Progress Toward System-Independent Image Analysis: An Example from Texture Analysis in Optical Coherence Tomography

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1: Optical Coherence Tomography (OCT)
Optical coherence tomography is an optical imaging technique analogous to ultrasonography that uses near-infrared light to create cross-sectional images of subsurface microstructure. A series of reflectometric images is captured, with a resolution of 10–20 μm or less. Using interferometry, a map of optical reflectivity versus depth can be created.

OCT has been shown to produce images with high spatial resolution, but due to the high level of scattering of near-infrared light in biological tissues, penetration depths range from only 1 to 2 mm.

2: Previous Study: Bladder Tissue Differentiation Using Texture Analysis

An algorithm was developed to discriminate cancerous from non-cancerous tissue in the bladder, using Optical Coherence Tomography and texture analysis. The algorithm, which had a sensitivity of 92% and a specificity of 82%, was trained using a leave-one-out cross-validation approach, was developed using images taken in vivo.

3: Texture Information from Blank Image

Texture features were calculated for a few "blank" images from each system. Images of areas assumed to be without structures (imagery of air or saline) were collected. The texture features of the blank images were then compared with the texture features for all of the images taken with a different system. The data points were color-coded based on the system used.

There were some features, most of which were measures of the amount of energy in specific areas of the Fourier spectrum. In which the texture features for the blank images fell in the same or similar ranges as the images themselves. The algorithm was shown when a particular system may provide a texture feature to be considered when selecting a system configuration.

4: Texture Information from Background Within Images

4.1: Texture Features from Background Within Images

The texture features were calculated for the background portion of each image in both data sets, and the results were plotted. The Lees' texture features were particularly useful in differentiating between systems.

5: Correcting for Known Parameters

There are certain parameters that can be considered when selecting a system. These parameters include the system's resolution and imaging depth, which in turn affect the sensitivity of the OCT signal. This information can be used to adjust the focusing parameters in a system.

We evaluated the effects of normalization and rescaling images on the feature values by using values for image width, image depth, and intensity range in both sets of images.

6: Conclusions

To develop algorithms that are system-independent, it is necessary to understand the system's performance differences, which can be achieved by studying the effects of OCT system differences. We developed a method for recognizing and compensating for these differences.

We have determined:
1) System parameters affect the results of structure and texture features; these features can be used to differentiate between systems.
2) 'Blank' images can be used to identify differences in configuration.
3) Texture analysis can compensate for differences in the background parameters of systems.
4) Known system or configuration parameters can be used to compensate for the differences between systems.