Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

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Bestimmung von Strahlgradienten mittels Dual-Kamera Experimental Ray Tracing (DuCam ERT).

ABSTRACT - Masterthesis

In conventional Experimental Ray tracing (ERT) the ray gradient is determined by evaluating the position of the beam spot at two different known image planes. Since moving the imaging device back and forth is time-consuming, this thesis aims to further improve the conventional method by acquiring and evaluating the beam spots simultaneously.

A non-polarizing cubical beamsplitter is used to split the ray whose gradient is to be determined. The splitted rays are captured using 2 different CMOS imaging devices independently. To determine the ray gradient from the captured images, a mathematical model is presented which is based on the laws of geometric optics and analytic geometry. In the Model, the noises in the images are first removed using convolution filter followed by the application of a series of geometric transformation operators. The images then are compared as in a stereo comparator to determine the disparity in the position of the centroid of the image pairs. Using this value and the estimated working distance between the source and the image planes, the ray gradients are computed. The model is tested by evaluating the Images obtained from Zemax simulation. The effect of the variables errors on the uncertainty of both the simulation and experimental results are presented quantitatively using the (linearized) Error Propagation. The accuracy of the model for the simulation results lies in the range of one-thousandth of a degree. The validity of the repeated measurements are tested using the RMS error analysis. To characterize the relationship between the measured x and y position of the centroids, Pearson and Spearman correlation coefficient are determined from a set of repeated measurements.

To selectively separate the noise from the image (signal) - without altering the signal - , other methods such as those based on spatial frequency analysis is required. Furthermore to decrease the inaccuracy in the estimated ray gradient due to systematic errors, optimal smoother (eg. RTS smoother) can be used over the estimations obtained from extended Kalman filter which can be applied either in recursive or batch mode.