Wavelet Denoising of Multiple-Frame OCT Data Enhanced by a Correlation Analysis

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Purpose

Speckle noise suppression on OCT images is currently performed by averaging multiple frames. In contrast to this common approach we propose a novel wavelet merging method that uses the structural properties of the actual image content to better differentiate between speckle and relevant tissue information.

Data

355 linear B-scans were acquired from a pig’s eye ex vivo with a Spectralis HRA+OCT, Heidelberg Engineering. Correlated noise was avoided by slightly moving the eye every 13 frames. All images are rigidly registered and averaged to form a noise suppressed gold standard.

Method

Each of the recorded single B-Scans is decomposed by a wavelet analysis, resulting in approximation coefficients AI and detail coefficients WI, i (i: Decomposition level, f: Frame number, d: Detail coefficient direction).

The signal-to-noise (SNR) ratio gain compared to the mean image (SNRG) is measured in selected regions of interest (see Figure 1). The noise is estimated on each image by subtracting the gold standard image, which is assumed to be nearly noise free. The sharpness reduction (SR) at selected borders is computed using Full-Width-Half-Maximum (see Figure 1). The evaluation is performed for each parameter set and method on 10 sets of 8 randomly selected frames. The results are averaged over these sets.

Results

The signal-to-noise (SNR) ratio gain compared to the mean image (SNRG) is measured in selected regions of interest (see Figure 1). The noise is estimated on each image by subtracting the gold standard image, which is assumed to be nearly noise free. The sharpness reduction (SR) at selected borders is computed using Full-Width-Half-Maximum (see Figure 1). The evaluation is performed for each parameter set and method on 10 sets of 8 randomly selected frames. The results are averaged over these sets.

Conclusion

1. With 8 recorded frames we reach an SNR that is comparable to an averaging of 35 frames.
2. A visual and quantitative evaluation shows: Nearly no detail or sharpness loss.
3. Proposed main application: Data preprocessing for segmentation tasks.

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Commercial Relationship

The authors declare that there is no conflict of interest.

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