A Modified U-net for Dispersion Compensation of Optical Coherence Tomography Simulated Layered Images

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Motivation - OCT

Dispersive sample causes different wavelengths lights travel at different velocities → broadens the peak and shifts the layers.

New Technique

[S. Ahmed et al.]

Modified U-net

- Data: custom OCT simulation, different number of layers, different amount of dispersion, different noise levels, different illuminations profiles.
- Axial shift correction: cross-correlation with circular shifting.
- Network training: ~1.9 million parameters. Optimizer: Adam SGD + L2 loss.
- Colab training time: 13 mins.
- Model evaluation: PSNR evaluation.

Data preparation → Axial shift correction → Training deep net → Model evaluation

Related Work

- Lippok et al.: Fractional Fourier transform.
- Cense et al. and Wojtkowski et al.: spectral domain phase correction mask - $e^{j\phi(k)}$, where $\phi(k)$ is found by optimizing a custom sharpness function.

Experimental Results

Uniform illumination

Gaussian illumination

Uniform illumination: average PSNR ~ 37 dB.
Gaussian illumination: average PSNR ~ 41 dB.
It is interesting that training with additive noise seems to have better performance for the case of uniform illumination.

References

[1] N. Lippok, "Dispersion compensation in Fourier domain optical coherence tomography using the fractional Fourier transform", Opt. Express 20, 23398-23413 (2012)

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[3] M. Wojtkowski, "Ultrahigh-resolution, high-speed, Fourier domain optical coherence tomography and methods for dispersion compensation," Opt. Express 12, 2404-2422 (2004)