

# On-orbit camera self-focusing with conjugated optical fiber waveguides

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## Abstract

High-precision focusing of space optical cameras is the prerequisite for capturing high-quality images in earth observation applications. We propose a real-time self-focusing method using conjugated optical fiber waveguides which can measure the focal length of on-orbit cameras in real time. We use two conjugated optical fiber waveguides. At one end of each waveguide, there is a light source located external to the camera. The light is guided into the focal plane of camera and it acts as an infinite point target. Contrary to image processing algorithm, our method is based on the optical components for focusing.

## Methods

In the proposed method, additional optical components are added to the original. This second set of components is comprised of a dichroic filter, two optical fibres, beam splitter and a CMOS. These fibers are installed on the optical plane. In this paper, we use the relative distance shift between two image spots on the CMOS to calculate the focal length. The change in focal length is produced by the original optical components of remote sensing cameras. The objective of our paper is to correctly measure this change in order to correct the distortion generated by movement of the original camera optics.

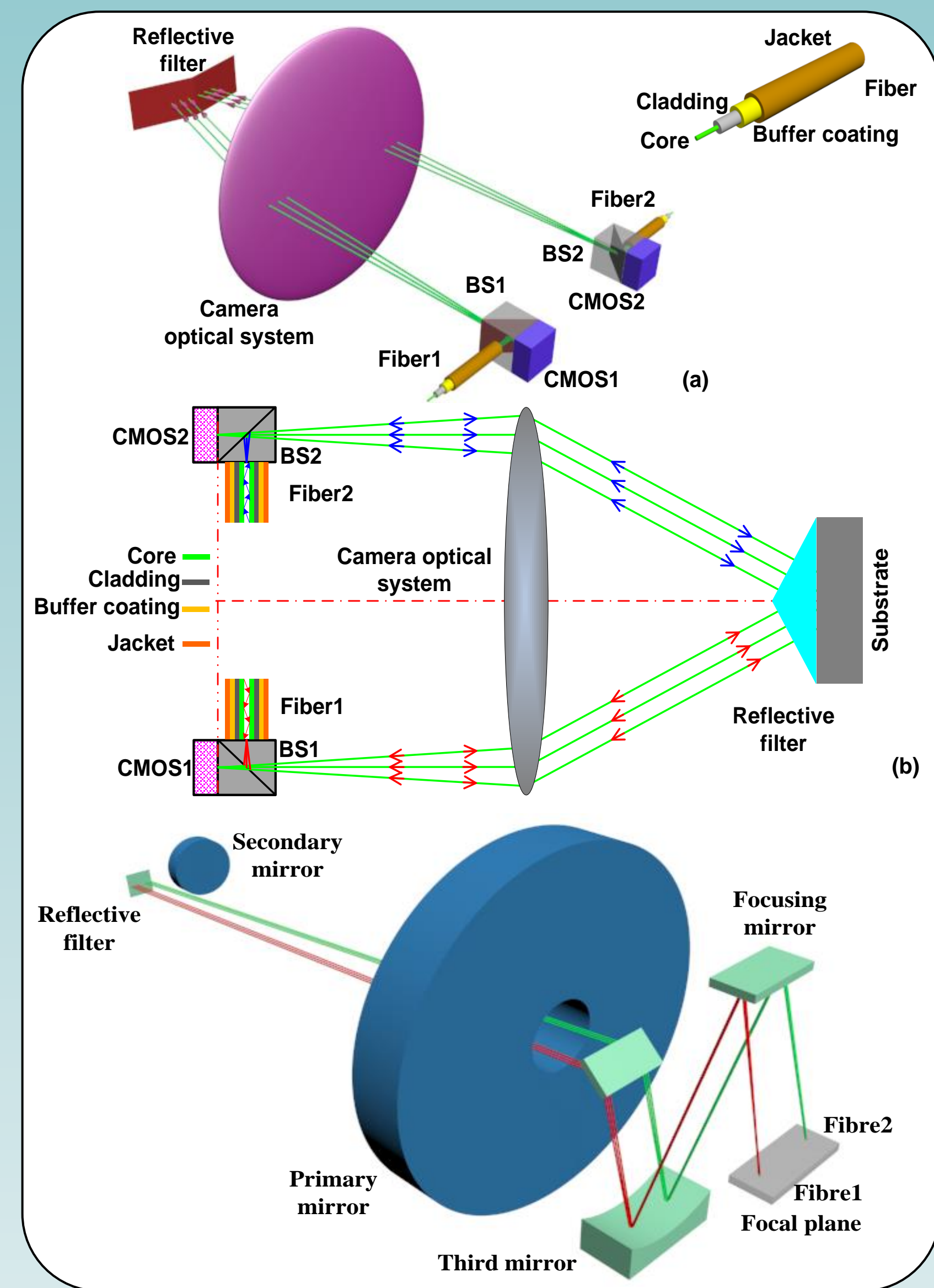


Figure1: Proposed simplified principle for measuring focal length in space orbit camera.

## Conclusion

Two conjugated optical fibers are integrated with a camera to serve as point sources with which to measure the focal length of the camera. Two fibers are located on the optical plane that can simulate the targets at infinity. We experimentally verified the working principle of this method. Our method applies the waveguides to help solve the high-precision on-orbit focusing problem for optical cameras and provide an alternative to the image focusing method. The proposed method has the potential to be used in real-time on-orbit self-calibration without space and time limitations.

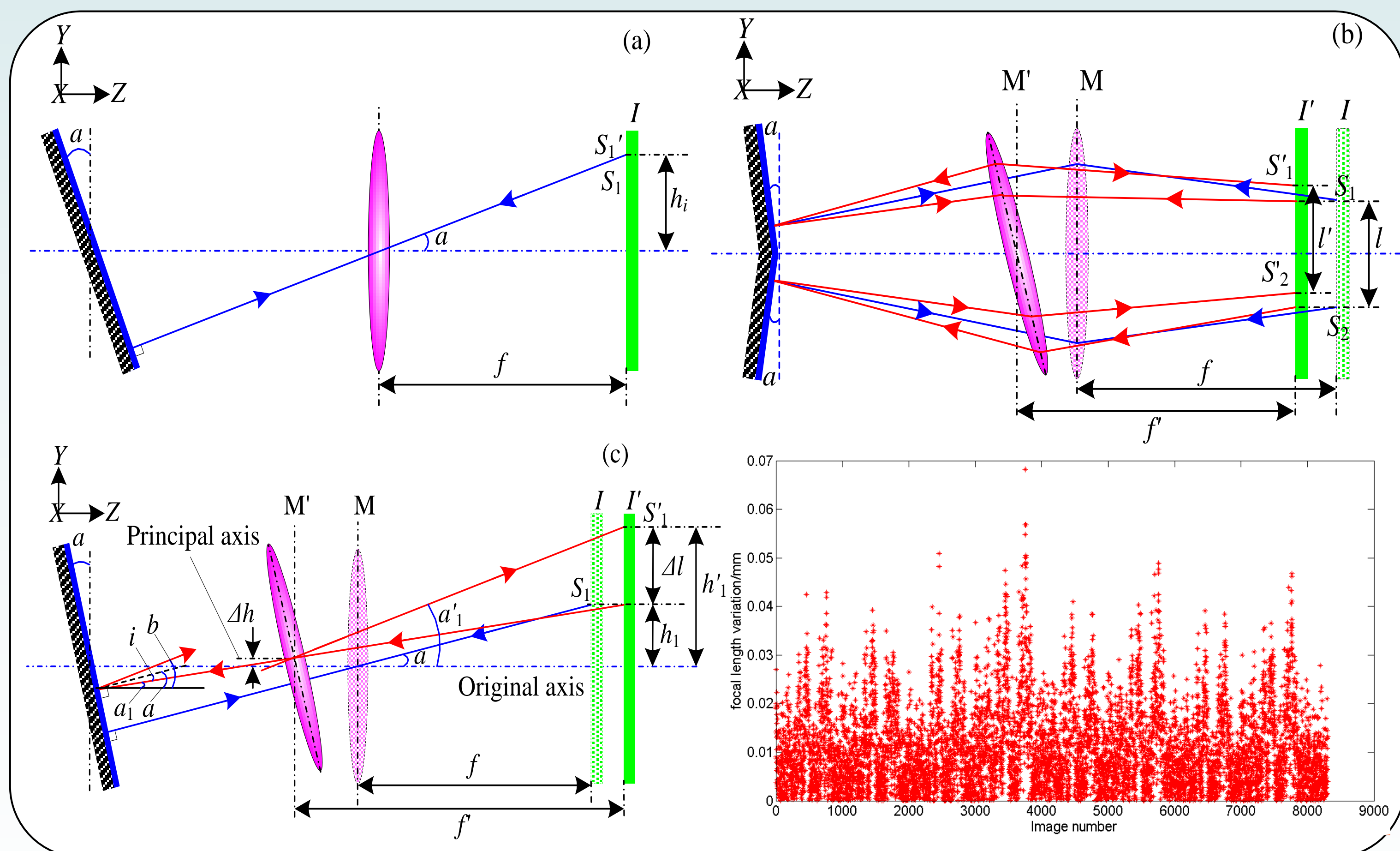


Figure2: Imaging relationship of optical fiber.(a) the imaging optical path of the point S1 when the optical system is ideal. (b) the imaging optical path of the points S1 and S2 and when the optical system has a maladjustments of shifting and tilting.(c) the imaging optical path of the points S1 in (b)

## References

Li, J., Xing, F., Shrestha, P. K., Shi, F., & Liu, Z. (2019). On-orbit self-focusing using conjugated optical fiber waveguides for space optical cameras. *IEEE Geoscience and Remote Sensing Letters*, 16(11), 1703-1705.

