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A Hybrid Image Processing Approach to Examine Abnormality in Retinal Optic Disc

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Abstract

In ophthalmology, retinal optic nerve and disc inspection is a generally adopted procedure to diagnose a variety of diseases, such as aging, diabetes, optic neuritis, glaucoma, papilloedema and ischaemic optic neuropathy. The paper presents a new method to examine the retina for diseases. Initially, examination of optic disc is considered. During this process, the optic disc recorded using a dedicated digital camera is scrutinized by means of a preferred image processing method in order to mine and appraise the infected section. After receiving the necessary information concerning the disease, the essential treatment procedures are deliberated to limit/cure the disease. This work implements a hybrid approach based on the heuristic algorithm supported multi-level thresholding and image segmentation. This approach is experimentally inspected using the well known RIM-ONE benchmark retinal database. This work implements the pre-processing based on Jaya algorithm guided Shannon's thresholding and post-processing based on the distance regularized level set segmentation. The performance of the proposed segmentation process is then confirmed with the approaches, such as the watershed and Chan-Vese procedures. The extracted optic disc is then compared with the ground truth images provided by the ophthalmologist. The investigational result illustrates that, proposed approach tends superior average values for image similarity and statistical index compared with the alternatives. This confirms that, proposed hybrid approach can be used in future to evaluate the clinical relevance retinal images.

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1. Introduction

In medical domain, image processing approaches are commonly adopted to examine the nature and harshness of

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diseases using the medical images recorded by a range of imaging procedures [1-9]. The imaging procedures can be used to record the picture of the internal or the external organs. After recording the image, an appropriate imaging procedure, with a semi-automated/automated disease investigative procedure is to be implemented to identify the cause, stage of infection, harshness, infected section and other related information.

In this work, a novel, soft-computing associated tool is proposed to examine the irregularity in retinal optic disc. Eye is a vital external organ, responsible to send the visual signals to the brain. In the eye, the innermost and the significant element is the optic disc. Retinal picture assessment is one of the major investigate domains, generally considered to examine the structural and bodily deviation of retinal blood vessel, optical nerve, and optic disc in order to predict the nature of eye disease and severe diabetes [10-15].

The retinal optic disc (ROD) pictures recorded with a fundus camera [16,17] or a particular digital camera can be considered to identify retinal vasculature [10,11], diabetic retinopathy [12], ocular hypertension (OHT) [15], optic nerve disorder [13,14], macular edema [16], and glaucoma [17]. Early research work confirms that, examination of optic disc and retinal vessels are adequate to recognize a range of retinal disease and this testing comprise the modification in silhouette, dimension, and exterior of disc/vessel sectors.

The aim of the research is to suggest a hybrid image processing tool to examine the digital ROD existing in RIM-ONE database. This work implements the combination of the multi-thresholding to pre-process the test image and segmentation to extract the region of interest.

This work implements the Jaya algorithm [18-20] and Shannon's entropy [21,22] based multi-thresholding to pre-process the test image and also implements well known segmentation procedures to extract the ROD from the pre-processed test image. Finally, a relative examination between the mined ROD and ground truth images are carried and the wellknown image similarity measures [23,24] and the image statistical measures [16] are calculated. The experimental work is implemented using the MATLAB software, and the result of this study confirms that, Distance Regularized Level Set(DRLS)[25] approach offers better throughput compared to watershed and Chan-Vesemethods.

2. Methodology

This section presents the methodology proposed in the research work to evaluate the ROD. Fig 1 depicts various stages existing in this hybrid tool.

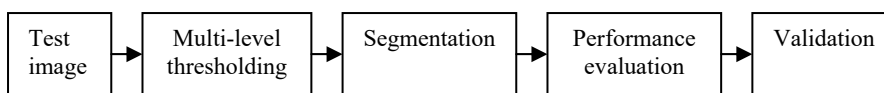


Fig. 1 Block diagram of proposed hybrid tool

2.1. Multi-Level Thresholding

Multilevel thresholding is used to segment the ROD image into several distinct regions, which enables the examination and accurate diagnosis of the various possible diseases.

The chosen test image is initially pre-processed by means of the multi-thresholding procedure with various threshold (Th) levels. This work implements Jaya Algorithm and Shannon's Entropy (JA+SE) based procedure to implement the pre-processing operation. The JA+SE can be used to enhance the ROD by grouping the similar pixel values based on the assigned Th .

2.1.1 Shannon's Entropy

Entropy assisted procedures are extensively considered to assess medical images [6,8,10,11]. In this work, Shannon's Entropy (SE) is considered to pre-process the digital ROD images and the mathematical expression of SE is existing in Paul and Bandyopadhyay [22].

Consider a RGB picture of size $M*N$, then the pixel through the coordinate (x, y) is defined as $F(x, y)$, for $x \in \{1,2,3,\dots,M\}$ and $y \in \{1,2,3,\dots,N\}$.

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