Quick Aligning Telescopes

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Many people enjoy looking through telescopes into the night sky as a hobby, and many people use them as a means of learning more about our universe. To work properly, telescopes must often be precisely aligned by minutely manipulating each individual element. I planned to design a method to quickly and accurately align a simple refractive telescope. My design goal was to efficiently align a Keplerian telescope to the accuracy to which its lenses were manufactured. Before aligning the optical elements in the Keplerian telescope, I characterized the aberrations as a result of specific misalignments of the telescope's elements. Since the telescope is radially symmetric, there are only three unique degrees of freedom to misalign. Using an optical design platform (Zemax OpticStudio), I verified the aberrations I measured. I matched these aberrations to the coefficients of Zernike polynomials. In characterizing the telescope, I discovered that the aberrations caused by one of the degrees of freedom could be easily corrected by changing view angles, eliminating it. Because I characterized the change in Zernike coefficients as a function of misalignment, I created a method to fit three random misaligned points to the function, align one degree of freedom, take two more points, and align the second degree of freedom. The method reached the accuracy goal, and was significantly more efficient than linearly adjusting the degrees of freedom in small steps. The process aligned the telescope to within the accuracy goal on the first iteration. The process is methodical enough that given future work, it could easily be automated.

Awards Won:

SPIE, the international society for optics and photonics: Third Award of $1,000