CMOS vs. CCD sensors in speckle interferometry

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Abstract

In the field of interferometric metrology the use of high resolution CCD sensors with 1024 × 1024 to 2048 × 2048 pixels is predominant. Due to special features (e.g. random pixel access, characteristic curve) CMOS sensors with similar resolution can be an interesting alternative. We compare some characteristics of both sensor types that are important for interferometry and demonstrate two exemplary applications that are only possible by using CMOS cameras.

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1. Introduction

For some time CMOS cameras have been discussed as an interesting alternative to CCD cameras in the field of interferometry, digital holography, and other fields of optical metrology[1–3]. The advantages of these cameras are their low price and low power consumption and certain physical characteristics. These are in particular (a) the random pixel access, which makes possible a fast readout of small regions of interest (ROI) and (b) the physical layout of the pixels, which enables active electronic components to be allocated to each pixel and prevents blooming. On the other hand, CMOS sensors have some disadvantages compared to CCD sensors. In literature[4–8] a lower sensitivity due to the smaller fill factor, higher temporal noise, higher pattern noise, higher dark current, and the nonlinear characteristic curve are primarily mentioned. However, this nonlinear characteristic curve can also be an advantage which helps to avoid saturation of the camera if light fields with large brightness variations have to be recorded.

The aim of this paper is to enable a quantitative comparison of important characteristics of high resolution CCD and CMOS cameras on the basis of experimental data. Moreover, we present results of two exemplary applications of CMOS cameras in electronic speckle pattern interferometry (ESPI) that are only possible by using these sensors. In one case we use the nonlinear characteristic curve of the camera in order to realize deformation measurements for an object with strongly varying reflectivity. In the other case we use...