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M. Schumann / P. Brückner

# New Methods for Numerical Correction of Geometrical distortion in Images

A major problem in digital image processing is the loss of accuracy that is introduced into the optical system by the lenses in use. If a lens differs from the ideal form, alignment or position then it's refractive effect changes the image and can thereby create distortion. Assuming that the optical components of the system are not exchanged, realigned or repositioned this distortion is a systematic error. It can be compensated if the impact is known for all positions inside the image. Detecting the exact amount and direction of distortion for every pixel is nearly impossible due to measurement restrictions. Therefore the offset must be approximated based upon measured information about the distortion at certain reference points using a suitable functional model. Practical tests have shown that the use of more than one lens in an optical system can result in a potentially complex non radial distortion pattern.

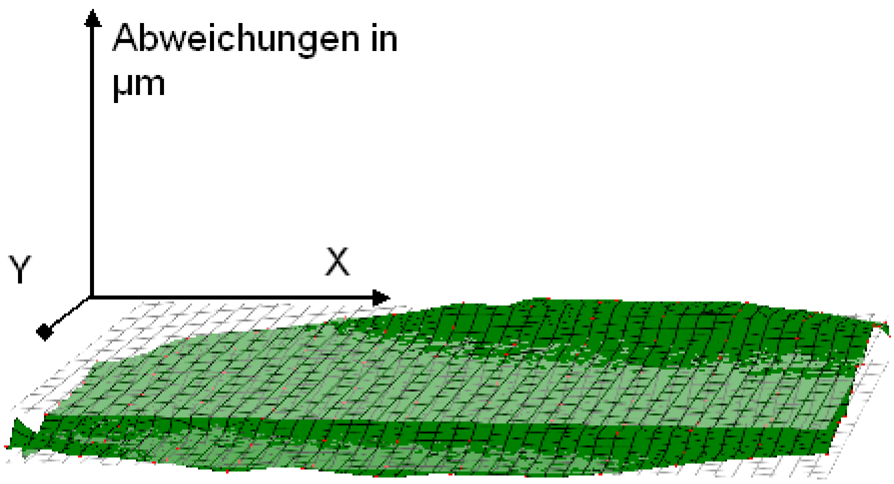


**Figure 1: Offset in one axial direction**

Since radial distortion is dominant in most applications there are a lot of approaches to correct the image based upon the assumption of symmetry. Additionally methods for function approximation by polynomials or neural networks are known. All of those suffer from a loss of precision even at the reference points due to the restrictive nature of the model in use.

In order to avoid this effect a method for interpolation is necessary. Due to the amount of information high order polynomials would be needed. This would result in possibly strong oscillations between the reference points. The new algorithm proposed in [1] solves this problem. In order to remove the dependency between the polynomial degree and the number of reference points utilized piecewise polynomial functions are used to estimate the offset in each direction (X and Y coordinates, potentially more components of data). Combined with suitable heuristics this approach can significantly reduce the oscillation of the polynomials while limiting their degree by a constant value. This functional model allows for a steadily differentiable interpolation of the distortion pattern.

In order to check the performance of the proposed method tests were conducted comparing the uncorrected measurements, corrected results and the output of a radial reference algorithm. For this purpose images of a coordinate measuring machine and a high precision camera were used.

**References:**

[1] M. Schumann: Untersuchungen von neuartigen numerischen Korrekturverfahren für die geometrische Verzeichnung von Bildern, Diplomarbeit, Technische Universität Ilmenau, 2008

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