Selection of task specific indicator functions in a multiscale measurement system

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New Measurement and Inspection Strategies
for the Production of Microsystems and Nanostructures

Project Partners

Universität Stuttgart IF isys

Aim:

Fast automated inspection of large-area objects with micro- and nano-scale structures

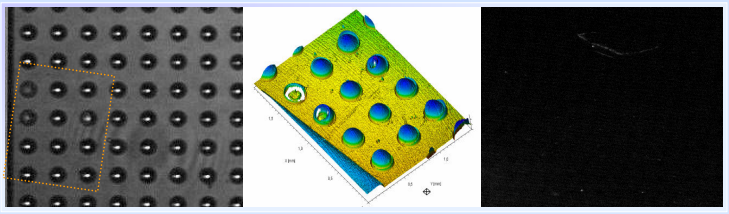
Problem:

Limited sensor resolution-to-field ($\delta A = 10^{-4}$)

Solution:

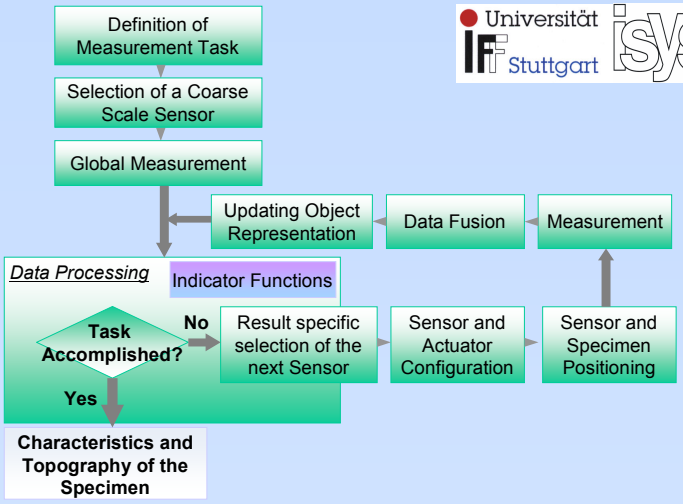
Automated Multiscale Measurement Strategy

- Multiscale sensor concept
- High resolution is only utilised where required
- Indicators, which are deviations from the expected measurement results, are used to enable the multisensor concept. Thus task specific selection of indicator functions is required



a) b) c)

Data from sensors measuring point spread function (a), topography (b) and stray light (c)

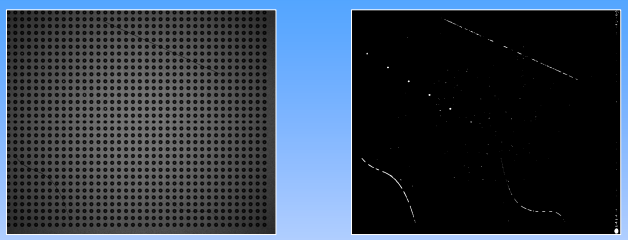


Indicator Functions	Remarks
Fourier Self Filtering	high periodic structures video microscopy level
Correlation Based Method	need of enough resolution good at video microscopy level best at confocal microscopy level
Fourier Descriptors Based Method	best at confocal microscopy level
Texture Based Method	lower sensitivity does not depend on illumination
Contrast Based Method under Incident light	only for scratch and particle pollution detection under incident illumination

Table 1: Several indicator detection algorithms for microlens arrays were used on the data from two different sensors: a video microscope and a confocal microscope

Example Indicator Detection Functions:

Fourier Self Filtering



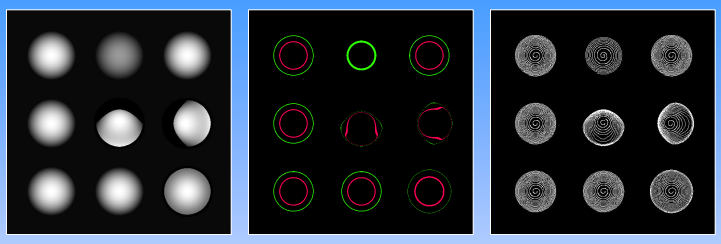
resulting image

Fourier self filtering is a process of removing all the periodic elements from the input image.

This can be done by masking out all the peaks in the Fourier domain of the input image and transforming back to spatial domain.

As it can be seen from the above result, the only elements that will be left are non-periodic elements, which are the indicators in our case.

Fourier Descriptor Based Method



Fourier Descriptors (FD) can be used to describe shapes based on their contours.
FD = FFT(Z); $Z_i = X_i + iY_i$ i=1..n (number of points on the contour), where X_i and Y_i correspond to the position of the points on the contour in pixels (x,y).
Two methods: 1. Ring Method and 2. Spiral Method
are presented in the above shown images to detect indicators on simulated confocal sensor data.

- Fourier descriptors are calculated for each Spiral /Ring
- Results are compared with the corresponding Spiral / Ring of an ideal lens to estimate the correctness of the lens.
- Fourier descripters are scale and rotation invariant

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