THE POINT SPREAD FUNCTION VARIATIONS INSIDE WIDE-FIELD ASTRONOMICAL IMAGES

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ABSTRACT. The Point Spread Function (PSF) of the astronomical imaging system is usually approximated by a Gaussian or Moffat function. For simplification, the astronomical imaging system is considered to be time and space invariant. This means that invariable PSF within an exposed image is assumed. If real wide-field imaging systems are considered, this presumption is not fulfilled. In real systems, stronger optical aberrations are expected (especially coma) at greater distances from the center of the captured image. This impacts the efficiency of stellar astrometry and photometry algorithms, so it is necessary to know the PSF variation. In this paper, we perform the first step toward assigning PSF changes: we study the dependence of the Moffat function fitting parameters (FWHM and the atmospheric scattering coefficient β) on the position of a stellar object.

KEYWORDS: astronomy, wide-field imaging, wavelet transform, à trous, fitting.

1. INTRODUCTION

Lenses with a wide field of view (WFC — Wide-Field Camera, UWFC — Ultra Wide-Field Camera) are used in a wide range of applications in sky monitoring. Well-known applications of this kind of image analysis are for detecting new objects, e.g. novae, supernovae and AGN (Active Galactic Nuclei).

UWFC image data analysis is in general a very difficult task. There are many different kinds of optical aberrations and distortions in these systems. The influence of optical aberrations increases towards the edges (at a high angular distance from the optical axis of the system). These aberrations distort the PSF of an optical or imaging system, and rapidly reduce the accuracy of the measurements. The optical aberrations are dependent on the spatial data. They affect the transfer characteristics of the optical systems, and make them spatially variant [7].

Astrometry measurements are often limited by variations of PSF shape and size over the image. These variations in PSF structure occur especially in UWFC systems, due to the number of aberrations, which increase towards the margins [7].

Conventional methods in astrometry and photometry do not take into account the variance of PSF, and are therefore not suitable for wide-field image processing and scientific data measurements. When the PSF variations are known, the efficiency of these methods can be improved.

2. IMAGE PROCESSING

A wide-field astronomical image exposed by an MI G1-2000 camera with an ultra wide-angle lens in Namibia (southern Africa) was chosen for our investigation.

FIGURE 1. (a) Testing wide-field image. (b) Testing image split into regions.