Diffraction method for finding the focal plane location of a lens

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Abstract

We demonstrate here an accurate method for finding the location of the focal plane of a converging lens. A beam of monochromatic light is passed through a single slit. The diffracted rays are then focused by a converging lens to form a diffraction pattern on a CCD sensor. The position of the CCD is adjusted to find the location for the Fraunhofer diffraction image. Since each position on the image is contributed from a set of parallel diffracted beams incident on the lens, position for the Fraunhofer image is exactly the location of the focal plane of the lens. The root-mean-square errors, or RMSE, of the normalized intensity distribution of the diffraction image compared with the square of cardinal sine function are calculated for several positions of CCD. An optimization algorithm can then be applied to find the position of CCD with minimum RMSE. Metrological analysis for the uncertainty of the RMSE is applied to indicate the accuracy of the focal plane location. The advantage of our method is on its simplicity. There is no need of special setup or complicated optical alignment. Also, the information of light source wavelength, slit width, and focal length of the lens are not necessary. We have tested our method with several converging lens. The location of the focal plane with millimeter accuracy can be easily obtained.

Keywords: focal plane, converging lens, Fraunhofer diffraction pattern, optimization