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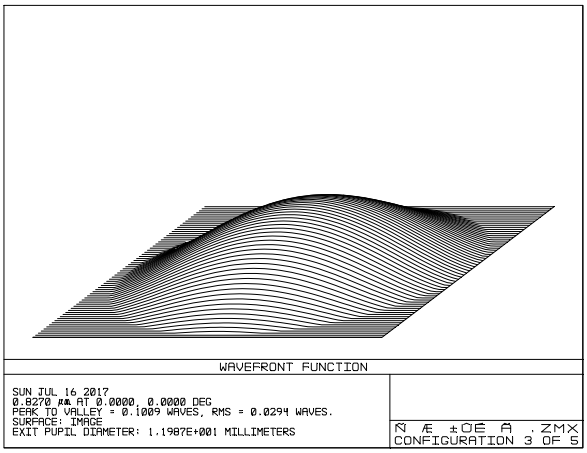
Resolution improvement for SD-OCT system based on Zemax

Xuya Zhang, Yongkai Zhu*, Xinhua Zhang and Mingcan He

College of Automation, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China



Wavefront map of the system after optimization.

Abstract: Spectral domain optical coherence tomography (SD-OCT) is a non-invasive cross-sectional imaging method that has been developed to obtain high-resolution tomographic images of biological, organic and inorganic objects. The high resolution, imaging depth, acquisition speed, and sensitivity of the SD-OCT system are significant for medical imaging. However, there are many negative factors which will result in lower system resolution. For example, if the field lens in sample arm is not appropriate, the lateral resolution will decrease. Similarly, if the focusing lens in spectrometer cannot provide the focal spot with a smaller size comparing with the pixel width of CCD, it will bring interference in each pixel of CCD, and the resolution of the spectrometer will decrease. As a result, the design and optimization for lens group in SD-OCT system are fairly important to the resolution and imaging quality. The aim of this study is to provide higher resolution of the system by designing and optimizing the lens group in sample arm and spectrometer based on Zemax, which can provide the optical designer with spot diagram, geometric aberration, optical transfer function and other means of analysis used to assess the imaging quality. The field lens in sample arm and the focusing lens in spectrometer are designed, and the imaging quality is evaluated according to spot diagram and wavefront map. The results indicate that the field lens can bring ideal lateral resolution of 7.9 μm, which is sufficient for high-resolution imaging. And the focusing lens in the spectrometer makes the size of focal spot smaller than the pixel width of CCD to avoid the interference in each pixel of CCD. In this way, we observe considerable improvement in the resolution of the spectrometer, and the signal-to-noise ratio of the system is improved, too. After design and optimization with Zemax, we measured the lateral resolution of the system with the USAF1951 resolution board. The results show that the lateral resolution is 12 μm, which differs from the simulation value by 5.1 microns. Then we calculate the resolution of the spectrometer with the focusing lens we designed. It turns out that the resolution of the spectrometer determined by the pixel width of CCD is 0.0363 nm. In conclusion, the simulation results, experimental results and calculation results show that the lens group we designed can achieve good resolution and imaging quality, and provide a strong theoretical basis for the processing of the device.

Keywords: Zemax; SD-OCT; resolution; optimization

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