-Disc Ratio(RDR) as a primary feature for detecting the optic neuritis disease. Further works based on Classification of the ON diseases based on the enlargement of the cup can also be studied.

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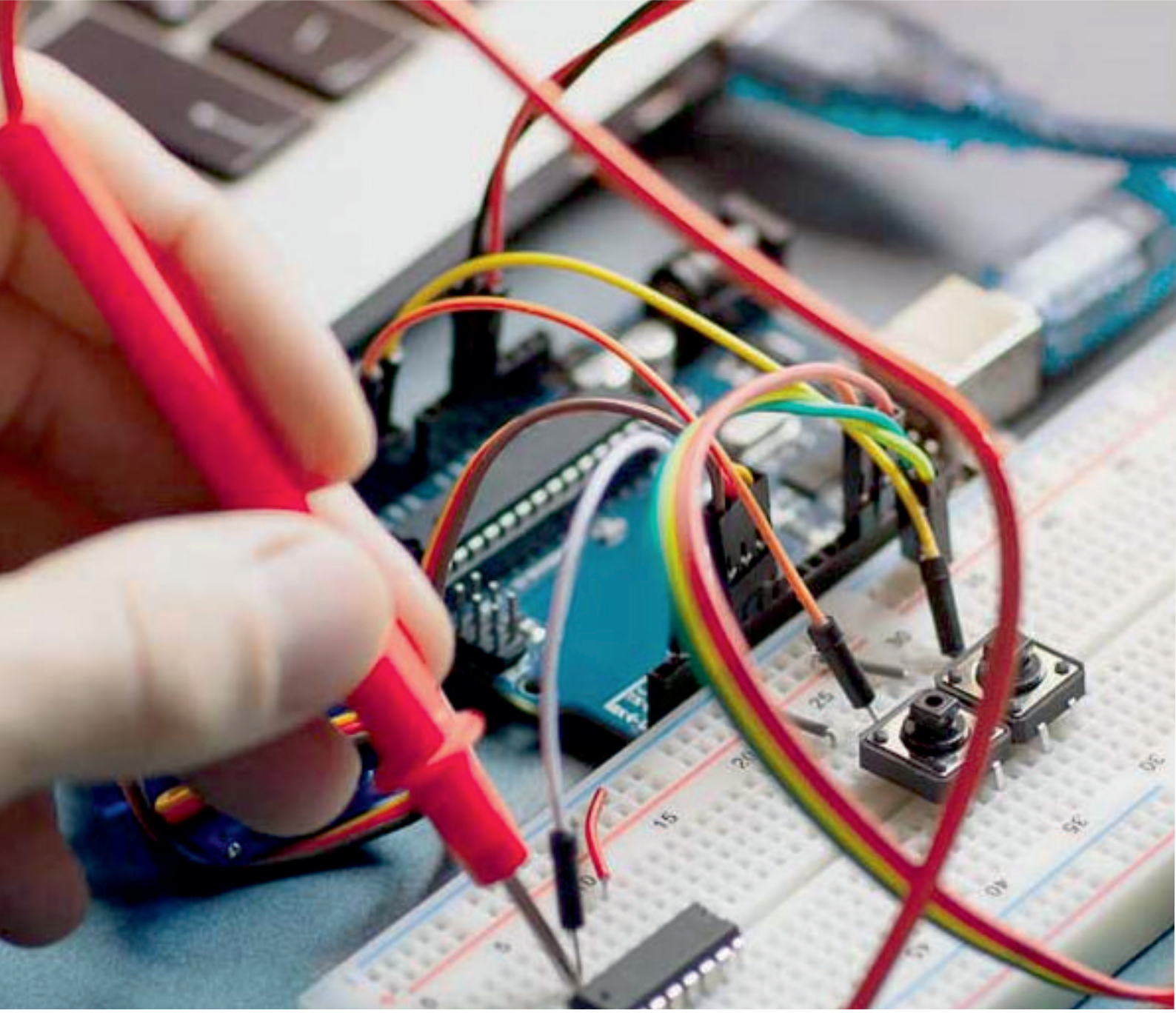

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