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SEGMENTATION OF DIABETIC RETINOPATHY IMAGES THROUGH A SUBJECTIVE APPROACH

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Abstract

Microvasculature change accompanying with persistent Hyperglycemia (High Blood Glucose) are the unpleasant things associated to diabetes mellitus. With the development of intelligent systems the detection of pathologies is made simple. Proliferative Diabetic Retinopathy is a chronic state in which new abnormal blood vessels grows in the fundus of eye. These are sensitive and are ruptured easily leaking blood, protein based exudates. Early detection of such symptoms may protect the patient from severe vision loss. In this paper we proposed an Image Segmentation algorithm, called Gaussian Expectation Maximization, which uses a probabilistic approach for expecting the data with maximum likelihood estimate.

Keywords: *Diabetic Retinopathy, Expectation maximization, Gaussian Mixture Model.*

1. INTRODUCTION

Diabetes Mellitus (DM) is defined as a metabolic disorder of multiple aetiologies characterised by chronic hyperglycaemia with disturbances of carbohydrate, protein and fat metabolism resulting from defects in insulin secretion, insulin action, or both [1]. The symptoms include frequent urination, increased dehydration and appetite. It is classified as Type 1 and Type 2 DM. Type 1 also called Insulin dependent diabetes mellitus (IDDM) which is a resultant of lack of sufficient insulin generation in the body. Whereas in Type 2 DM the tissue cells fails to use the insulin properly. Also in ladies during their gestational period may be caught with this complication. The disease progresses from Acute to Chronic complication. In the Acute state there exist a possibility of ketoacidosis and nonketotic hyperosmolar coma. AT the advanced stage (Chronic) it leads to cardiomayopathy, Retinopathy and Nephropathy complications. Diabetic retinopathy is the most well-known ocular complication of diabetes and the leading cause of blindness among people 20–64 years of age in the U.S. (2). Control of glucose levels can reduce the risk of retinal damage and slows down the advancement of this pathos. Even it reduces the ill effects of damage to other organs. DR is classified in two types: Non Proloferative and Proliferative. Proliferative refers the existence of NEOVASCULARIZATION. If the retina don't suffer from this then it is treated as Non Proliferative. In Non Proliferative Diabetic Retinopathy (NPDR) high levels of Glucose (Hyperglycemia) consequences in injury to retinal vessels. The Capillaries swells (microaneurysms) and may get ruptured and forms haemorrhages in the fundus. As the disease turn chronic (Proliferative Diabetic Retinopathy (PDR)), the capillaries leak blood, cholesterol and protein based particles in the fundus. These leaked particles are named as Exudates which obstructs the light propagation from eye pupa to the retina and then it leads to distorted vision.

2. ALGORITHM

A. Expectation Maximization (EM)

Expectation-maximization (EM) algorithm is an iterative method that computes maximum-likelihood estimates in a given data or image. EM, an unsupervised approach aims for density estimation of data points. This is a standard approach for minimizing problems with maximum

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likelihood approach. It involves two stages; in E-stage we calculate the probability (expectancy) and in M-stage the boosting (Maximization) of the likelihood estimates is done. This process is iteratively preceded till convergence happen. The EM algorithm is used for the exploration of the constraint accomplishing the maximum likelihood. The benchmarks of halt of the process, is whichever an extreme number of repetitions to limit the calculation time, or a minor error. It is laid effortlessly in use as it inclines on the calculation of the whole information. The drawback of EM is, it does not directly incorporate spatial modelling and can therefore be sensitive to noise and intensity inhomogeneity [4].

B. Gaussian Mixture Model (GMM)

The application of standard GMM yields optimum segmentation results. Let X be a random variable that takes image pixel values. This Gaussian distribution is represented mathematically as:

$$f(x) = \sum_{i=1}^{k} p_i N(x \mid \mu_i, \sigma_i^2), \quad (1)$$

where k is the number of components or regions and $p_i > 0$ are weights such that $\sum_{i=1}^{k} p_i = 1$,

$$N(\mu_i, \sigma_i^2) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-(x-\mu_i)^2}{2\sigma^2}\right), \quad (2)$$

where μ_i, σ_i^2 are mean and standard deviation of i^{th} class. For a given image X, the lattice data are the values of pixels. However, the parameters are $= (p_1, \ldots, p_k, \mu_1, \ldots, \mu_k, \sigma_1^2, \ldots, \sigma_k^2)$.

The use of the GMM segmentation procedure can produce a worthy grouping of the internal pels to the region of interest and even fits to the noisy pels, but produces a deterioration of the contours between the two regions. Of this study the advantage and the inconvenient of the use of the grey level and the spatial feature for the noise and the contours classification [5][6].

Results

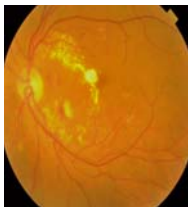

Fig 1: Diabetic Macular Edema

Figure 1 shows fundoscope image of typical Diabetic Macular Edema. Hard exudates are observed near to optic disc.

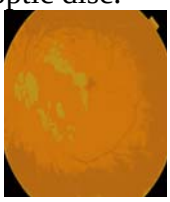

Fig2: Expectation Maximization

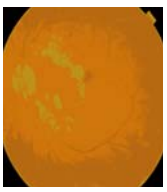

Fig3: Gaussian Expectation Maximization

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Figure 2 represents the Expectation maximization (EM) output. It can be observed that the exudates are segmented properly. But direct utilization of EM may also leads to enhance noise.
Figure 3 represents the resultant of Gaussian Expectation Maximization (GEM) which looks almost identical to Figure 2. But it is noise free as the original image Smoothened by Gaussian filter.

Table 1: Statistical analysis:

	MSE	PSNR
Figure 2 [EM]	0.24	52.05
Figure 3 [GEM]	0.00013	142.069

CONCLUSION

The qualitative and quantitative analysis reveals the significance of the proposed approach. Further direct utilization of Gaussian smoothening filter may results in loss of some edge information. Edge preserving smoothening will help in attaining optimum results through this approach.

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