

# Real-Time Monitoring of Laser Scribing Process Utilizing High-Speed Camera

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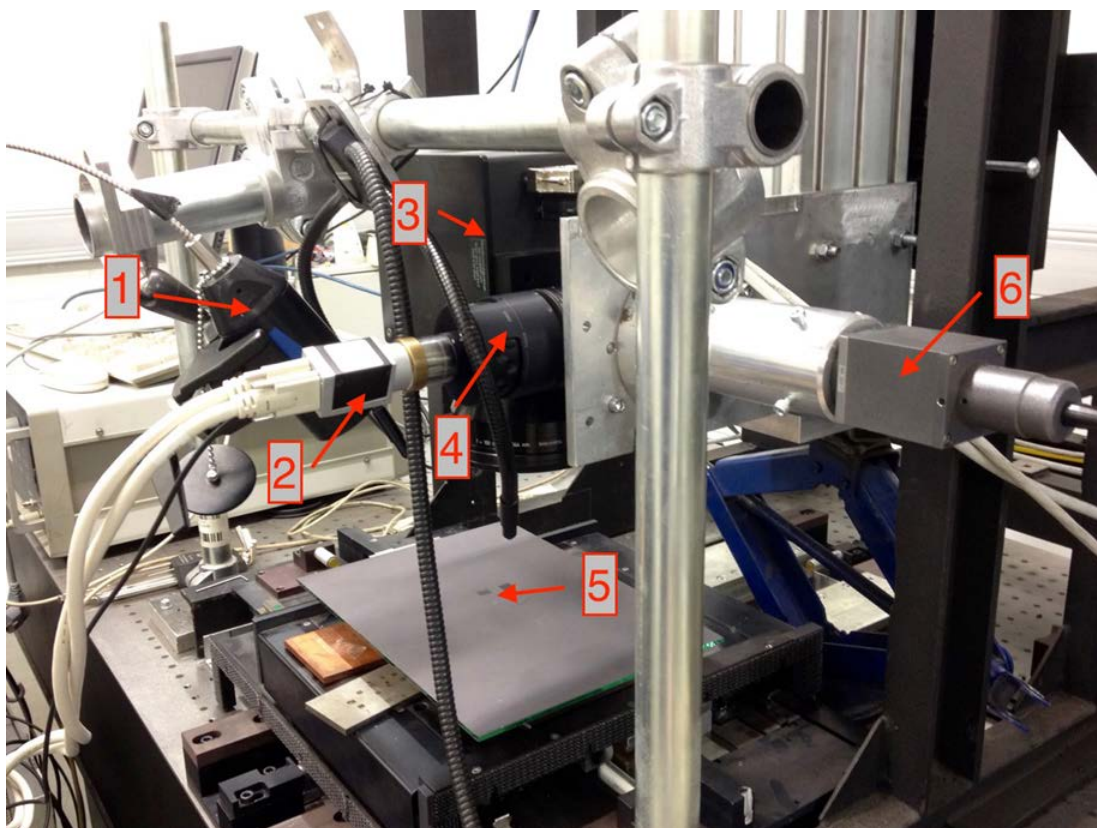
## Research target

The aim of this research is to find a method for laser scribing monitoring with a high-speed camera and evaluate reliability and performance of the developed monitoring system with experiments.

## Test Setup

The laser used in experiments is an IPG ytterbium pulsed fiber laser with 20 W maximum average power and Scan head optics used in the laser is Scanlab's Hurryscan 14 II with an f100 tele-centric lens. The camera was connected to laser scanner using camera adapter to follow the laser process.

A powerful fully programmable industrial computer was chosen for executing image processing and analysis. Algorithms for defect analysis, which are based on particle analysis, were developed using LabVIEW system design software.

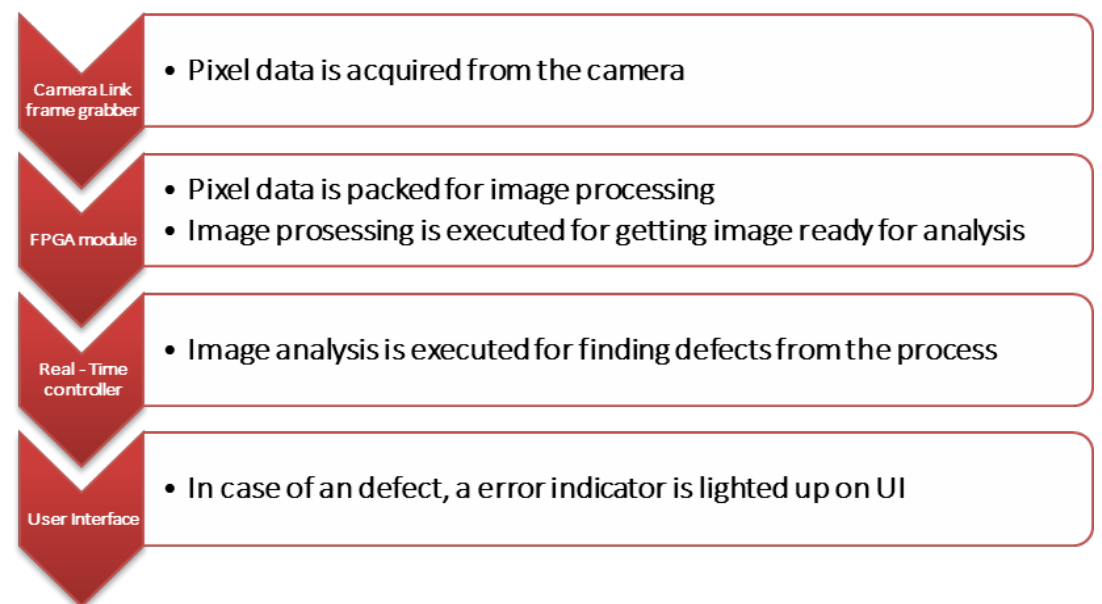


Test bed for experiments (1. Illumination laser, 2. High-speed camera, 3. Scan head, 4. Camera adapter, 5. Work piece, 6. Pulsed fiber laser).

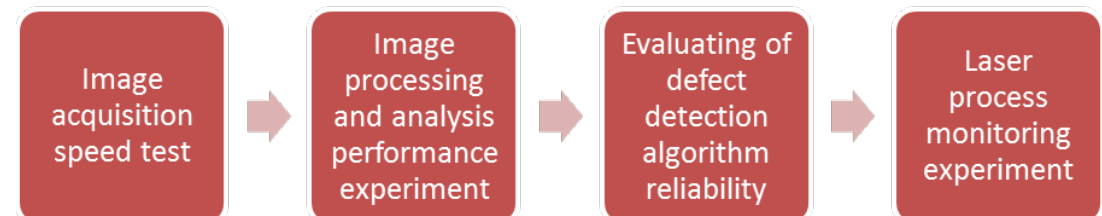
## Experiment

The performance of the algorithms was analyzed by analyzing a non-moving image from the scribing line with resolution 960x20 pixel. As a result, the maximum analysis speed was 560 frames per second. Reliability of the algorithm was evaluated by imaging scribing path with a variable number of defects 2000 mm/s when the laser was turned off and image analysis speed was 430 frames per second. The experiment was successful and as a result, the algorithms detected all defects from the scribing path.

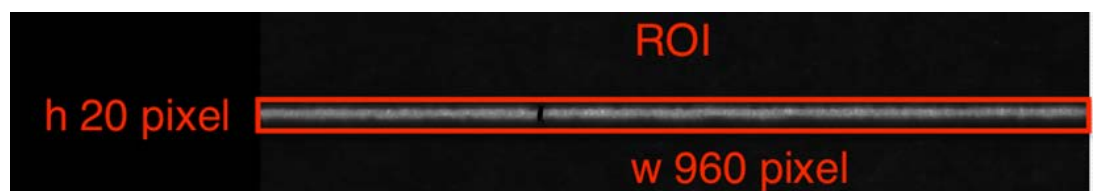
## Image processing and analysis procedure



## Experimental phases



## Results



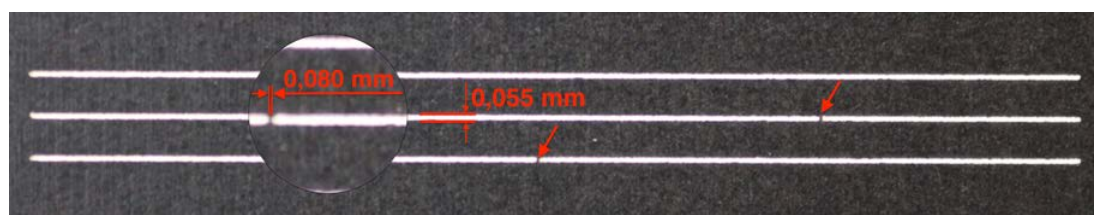
Selection of the ROI



Threshold image with unwanted particles



Threshold image where unwanted particles are removed



Scribed lines for reliability experiments

