Review of paper on statistical denoising and segmentation

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1 Introduction

The paper proposes a six step algorithm to denoise OCT images and identify the six retinal layers. Subsequently the thickness of the layers are found out. This is an important feature for disease detection. The algorithm identifies the following six layers in the image: nerve fiber layer (NFL) inner plexiform layer (IPL), inner nuclear layer (INL), outer plexiform layer (OPL), outer nuclear layer (ONL), photoreceptor outer segments (POS).

2 Algorithm

2.1 Step 1: Alignment of the A-scans

An OCT B scan consists of several A scans. The A scans constitute the columns of a B scan. Often the misalignment of the A scan columns can occur. They can be realigned with the help of a referance layer which is assumed to be straight. retinal pigment epithelium (RPE) inner boundary, bottomost contour marked in figure.

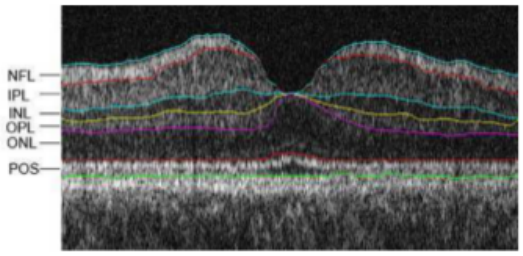

Figure 1: Layers of the eye

In order to detect the edges corresponding to this layer, a two step approach is used. A Gaussian filter with $\sigma = 10$ is initially used and few prominent edges are choosen. Next $\sigma = 3$ is used and here more edges are identifiable. Only the ones coinciding with the first pass are taken. These correspond to the RPE, using these edges the A scans are aligned. The Gaussian filtering done here does not affect the subsequent steps of the algorithm. It is only used for the purpose of detecting the RPE and aligning the A scans.

2.2 Step 2: Pixel mapping

Certain edges between layers are more prominent than the others, for eg. NFL to ganglion cell layer represents a change in approximate gray level value from 1800 to 1100 (12-bit data), whereas a transition from OPL to ONL translates to a change in approximate gray level value from 1200 to 900. In order to make all edges equally prominent, the pixel intensities are mapped using the following functions. $G_i(x,y) = 0.5(1 + \frac{erf(f(x,y)-t_i)}{\sqrt{2}\sigma_i^2})$ To determine t_i and σ_i we feed the pixels which are between the RPE and ILM to the expectation maximisation algorithm. It is assumed that the pixels in this region are a combination of three Gaussian distributions. The EM algorithm provides a maximum likelihood estimate of the means and the variances using which the values for σ_i and t_i are fixed. Here we have i=1,2 i.e two mapping functions G_1 and G_2. the boundary between NFL and IPL+GCL and the boundary between IS/OS and RPE was determined with G1, while the remaining boundaries were determined with G2. The plots are as shown.

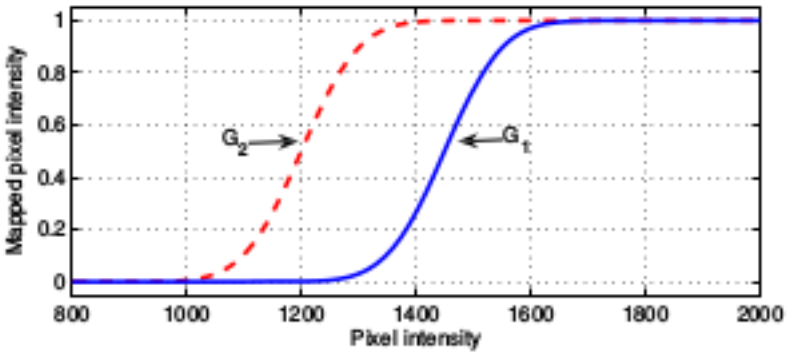

Figure 2: Mapping functions