

Segmentation and characterization of fibers

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Dictionary 00000000000 Discretization

Tracking

Radius 0

Segmentation and characterization of fibers

Vedrana Andersen Dahl, DTU Compute September 2015



DTU Compute Department of Applied Mathematics and Computer Science

Introduction	Dictionary	Discretization	Tracking	Radius
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Background

- My background
- DTU imaging industry portal, industrial application, scientific advice, and research within 3D imaging
- CINEMA, the allianCe for ImagiNg of Energy MAterials, a five year DSF project with participants from both academia and the industry

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- CINEMA at DTU Compute:
 - Tomographic reconstruction using movable meshes
 - Volume segmentation using movable meshes
 - Texture based volume segmentation

Presenting (mostly) the work of

- Monica Jane Emerson, PhD student, DTU Compute
- Anders Bjorholm Dahl, associate professor, DTU Compute

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Segmentation (and quantification) of fibers



Focus areas

- Micro-CT of glass fiber, thick carbon fiber and thin carbon fiber ►
- ► Segmentation and quantification (orientation and alignment)

Motivation

- Quality control mechanical tests for each production protocol. Time aspect. ►
- Quality control quantification of fibers based on imaging, simulation using FEM. ►
- Our part: from images to fibers.

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Segmentation (and quantification) of fibers



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Pipeline

- Probabilistic fiber center detection. Dictionary based.
- Discretization. Treasholding or blob detection.
- Tracking. Nearest neighbour heuristics.
- Radius estimation. Back to blob detection response.

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Probabilistic fiber center detection



Dictionary based approach

- Fiber detection vs. fiber center detection.
- Closely related to dictionary based segmentation of textured images.

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Dictionary based segmentation of textured images

Recent segmentation methods

 Anders L Dahl and Rasmus Larsen, Learning dictionaries of discriminative image patches, BMVC, 2011.

Training-testing approach. Computation based on averaging.

- Anders B Dahl and Vedrana A Dahl, Dictionary snakes, ICPR, 2014. Deformable model, snakes. Requires initialization. Computation based on averaging.
- Anders B Dahl and Vedrana A Dahl, Dictionary based image segmentation, SCIA, 2015.

Deformable model, level sets. Requires initialization. Graph based representation.

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Monica J Emerson, Kristine M Jespersen, Peter S Jørgensen, Rasmus Larsen, and Anders B Dahl, Dictionary based segmentation in volumes, SCIA, 2015.

3D version. Training-testing approach.

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Dictionary based texture representation



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Dictionary based texture representation

Graph (matrix) based representation

Biadjacency matrix B representing binary relation between image pixels and dictionary elements, given by a dictionary assignment image

$$b_{ij} = \left\{ egin{array}{cc} 1 & ext{if } i \sim j \ 0 & ext{otherwise} \end{array}
ight.$$

Self similarity matrix

$$\mathbf{S} = (\mathbf{D}_{\mathbf{B}})^{-1} \mathbf{B}^{\mathsf{T}} (\mathbf{D}_{\mathbf{B}^{\mathsf{T}}})^{-1} \mathbf{B}$$

▶ **B** is a *n* × *m* matrix, where *n* is the size of the image, and *m* is the size of the dictionary.

Demo

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Research topics

Current research topics

- Generalization to 3D
- User input, small and easy
- Dictionary, when and how
- Handling big data

Dictionary

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Discretization



Tested options

- Treasholding
- Scake space blob detection

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Discretization, scale space blob detection





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Discretization, Monicas results



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Discretization, Monicas results

True positive ratio depending on discretization, in percentages

	tresholding	blob detection
glass fiber	99.1	93.4
thick carbon fibre	100	98.9
thin carbon fibre	95.5	100

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Tested options

Nearest neighbor heuristics

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Fibers in abaqus



Visualization of fiber centers by Kristine Munk Jespersen, DTU Wind Energy.

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40				
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Monicas results, visualization of fiber radii.

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Thank you!

${\sf Questions?}$

