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Monocentric imaging system with wide field of view and high resolution for distant view observation

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Abstract An imaging system with wide field of view (FOV) and high resolution is proposed in this paper. The optical design employed monocentric objective lens design combined with the unique arrangement of multi-aperture array, which empowers the system of good tradeoff between imaging performances and structural complexity. A prototype is built based on the design, achieving the field angle of 55 degrees as well as the angular resolution of 40 μ rad. Experiments show excellent performances in distant view observation and images with 0.1 gigapixels can be finally obtained after image mosaicing, in addition, the proposed system has potential applications in airborne ground observation and crops survey in the future.

Keywords Monocentric imaging • Wide FOV • High resolution • Multi-aperture array arrangement

1. Introduction

High resolution and large FOV is always an irreconcilable conflict in the area of high performance imaging. As the desired imaging resolution increases, the entrance aperture and the whole system size must scale in the same direction. However, the optical aberration scales simultaneously with the aperture and physical size, which makes it hard to correct the aberration in off-axis field, thus restricting the whole system's FOV [1]. So it is really a challenge to do a trade-off between wide FOV and high image resolution. In the application of distant view observation, imaging system is required to be compact and portable so as to make it convenient to carry about. Thus we also need to nicely balance the imaging performance and the complexity of the system.

One of the effective methods is to use camera arrays or detectors to get multiple observation fields and apply image mosaic technique to obtain the large FOV and high resolution image [2-5]. In 2005, researchers in Stanford University constructed a unique camera array constructed of 100 cameras to realize high resolution, high dynamic range and wide FOV imaging [6]. Autonomous real-time ground ubiquitous surveillance-image system (ARGUS-IS) [7] implies 382 CMOS detectors to provide continuous high resolution imagery as well as a 60° degree FOV. In 2012, D. J. Brady constructed AWARE-2 applying multi-scale lens design theory, obtaining a 50°×120° FOV with a gigapixel resolution [8, 9]. But system volume and design complexity of the systems mentioned above are the problems that limits the applied range in some degree.

Here we present a wide FOV, high resolution imaging system with unique optical and

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