Hyperbolic tangent algorithm for periodic effect cancellation in sub-pixel resolution edge displacement measurement

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Abstract

This work explores the effect of sensor fill-factor, acquisition noise and blurring level on sub-pixel edge detection uncertainty and finally proposes a new edge detection algorithm to reduce the measurement uncertainty. Optics analysis demonstrates that the intensity profile of an edge, acquired with a digital camera, has the mathematical shape of the error function (erf). The erf is therefore expected to be the best function to fit the intensity profiles of edges. The position of the edge is then estimated through the position of the flex of the approximating curve. However, the hyperbolic tangent can be used to fit the erf with a low discrepancy, though requiring a lower computation time. For this reason the hyperbolic tangent was selected to implement the proposed edge detection algorithm. This algorithm was tested using both numerically generated images and real data. Results demonstrated the efficiency of the proposed algorithm, strongly reducing sub-pixel edge detection systematic effect.

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