PROCEEDINGS

53. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

Faculty of
Mechanical Engineering

PROSPECTS IN MECHANICAL ENGINEERING

8 - 12 September 2008

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TECHNISCHE UNIVERSITÄT
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Published by
Impressum

Publisher Herausgeber	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Dr. h. c. Prof. h. c. Peter Scharff
Editor Redaktion	Referat Marketing und Studentische Angelegenheiten Andrea Schneider
	Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurz, Univ.-Prof. Dr.-Ing. habil. Rainer Grünwald, Univ.-Prof. Dr.-Ing. habil. Prof. h. c. Dr. h. c. mult. Gerd Jäger, Dr.-Ing Beate Schlütter, Dipl.-Ing. Silke Stauche
Editorial Deadline Redaktionsschluss	17. August 2008
Publishing House Verlag	Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16, 98693 Ilmenau

CD-ROM-Version:

Implementation Realisierung	Technische Universität Ilmenau Christian Weigel, Helge Drumm
Production Herstellung	CDA Datenträger Albrechts GmbH, 98529 Suhl/Albrechts

ISBN: 978-3-938843-40-6 (CD-ROM-Version)

Online-Version:

Implementation Realisierung	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau

Home / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=17534

53rd Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
08 – 12 September 2008

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Transformation of Colour-Images for precision edge probing

Colour and spectral images gain more interest in all types of applications of digital image processing. Even in geometric measurement, where the colour information is usually of minor importance, the number of tasks in which the colour information becomes useful is rising. Sometimes it is just a question of usability for the human operator of the system, in other cases the measurement could be done more robust or with higher precision than in a greyscale image only.

There are a lot of algorithms for digital colour image processing concerning recognition/ detection or colour measurement. But there are very little approaches for subpixel precision edge probing methods as needed for geometric measurements.

Subpixeling methods in grey value images enable probing of edges with a resolution larger than the pixel centre distance of the sensors. Depending on the quality of the image data an increase of resolution of 1/10th to 1/100th pixels is attainable. Typically methods [1] for subpixel-accurate edge position determination presume that only one function value, i.e. the intensity respectively the grey value, varies within the image.

In colour and spectral images there is more than one value per pixel. In [2] an approach based on vector difference has been shown with the restriction to a single pixel line. The aim is to create a new edge filter for digital colour images with properties that are useful for subsequent edge probing methods.

The requirements for the new filter are:

- as little softening as possible
- direction independent
- no irreproducible change of the edge position
- method applicable for more than three channels

Averaging over larger image areas is not necessary since in our application image quality is high and SNR is good. To achieve very little softening and therefore a better

performance of the subsequent edge probing methods, we decided to use a 2x2 mask. Most other edge operators that are commonly used work with 3x3 or even larger areas. Another decision was to work in-between the pixel grid of our source image not on it (in the centre of the 2x2 mask). The offset of 0.5 pixels is not a problem for geometric measurement, it is easily corrected. Working off the pixel grid is possibly a better way to search for edges. With a high quality in-focus image the edge information is rather in the differences in-between neighbouring pixels than in all the surrounding elements of one central pixel. Calculating a scalar representative for an edge in the centre of a 2x2 mask means that there are only 4 directions to work with: horizontal, vertical and the two diagonals. If calculated and weighted correctly the result can be considered direction independent.

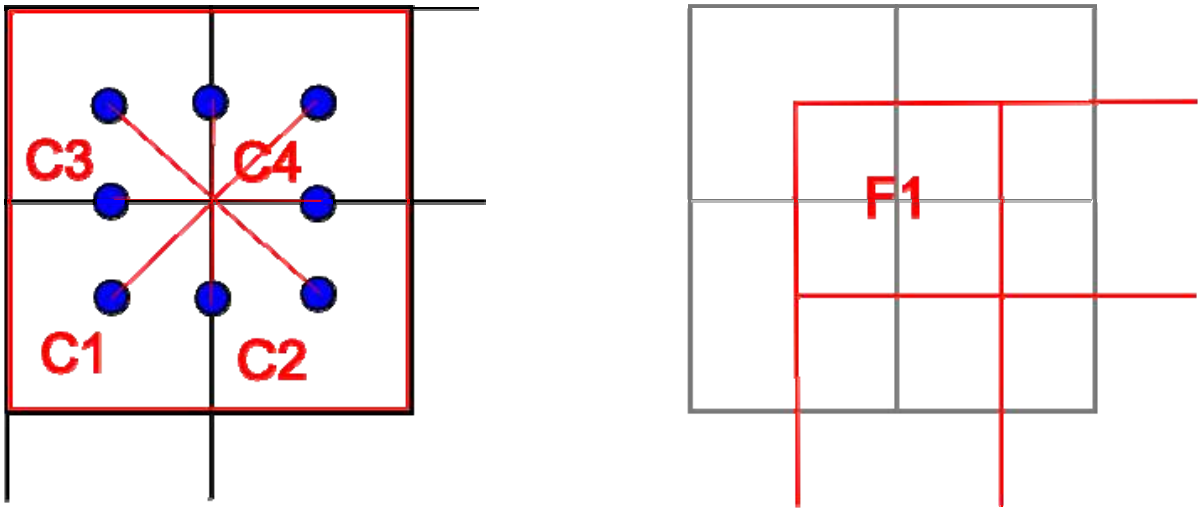

Fig. 1: Source image with 2x2 filter scope and greyscale edge image 0.5 pixels shifted

The filter is primarily developed for use with RGB-images but it is easily extended to multi and hyper spectral images. The vectorial method does not restrict the number of channels of the source, the limitation is only determined by the implementation of the algorithm.

The paper presents a simple method for an image transformation that delivers a greyscale image where the grey value represents colour and intensity edges based on vector differences. Different types of cameras, their individual influences on the digital image and the effects on the transformation results are discussed. Comparison to other edge filters is made and the applicability for geometric measurement is determined.

References:

[1] O. Kühn: Ein Beitrag zur hochauflösenden zweidimensionalen Geometriemessung mit CCD-Zeilensensoren. Dissertation, Technische Universität Ilmenau, 1997.
[2] P. Brückner, S. Töpfer, M. Correns, J. Schnee: Position- and colour-accurate probing of edges in colour images with subpixel resolution. 52. Internationales Wissenschaftliches Kolloquium der TU Ilmenau, September 2007.

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