COMBINING INNOVATIVE PRODUCTION COMPETENCES

Fraunhofer IGCV
Fraunhofer IGCV
Facts and figures

- **Established:** July 01, 2016
- **Management:**
  - Prof. Dr.-Ing. Gunther Reinhart (executive)
  - Prof. Dr.-Ing. Klaus Drechsler
  - Prof. Dr.-Ing. Wolfram Volk
- **Augsburg site – headquarters**
  Management, administration, fields of research:
  processing and composite technology
- **Garching site:**
  Field of research: casting technology
- **Staff size**
  ~ 140 employees
- **Supported by:**
  ![Supporting Partners](image)
Fraunhofer IGCV
We use synergies in these fields of research and development:

**Casting technology**
- Molding materials
- Sand and gravity die casting processes
- Simulation and design of mold and cast components

**Composite technology**
- Hybride Hybrid composite constructions
- Online process monitoring
- Materials and test engineering
- CFRP manufacturing engineering
- Recycling of composites
- Efficiency and balancing

**Processing technology**
- Resource efficiency in factories
- Intelligent networked production
- Flexible production
- Networked modeling and simulation
- Additive manufacturing
Online monitoring and classification of carbon fiber and textile production defects using scalable line scan optics and computer vision
TIA Workshop: Carbon fiber and textile defect detection

Contents

- Online process monitoring
- Overview
- System layouts
- Image processing
- Machine learning
- Integrated solutions
- Conclusion and outlook
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Online Process Monitoring

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Online Process Monitoring

System solutions
- Customer-specific concepts
- Online
- Dynamic processes

Vision applications
- Image processing chains
- Design & optimization
- Modularised & scalable

Data handling
- High volume data
- Classification & analysis
- Realtime conditions
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Overview

Online Process Monitoring

Overview

System layouts

Image processing

Machine learning

Integrated solutions

Conclusion and outlook
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Overview: carbon fiber and textile defects


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**System layouts**

- Online process monitoring
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- Image processing
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System layouts

Preconditions and system features

- varying conditions along the production process
  - material state changes significantly
  - different environments on inspection points
- Therefore: adaption of software and hardware

Material types

<table>
<thead>
<tr>
<th></th>
<th>PAN precursor</th>
<th>oxidized PAN</th>
<th>Carbon fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fiber color</strong></td>
<td>white</td>
<td>black</td>
<td>black</td>
</tr>
<tr>
<td><strong>Fiber surface</strong></td>
<td>glossy</td>
<td>dull</td>
<td>glossy</td>
</tr>
<tr>
<td><strong>Illumination</strong></td>
<td>dark field</td>
<td>diffuse incident light</td>
<td>diffuse incident light</td>
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System layouts

Vision hardware

- moving target
- small defects
  - high resolution line scan sensor
  - scan range extension (factor 3) - patent pending
- high volume data
  - use of FPGA¹

¹: Field Programmable Gate Array
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Image processing

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Image processing

Software requirements

- solid architecture
- image filtering
- segment regions of interest (ROI)
- classification of defects: use of SVM

1: Support Vector Machine
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Image processing

Image enhancement and segmentation

- Split regions of interest
- Merge regions by distance-based algorithms

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**Machine Learning**

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**Machine Learning**

**Approaches**

- Cartesian Genetic Programming (CGP)
  - Optimizing image processing
  - Simplify configuration
- ANN\(^1\)/SVM\(^2\) based classification
- Principles of Organic Computing (OC) \(^3\)

**Applications**

- Usage: CF, further material defects, imaging technologies

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1: Artificial Neural Network
2: Support Vector Machine
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Machine Learning

1: Professional Integrated Monitoring Environment

Fiber Monitoring
Binder Monitoring

Image Processing

Data Analysis

Interfaces

Data Management

Classification

PrIME

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Integrated Solutions

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**Integrated Solutions**

**Dynamic hardware control & defect detection**

- dynamic binder application - *patented*
- flexible measurement unit
  - Evaluate binder application homogeneity
  - nitting defect detection
- optimization of preform permeability
- acceleration for preform compaction

- Spool gate
- Binder application unit
- Robot based fiber placement

- Fiber placement with integrated binder application

- Image acquisition
- Image enhancement
- Automated evaluation

**Inline evaluation of binder application**

- Binder pattern
- Fiber misalignments and nitting defects
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**Integrated Solutions**

**Roving metrology**

- full surface-metrology by InFactory Solutions
- cooperation with InFactory Solutions and Coriolis Composites
  - automated Tool detection and measurement
  - automated localisation in the FAI process

**Goals:**

- meet FAI requirements
- ensure integration in industrial process
**Temperature control**

**Challenge:**

*Keep element temperature in a critical range*

- **solution:** embedded control loop for IR heater using an IR camera
- **tasks:**
  - collision control
  - hotspot detection
  - realtime conditions

» **Proof of Feasability by Fraunhofer IGCV**
Online Process Monitoring
Overview
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# Conclusion and Outlook

## Summary

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<th>Detection Method</th>
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<td>Detection by image processing</td>
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