Muscle fibre morphology and microarchitecture in cerebral palsy patients obtained by 3D synchrotron X-ray computed tomography

Background: Synchrotron X-ray computed tomography (SXCT) allows for three-dimensional imaging of objects at a very high resolution and in large field-of-view. Purpose: The aim of this study was to use SXCT imaging for morphological analysis of muscle tissue, in order to investigate whether the analysis reveals complementary information to two-dimensional microscopy. Methods: Three-dimensional SXCT images of muscle biopsies were taken from participants with cerebral palsy and from healthy controls. We designed morphological measures from the two-dimensional slices and three-dimensional volumes of the images and measured the muscle fibre organization, which we term orientation consistency. Results: The muscle fibre cross-sectional areas were significantly larger in healthy participants than in participants with cerebral palsy when carrying out the analysis in three dimensions. However, a similar analysis carried out in two dimensions revealed no patient group difference. The present study also showed that three-dimensional orientation consistency was significantly larger for healthy participants than for participants with cerebral palsy. Conclusion: Individuals with CP have smaller muscle fibres than healthy control individuals. We argue that morphometric measures of muscle fibres in two dimensions are generally trustworthy only if the fibres extend perpendicularly to the slice plane, and otherwise three-dimensional aspects should be considered. In addition, the muscle tissue of individuals with CP showed a decreased level of orientation consistency when compared to healthy control tissue. We suggest that the observed disorganization of the tissue may be induced by atrophy caused by physical inactivity and insufficient neural activation.
Multi-phase image segmentation with the adaptive deformable mesh

This paper proposes a method for image segmentation using a deformable triangle mesh in the image domain. We define a piecewise constant function by labeling the mesh triangles with different phases, each representing a segment of an image. Our method finds the optimal mesh configuration and triangle labeling that minimize the piecewise constant Mumford-Shah functional. Contributions of this paper include a force model that moves mesh vertices towards the solution, and an adaptivity model that further adapts the mesh by introducing or removing vertices. The results demonstrate the advantages of our method over traditional methods like snakes and level set. Our approach supports multi-phase segmentation incurring no particular overhead. Furthermore, the use of an adaptive mesh facilitates accurate segmentation with a very compact representation. The biggest challenge of deformable meshes, changes to the topology of the segments, is handled by employing Deformable Simplicial Complex (DSC), a method for explicit interface tracking.

Process characterization for molding of paper bottles using computed tomography and structure tensor analysis

Packaging products find their significance in almost all classes of consumer goods and products. The use of plastic and metal based packaging for beverages is highly dominant. However, there is a constant urge for development of eco-friendly packaging alternatives. The article focuses on characterizing an inflatable core assisted paper bottle molding process with respect to the obtained fiber distribution in the bottle. Distribution of paper fibers affect product characteristics such as thickness and mechanical strength of the bottle. Assessment of fiber orientation using structure tensor analysis is therefore performed. The results confirmed non-uniform fiber compaction in the paper bottle. This gives rise to non-conformities such as non-uniform thickness distribution. The approach discussed in the work can be utilized as a Non Destructive Testing technique to evaluate the quality of paper bottles.
Zonohedral Approximation of Spherical Structuring Element for Volumetric Morphology

Performing dilation and erosion using large structuring elements can be computationally slow – a problem especially pronounced when processing volumetric data. To reduce the computational complexity of dilation/erosion using spherical structuring elements, we propose a method for approximating a sphere with a zonohedron. Since zonohedra can be created via successive dilations/erosions of line segments, this allows morphological operations to be performed in constant time per voxel. As the complexity of commonly used methods typically scales with the size of the structuring element, our method significantly improves the run time. We use the proposed approximation to detect large spherical objects in volumetric data. Results are compared with other image analysis frameworks demonstrating constant run time and significant performance gains.

A multimodal data-set of a unidirectional glass fibre reinforced polymer composite

A unidirectional (UD) glass fibre reinforced polymer (GFRP) composite was scanned at varying resolutions in the micro-scale with several imaging modalities. All six scans capture the same region of the sample, containing well-aligned fibres inside a UD load-carrying bundle. Two scans of the cross-sectional surface of the bundle were acquired at a high resolution, by means of scanning electron microscopy (SEM) and optical microscopy (OM), and four volumetric scans were acquired through X-ray computed tomography (CT) at different resolutions. Individual fibres can be resolved from these scans to investigate the micro-structure of the UD bundle. The data is hosted at https://doi.org/10.5281/zenodo.1195879 and it was used in [1] to demonstrate that precise and representative characterisations of fibre geometry are possible with relatively low X-ray CT resolutions if the analysis method is robust to image quality.
Computing segmentations directly from x-ray projection data via parametric deformable curves: Paper

We describe an efficient algorithm that computes a segmented reconstruction directly from x-ray projection data. Our algorithm uses a parametric curve to define the segmentation. Unlike similar approaches which are based on level-sets, our method avoids a pixel or voxel grid; hence the number of unknowns is reduced to the set of points that define the curve, and attenuation coefficients of the segments. Our current implementation uses a simple closed curve and is capable of separating one object from the background. However, our basic algorithm can be applied to an arbitrary topology and multiple objects corresponding to different attenuation coefficients in the reconstruction. Through systematic tests we demonstrate a high robustness to the noise, and an excellent performance under a small number of projections.

General information
Publication status: Published
Number of pages: 16
Publication date: 2018
Peer-reviewed: Yes

Deformable Curves for Outlining Objects Directly From Projections

General information
Publication status: Published
Number of pages: 1
Publication date: 2018
Peer-reviewed: Yes
Keywords: Tomographic reconstruction, Deformable models, Segmentation, Meshing
Electronic versions:
Investigation of a Monturaqui Impactite by Means of Bi-Modal X-ray and Neutron Tomography

X-ray and neutron tomography are applied as a bi-modal approach for the 3D characterisation of a Monturaqui impactite formed by shock metamorphism during the impact of an iron meteorite with the target rocks in the Monturaqui crater (Chile). The particular impactite exhibits structural heterogeneities on many length scales: its composition is dominated by silicate-based glassy and crystalline materials with voids and Fe/Ni-metal and oxihydroxides particles generally smaller than 1 mm in diameter. The non-destructive investigation allowed us to apply a novel bi-modal imaging approach that provides a more detailed and quantitative understanding of the structural and chemical composition compared to standard single mode imaging methods, as X-ray and neutron interaction with matter results in different attenuation coefficients with a non-linear relation. The X-ray and neutron data sets have been registered, and used for material segmentation, porosity and metallic content characterization. The bimodal data enabled the segmentation of a large number of different materials, their morphology as well as distribution in the specimen including the quantification of volume fractions. The 3D data revealed an evaporite type of material in the impactite not noticed in previous studies. The present study is exemplary in demonstrating the potential for non-destructive characterisation of key features of complex multi-phase objects such as impactites.

Layered Surface Detection for Virtual Unrolling

We present a method for virtual unrolling of a thin rolled object. From a volumetric image of the rolled object we obtain a flat image of the object's surface, which allows visual inspection of the object and has a number of applications. Our method exploits the geometric constrains of the problem and detects a single rolled surface. For surface detection we adapt a solution to an optimal net surface problem, previously used for terrain-like and tubular surfaces. We present our approach on an example of a rolled sheet of microelectronic, which has a layer of flexible polymer substrate and a thin metal layer lithographically coated onto the
Linear, Transfinite and Weighted Method for Interpolation from Grid Lines Applied to OCT Images

When performing a line scan using optical coherence tomography (OCT), the distance between the successive scan lines is often large compared to the resolution along each scan line. If two sets of such line scans are acquired orthogonal to each other, intensity values are known along the lines of a square grid, but are unknown inside each square. To view these values as an image, intensities need to be interpolated at regularly spaced pixel positions. In this paper we evaluate three methods for interpolation from grid lines: linear, transfinite and weighted. The linear method does not preserve the known values along the grid lines. The transfinite method, known from mesh generation, preserves the known values but might cause artifacts further away from the grid lines. The weighted method, which we propose, is designed to combine the desired properties of the transfinite method close to grid lines and the stability of the linear method further away. An important parameter influencing the performance of the interpolation methods is the upsampling rate. We perform an extensive evaluation of the three interpolation methods across a range of upsampling rates. Our statistical analysis shows significant difference in the performance of the three methods. We find that the transfinite interpolation works well for small upsampling rates and the proposed weighted interpolation method performs very well for all upsampling rates typically used in practice. On the basis of these findings we propose an approach for combining two OCT scans, acquired such that the lines of the second scan are orthogonal to the first.
Multi-phase Volume Segmentation with Tetrahedral Mesh

In life science and material science, it is often desirable to segment a volumetric data set in such a way that multiple materials (phases) are segmented and a tetrahedral mesh representation is obtained for each segment for downstream applications. Unfortunately, obtaining a mesh, typically from CT or MRI scan, is challenging, especially in 3D. This paper proposes an novel approach for volume segmentation using a tetrahedral mesh. Our method employs a deformable model that minimizes the Mumford-Shah energy function. We apply our method to several CT data sets in order to demonstrate its advantages: multi-phase support, robustness to noise, and adaptive resolution outputs. Our method is based on the Deformable Simplicial Complex (DSC) method for tracking deformable interfaces which is designed specifically to deal with topology changes.

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Statistics and Data Analysis
Number of pages: 13
Publication date: 2018

Host publication information
Title of host publication: Proceedings of British Machine Vision Conference
Publisher: BMVA Press
Electronic versions: 0910.pdf
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2018 › Research › peer-review

Quantifying fibre reorientation during axial compression of a composite through time-lapse X-ray imaging and individual fibre tracking

The sudden compressive failure of unidirectional (UD) fibre reinforced composites at loads well below their tensile strengths is a cause of practical concern. In this respect and more generally, analytical and numerical models that describe composite behaviour have been hard to verify due to a lack of experimental observation, particularly in 3D. The aim of this paper is to combine fast in-situ X-ray computed tomography (CT) with advanced image analysis to capture the changes in fibre orientation in 3D during uninterrupted progressive loading in compression of a UD glass fibre reinforced polymer (GFRP). By analysing and establishing correspondence between a sequence of time-lapse X-ray CT images of the composite, we are able for the first time to follow each fibre and quantify the progressive deflection that takes place during axial compression in the steps leading up to fibre micro-buckling and kinking. Even at just 25% of the failure load, fibres have started to tilt in approximately the direction of the ultimate kink band. The rate of tilting increases as the composite approaches the collapse load. More generally, our approach can be applied to investigate the behaviour of a wide range of fibrous materials under changing loading conditions.

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Statistics and Data Analysis, University of Manchester
Pages: 47-54
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: COMPOSITES SCIENCE AND TECHNOLOGY
Volume: 168
ISSN (Print): 0266-3538
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
Original language: English
Keywords: A. Carbon fibres, B. Mechanical properties, C. Damage mechanisms, Buckling, Fibre misalignment
DOIs: 10.1016/j.compscitech.2018.08.028
Source: FindIt
Source-ID: 2438714925
Research output: Contribution to journal › Journal article – Annual report year: 2018 › Research › peer-review
Statistical validation of individual fibre segmentation from tomograms and microscopy

Imaging with X-ray computed tomography (CT) enables non-destructive 3D characterisations of the micro-structure inside fibre composites. In this paper we validate the use of X-ray CT coupled with image analysis for characterising unidirectional (UD) fibre composites. We compare X-ray CT at different resolutions to optical microscopy (OM) and scanning electron microscopy (SEM), where we characterise fibres by their diameters and positions. In addition to comparing individual fibre diameters, we also model their spatial distribution, and compare the obtained model parameters. Our study shows that X-ray CT is a high precision technique for characterising fibre composites and, with our suggested image analysis method for fibre detection, high precision is also obtained at low resolutions. This has great potential, since it allows larger fields of view to be analysed. Besides analysing representative volumes with high precision, we demonstrate that based on our methodology for individual fibre segmentation it is now possible to study complete bundles at the fibre scale and reveal inhomogeneities in the physical sample.

Understanding UD Fibre-reinforced Polymers through X-ray Imaging and Individual Fibre Tracking

X-ray computed tomography (CT) is a powerful tool for characterising materials for its ability to reveal their internal structure in a non-destructive manner. The recent advances in X-ray imaging have brought high-resolution X-rays to laboratory sources, making this tool available to a broader public. Additionally, thanks to the developments in ultra-fast X-ray imaging at synchrotron beamlines, it is now possible to capture the very fast structural changes inside materials under realistic working conditions, e.g. in operation or under loading. There is a need for advanced image analysis methods that can exploit the information contained in these 3D and 4D data-sets of high spatial and temporal resolution, which often contain image artefacts and noise. We have developed a method to characterise the geometry of materials reinforced with long fibres [1], such as glass and carbon fibre reinforced polymers. The method is based on segmenting individual fibres and the task is specially challenging when the image is noisy and its resolution is limited, because the fibres are densely packed. A limited spatial resolution might arise from the need of performing fast scans, to capture the sudden micro-structural changes that happen when reaching the composite’s collapse load, and will facilitate scanning large fields of view containing many fibres, necessary to ensure representative characterisations of a material’s micro-structure. Due to the robustness of our method to image quality [2], we have been able to characterise fibre orientations and diameter distributions in complete bundles, relevant for investigating the effect of the design and manufacturing processes on the mechanical properties of the materials. Moreover, we have applied our methodology to study the behaviour of a fibre composite under compressive loading. Following the changes in each individual fibre under progressive loading conditions, and correlating these with the initial structure of the material, can reveal the precursors to the very complex damage mechanisms that affect fibre composites.
A Probabilistic Framework for Curve Evolution

In this work, we propose a nonparametric probabilistic framework for image segmentation using deformable models. We estimate an underlying probability distribution of image features from regions defined by a deformable curve. We then evolve the curve such that the distance between the distributions is increasing. The resulting active contour resembles a well-studied piecewise constant Mumford-Shah model, but in a probabilistic setting. An important property of our framework is that it does not require a particular type of distributions in different image regions. Additional advantages of our approach include ability to handle textured images, simple generalization to multiple regions, and efficiency in computation. We test our probabilistic framework in combination with parametric (snakes) and geometric (level-sets) curves. The experimental results on composed and natural images demonstrate excellent properties of our framework.

Automatic Segmentation of Abdominal Fat in MRI-Scans, Using Graph-Cuts and Image Derived Energies

For many clinical studies changes in the abdominal distribution of fat is an important measure. However, the segmentation of abdominal fat in MRI scans is both difficult and time consuming using manual methods. We present here an automatic and flexible software package, that performs both bias field correction and segmentation of the fat into superficial and deep subcutaneous fat as well as visceral fat with the spinal compartment removed. Assessment when comparing to the gold standard - CT-scans - shows a correlation and bias comparable to manual segmentation. The method is flexible by tuning the image-derived energies used for the segmentation, allowing the method to be applied to other body parts, such as the thighs.
Cache-mesh, a Dynamics Data Structure for Performance Optimization
This paper proposes the cache-mesh, a dynamic mesh data structure in 3D that allows modifications of stored topological relations effortlessly. The cache-mesh can adapt to arbitrary problems and provide fast retrieval to the most-referred-to topological relations. This adaptation requires trivial extra effort in implementation with the cache-mesh, whereas it may require tremendous effort using traditional meshes. The cache-mesh also gives a further boost to the performance with parallel mesh processing by caching the partition of the mesh into independent sets. This is an additional advantage of the cache-mesh, and the extra work for caching is also trivial. Though it appears that it takes effort for initial implementation, building the cache-mesh is comparable to a traditional mesh in terms of implementation.

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Statistics and Data Analysis
Contributors: Nguyen, T. T., Dahl, V. A., Bærentzen, J. A.
Pages: 193-205
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Procedia Engineering
Volume: 203
ISSN (Print): 1877-7058
Scopus rating (2017): CiteScore 0.89
Web of Science (2017): Indexed yes
Original language: English
Keywords: Cache, Geometry processing, Dynamics structure, Data Structure, Performance optimization

Geometrical Characterisation of Individual Fibres From X-Ray Tomograms
We have developed an image analysis pipeline that can extract individual fibre tracks from low contrast X-ray tomograms of unidirectional composites with high fibre volume fraction. Measuring individual fibre tracks opens up the possibility of modelling the empirical data in a statistical manner. Thus, allowing to analyse the spatial distribution of the parameters characterising the orientation and curvature of these individual fibres, which can also provide insights on the interactions amongst the individual fibres. Finite element models (FEMs) can be built from the extracted geometry to simulate the performance of the scanned fibre structure under realistic conditions. Moreover, aspects of the fibre architecture that influence the macroscopic behaviour of the composite can be quantified. Examples are 2D FEMs to predict the transverse stiffness or the quantification of fibre orientations to estimate the compression strength. And last but not least, already developed analytical and numerical models to describe the composite's behaviour can be validated against the observed data.

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Statistics and Data Analysis
Number of pages: 1
Pages: 59
Publication date: 2017

Host publication information
Interpolation from Grid Lines: Linear, Transfinite and Weighted Method

When two sets of line scans are acquired orthogonal to each other, intensity values are known along the lines of a grid. To view these values as an image, intensities need to be interpolated at regularly spaced pixel positions. In this paper we evaluate three methods for interpolation from grid lines: linear, transfinite and weighted. Linear method does not preserve the known values along the grid lines. Transfinite method, known from mesh generation, preserves the known values but might cause overshoot. The weighted method, which we propose, is designed to combine the desired properties of transfinite method close to grid lines, and the stability of the linear method. We perform an extensive evaluation of the three interpolation methods across a range of upsampling rates for two data sets. Depending on the upsampling rate, we show significant difference in the performance of the three methods. We find that the transfinite interpolation works well for small upsampling rates and the proposed weighted interpolation method performs very well for all relevant upsampling rates.

Multi-phase Volume Segmentation with Tetrahedral Mesh

Volume segmentation is efficient for reconstructing material structure, which is important for several analyses, e.g. simulation with finite element method, measurement of quantitative information like surface area, surface curvature, volume, etc. We are concerned about the representations of the 3D volumes, which can be categorized into two groups: fixed voxel grids [1] and unstructured meshes [2]. Among these two representations, the voxel grids are more popular since manipulating a fixed grid is easier than an unstructured mesh, but they are less efficient for quantitative measurements. In many cases, the voxel grids are converted to explicit meshes, however the conversion may reduce the accuracy of the segmentations, and the effort for meshing is also not trivial. On the other side, methods using unstructured meshes have difficulty in handling topology changes. To reduce the complexity, previous methods only represent the surfaces, thus they only segment a single region without exterior or interior information (e.g. holes). Finally, yet importantly, previous methods of both representations have issues with multi-material segmentation, where vacuum and overlapping between surfaces occur. This paper proposes a method for volume segmentation using a tetrahedral mesh. The compelling advantages of our method include: natural multi-material support; output is tetrahedral mesh that can be utilized for simulation and analysis directly; and the ability to control the resolution for compact meshes. We are also experimenting to prove our advantages on high accuracy; and the potentiality to accompany shape prior information during segmentation.
New approach for validating the segmentation of 3D data applied to individual fibre extraction

We present two approaches for validating the segmentation of 3D data. The first approach consists on comparing the amount of estimated material to a value provided by the manufacturer. The second approach consists on comparing the segmented results to those obtained from imaging modalities that provide a better resolution and therefore a more accurate segmentation. The imaging modalities used for comparison are scanning electron microscopy, optical microscopy and synchrotron CT. The validation methods are applied to the assess the segmentation of individual fibres from X-ray microtomograms.

Quantitatively Measured Anatomic Location and Volume of Optic Disc Drusen: An Enhanced Depth Imaging Optical Coherence Tomography Study

Optic disc drusen (ODD) are found in up to 2.4% of the population and are known to cause visual field defects. The purpose of the current study was to investigate how quantitatively estimated volume and anatomic location of ODD influence optic nerve function. Anatomic location, volume of ODD, and peripapillary retinal nerve fiber layer and macular ganglion cell layer thickness were assessed in 37 ODD patients using enhanced depth imaging optical coherence tomography. Volume of ODD was calculated by manual segmentation of ODD in 97 B-scans per eye. Anatomic characteristics were compared with optic nerve function using automated perimetric mean deviation (MD) and multifocal visual evoked potentials. Increased age (P = 0.015); larger ODD volume (P = 0.002); and more superficial anatomic ODD location (P = 0.007) were found in patients with ODD visible by ophthalmoscopy compared to patients with buried ODD. In a multivariate analysis, a worsening of MD was significantly associated with larger ODD volume (P <0.0001). No association was found between MD and weighted anatomic location, age, and visibility by ophthalmoscopy. Decreased ganglion cell layer thickness was significantly associated with worse MD (P = 0.025) and had a higher effect on MD when compared to retinal nerve fiber layer thickness. Large ODD volume is associated with optic nerve dysfunction. The worse visual field defects associated with visible ODD should only be ascribed to larger ODD volume and not to a more superficial anatomic ODD location.
Quantitative measure of optic disc drusen location in enhanced depth imaging optical coherence tomography scans

Purpose: A quantitative measure of anatomical optic disc drusen (ODD) location in the optic nerve head can be an important parameter in the investigation of ODD formation and the development of visual field defects. We propose a method for defining a quantitative measure of ODD location relative to Bruch’s membrane.

Methods: Optic disc drusen in high resolution enhanced depth imaging optical coherence tomography scans were manually segmented using ITK-SNAP by a trained ophthalmologist. To quantify a location of each ODD, we need a reference. Bruch’s membrane serves as an excellent reference, but does not exist within the optic nerve head, where the ODD are located. Therefore we performed a semi-automatic graph based segmentation of Bruch’s membrane at the margin in each B-scans. From the segmentation we obtained two landmarks per B-scan. Based on the landmarks in each B-scan, we defined a reference surface relative to Bruch’s membrane. The Euclidean distance from the center of mass of each manually segmented ODD to the defined reference surface gave a quantitative measurement of each druse location. Furthermore, the quantitative measure was signed which indicated whether the ODD was located above or below the reference surface.

Results: We computed a reference surface (Fig. 1) based on Bruch’s membrane segmented at the margin in 97 B-scans per patient for 37 patients in total (Fig. 2). The average number of ODD was 4.4 (± 5.78) per patient and the average distance from the center of mass for each ODD to the defined reference surface was 0.19 mm (± 0.3 mm).

Conclusions: A defined reference surface based on Bruch’s membrane in ODD patients resulted in a quantitative measure of ODD location. The quantitative measure indicates whether the ODD is located above or below the reference surface. The quantitative measure of anatomical ODD location can act as an important parameter in future ODD research.
Unidirectional Fibre Composite Characterisation from X-ray Tomography

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Department of Wind Energy, Composites Mechanics and Materials Mechanics, Statistics and Data Analysis, University of Manchester
Number of pages: 1
Publication date: 2017
Peer-reviewed: No
Event: Poster session presented at TMS 2017, San Diego, United States.
Electronic versions:
posterTMSconference_monj_final.pdf
Source: PublicationPreSubmission
Source-ID: 130858539
Research output: Contribution to conference › Poster – Annual report year: 2017 › Research

Automatic measurement of orbital volume in unilateral coronal synostosis
Premature fusion of the coronal suture on one side of the calvaria (unilateral coronal synostosis, UCS) results in asymmetric craniofacial development and the deformation of the orbits. Often this necessitates surgery, where CT scanning is employed to obtain measures of the bony orbit. These measures are typically computed by guided procedures that require expert time. We propose a method with higher degree of automation based on finding an optimal smooth closed surface. CT scans of 17 infants with UCS are included in our experimental validation, where we compare our method to expert guided segmentations. We obtain similar measures, as well as high Dice scores, compared to the experts. The run time for the proposed approach with a prototype implementation is around 3 minutes on a standard laptop, making the method suitable for rapid evaluation of orbital volume in UCS.

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Image Analysis & Computer Graphics, Copenhagen University Hospital, University of Copenhagen, Osaka University
Pages: 889-893
Publication date: 2016
Host publication information
Title of host publication: Proceedings of the 13th International Symposium on Biomedical Imaging (ISBI 2016)
Publisher: IEEE
ISBN (Electronic): 978-1-4799-2349-6
Keywords: Image segmentation, Bone, Computed tomography (CT)
DOIs:
10.1109/ISBI.2016.7493408
Source: FindIt
Source-ID: 2305940852
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2016 › Research › peer-review

Layered Surface Detection in Micro-CT Tetra Pak Data

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Department of Physics, Neutrons and X-rays for Materials Physics, Image Analysis & Computer Graphics, Tetra Pak Packaging Solutions AB
Number of pages: 3
Publication date: 2016
Peer-reviewed: Yes
Electronic versions:
The Traveling Optical Scanner – Case Study on 3D Shape Models of Ancient Brazilian Skulls

Recovering detailed morphological information from archaeological or paleontological material requires extensive hands-on time. Creating 3D scans based on e.g. computed tomography (CT) will recover the geometry of the specimen, but can inflict bimolecular degradation. Instead, we propose a fast, inoffensive and inexpensive 3D scanning modality based on structured light, suitable for capturing the morphology and the appearance of specimens. Benefits of having 3D models are manifold. The 3D models are easy to share among researchers and can be made available to the general public.

Advanced morphological modelling is possible with accurate description of the specimens provided by the models. Furthermore, performing studies on models reduces the risk of damage to the original specimen. In our work we employ a high resolution structured light scanner for digitalizing a collection of 8500 year old human skulls from Brazil. To evaluate the precision of our setup we compare the structured light scan to micro-CT and achieve submillimetre difference. We analyse morphological features of the Brazilian skulls using manual landmarks, but a research goal is to automate this, fully utilize the dense 3D scans, and apply the method to many more samples.

X-ray based micromechanical finite element modeling of composite materials

This is a study of a uni-directional non-crimp fabric reinforced epoxy composite material typically used as the load carrying laminate in wind turbine blades. Based on a 3D xray tomography scan, the bundle and fibre/matrix structure of the composite is segmented. This segmentation is used in a multi-scale finite element model bridging the gap from the individual fibers organized in bundles to the stitched non-crimp fabric used for building up the load carrying laminates.
Dictionary Based Image Segmentation

We propose a method for weakly supervised segmentation of natural images, which may contain both textured or non-textured regions. Our texture representation is based on a dictionary of image patches. To divide an image into separated regions with similar texture, we use an implicit level sets representation of the curve, which makes our method topologically adaptive. In addition, we suggest a multi-label version of the method. Finally, we improve upon a similar texture representation, by formulating the computation of a texture probability in terms of a matrix multiplication. This results in an efficient implementation of our segmentation method. We experimentally validated our approach on a number of natural as well as composed images.

Layered Surface Detection in Micro-CT Tetra Pak Data

General information
Segmentation and characterization of fibers

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
Contributors: Dahl, V. A.
Publication date: 2015
Media of output: PowerPoint

Event information
Event: ERF
Location: Lund, Sweden
Electronic versions:
ERFA_meeting_20141007_removed
Research output: Non-textual form › Sound/Visual production (digital) – Annual report year: 2015 › Research

Surface Detection and Segmentation

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
Contributors: Dahl, V. A.
Publication date: 2015
Media of output: PowerPoint

Event information
Event: CT Scanning Erfa-gruppe
Location: Kgs. Lyngby, Denmark
Electronic versions:
20150915_fibersegmentering.pdf
Research output: Non-textual form › Sound/Visual production (digital) – Annual report year: 2015 › Research

Two segmentation methods

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
Contributors: Dahl, V. A.
Publication date: 2015
Media of output: PowerPoint

Event information
Event: Image reconstruction and analysis workshop
Location: University of Copenhagen, Copenhagen, Denmark
Electronic versions:
segmentation_slides.pdf
Research output: Non-textual form › Sound/Visual production (digital) – Annual report year: 2014 › Research
Dictionary Snakes
Visual cues like texture, color and context make objects appear distinct from the surroundings, even without gradients between regions. Texture-rich objects are often difficult to segment because algorithms need advanced features which are unique for the image. In this paper we suggest a method for image segmentation that operates without training data. Our method is based on a probabilistic dictionary of image patches coupled with a deformable model inspired by snakes and active contours without edges. We separate the image into two classes based on the information provided by the evolving curve, which moves according to the probabilistic information obtained from the dictionary. Initially, the image patches are assigned to the nearest dictionary element, where the image is sampled at each pixel such that patches overlap. The curve divides the image into an inside and an outside region allowing us to estimate the pixel-wise probability of the dictionary elements. In each iteration we evolve the curve and update the probabilities, which merges similar texture patterns and pulls dissimilar patterns apart. We experimentally evaluate our approach, and show how textured objects are precisely segmented without any prior assumptions about image features. In addition, a texture probability image is obtained.

Multiphase Image Segmentation Using the Deformable Simplicial Complex Method
The deformable simplicial complex method is a generic method for tracking deformable interfaces. It provides explicit interface representation, topological adaptivity, and multiphase support. As such, the deformable simplicial complex method can readily be used for representing active contours in image segmentation based on deformable models. We show the benefits of using the deformable simplicial complex method for image segmentation by segmenting an image into a known number of segments characterized by distinct mean pixel intensities.
Surface Detection using Round Cut
We propose an iterative method for detecting closed surfaces in a volumetric data, where an optimal search is performed in a graph build upon a triangular mesh. Our approach is based on previous techniques for detecting an optimal terrain-like or tubular surface employing a regular grid. Unlike similar adaptations for triangle meshes, our method is capable of capturing complex geometries by iteratively refining the surface, where we obtain a high level of robustness by applying explicit mesh processing to intermediate results. Our method uses on-surface data support, but it also exploits data information about the region inside and outside the surface. This provides additional robustness to the algorithm. We demonstrate the capabilities of the approach by detecting surfaces of CT scanned objects.

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Image Analysis & Computer Graphics
Contributors: Dahl, V. A., Dahl, A. B., Larsen, R.
Number of pages: 8
Pages: 82-89
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the International Conference on 3D Vision (3DV 2014): Workshop on Dynamic Shape Measurement and Analysis
Publisher: IEEE
Keywords: Image Processing, Image analysis, object detection
Electronic versions:
RoundCut_DSMA_FINAL.pdf
DOIs:
10.1109/3DV.2014.60
Source: PublicationPreSubmission
Source-ID: 101143671
Research output: Chapter in Book/Report/Conference proceeding → Article in proceedings – Annual report year: 2014 → Research → peer-review

3D Shape Modeling Using High Level Descriptors
The goal of this Ph.D. project is to investigate and improve the methods for describing the surface of 3D objects, with focus on modeling geometric texture on surfaces. Surface modeling being a large field of research, the work done during this project concentrated around a few smaller areas corresponding to the research papers presented here. One of those areas is formulating surface priors by utilizing local surface properties. A well defined prior can, in a Bayesian framework, assist many common task in geometry processing, like denoising, object recovery, object matching and classification. Some of the priors described here are defined on the main entities of the triangular mesh, vertices, edges and faces. Other priors are defined on small planar patches, denoted surfels. Another area of research deals with textures which cannot be described by height fields, for example biological features like thorns, bark and scales. Presented here is a simple method for easy modeling, transferring and editing that kind of texture. The method is an extension of the height-field texture, but incorporates an additional tilt of the height field. Related to modeling non-heightfield textures, a part of my work involved developing feature-aware resizing of models with complex surfaces consisting of underlying shape and a distinctive texture detail. The aim was to deform an object while preserving the shape and size of the features.

General information
Publication status: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Contributors: Andersen, V.
Number of pages: 139
Publication date: 2011

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark, DTU Informatics, Building 321
Original language: English
(IMM-PHD-2011; No. 233).
Electronic versions:
phd233_va-m.pdf
Source: orbit
Source-ID: 263603
Deliverable 3.1: Sampling protocols for inorganic ENP from at least 3 matrices (meat, soup, olive oil)

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, National Food Institute, Research group for Nano-Bio Science
Contributors: Ersbøll, B. K., Dahl, V. A., Löschner, K., Larsen, E. H.
Number of pages: 25
Publication date: 2011

Publication information
Publisher: NanoSafety Cluster
Original language: English
Electronic versions:
NanoLyse_D3_1.pdf
Source: PublicationPreSubmission
Source-ID: 149478710
Research output: Book/Report › Report – Annual report year: 2011 › Commissioned

Markov Random Fields on Triangle Meshes
In this paper we propose a novel anisotropic smoothing scheme based on Markov Random Fields (MRF). Our scheme is formulated as two coupled processes. A vertex process is used to smooth the mesh by displacing the vertices according to a MRF smoothness prior, while an independent edge process labels mesh edges according to a feature detecting prior. Since we should not smooth across a sharp feature, we use edge labels to control the vertex process. In a Bayesian framework, MRF priors are combined with the likelihood function related to the mesh formation method. The output of our algorithm is a piecewise smooth mesh with explicit labelling of edges belonging to the sharp features.

General information
Publication status: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, University of Copenhagen
Contributors: Andersen, V., Aanæs, H., Bærentzen, J. A., Nielsen, M.
Pages: 265-270
Publication date: 2010

Host publication information
Title of host publication: 18th International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision : Communication Papers Proceedings
Editor: Scala, V.
ISBN (Print): 978-80-86943-87-9
Electronic versions:
MRF_article.pdf
Source: orbit
Source-ID: 256241
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2010 › Research › peer-review

Surfel Based Geometry Reconstruction
We propose a method for retrieving a piecewise smooth surface from noisy data. In data acquired by a scanning process sampled points are almost never on the discontinuities making reconstruction of surfaces with sharp features difficult. Our method is based on a Markov Random Field (MRF) formulation of a surface prior, with the surface represented as a collection of small planar patches, the surfels, associated with each data point. The main advantage of using surfels is that we avoid treating data points as vertices. MRF formulation of the surface prior allows us to separately model the likelihood (related to the mesh formation process) and the local surface properties. We chose to model the smoothness by considering two terms: the parallelism between neighboring surfels, and their overlap. We have demonstrated the feasibility of this approach on both synthetical and scanned data. In both cases sharp features were precisely located and planar regions smoothed.

General information
Publication status: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Contributors: Andersen, V., Aanæs, H., Bærentzen, J. A.
Pages: 39-44
Height and Tilt Geometric Texture

We propose a new intrinsic representation of geometric texture over triangle meshes. Our approach extends the conventional height field texture representation by incorporating displacements in the tangential plane in the form of a normal tilt. This texture representation offers a good practical compromise between functionality and simplicity: it can efficiently handle and process geometric texture too complex to be represented as a height field, without having recourse to full blown mesh editing algorithms. The height-and-tilt representation proposed here is fully intrinsic to the mesh, making texture editing and animation (such as bending or waving) intuitively controllable over arbitrary base mesh. We also provide simple methods for texture extraction and transfer using our height-and-field representation.

Markov Random Fields on 3D Polygonal Meshes

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling, University of Copenhagen
Contributors: Andersen, V., Aanæs, H., Bærentzen, J. A., Nielsen, M.
Number of pages: 27
Pages: 16-17
Publication date: 2008

Host publication information
Title of host publication: Proceedings of the 16th Danish Conference on Pattern Recognition and Image Analysis
Place of publication: Copenhagen
Publisher: University of Copenhagen, Department of Computer Science
Electronic versions:
MeshesMRF.pdf
URLs:
http://www.diku.dk/publikationer/tekniske.rapporter/rapporter/08-10.pdf
Projects:

**Physical model priors for tomogram segmentation**
Brenne, E. O., PhD Student, Department of Energy Conversion and Storage
Jørgensen, P. S., Main Supervisor
Dahl, V. A., Supervisor
Marie Curie (EU-stipendium) m/virksomhed
01/08/2018 → 31/07/2021
Award relations: Physical model priors for tomogram segmentation
Project: PhD

**Segmentation from projections**
Koo, J., PhD Student, Department of Mathematics
Dahl, V. A., Main Supervisor
Dahl, A. B., Supervisor
Hansen, P. C., Supervisor
Marie Curie (EU-stipendium)
15/03/2018 → 14/03/2021
Award relations: Segmentation from projections
Project: PhD

**Multi-modal microstructure imaging of biological tissue**
Andersson, M., PhD Student, Department of Mathematics
Dyrby, T. B., Main Supervisor
Bech, M., Supervisor
Dahl, V. A., Supervisor
Offentlig finansiering
15/10/2017 → 14/10/2020
Award relations: Multi-modal microstructure imaging of biological tissue
Project: PhD

**New Multi-Modal Registration Methods: Application in Fetal Image Reconstruction**
Engberg, A. M. E., PhD Student, Department of Mathematics
Van Leemput, K., Main Supervisor, Department of Applied Mathematics and Computer Science
Cuadra, M. B., Supervisor
Thiran, J., Supervisor
Dahl, V. A., Main Supervisor
Dahl, A. B., Supervisor
Samfinansieret - Andet
01/11/2016 → 31/10/2019
Award relations: New Multi-Modal Registration Methods: Application in Fetal Image Reconstruction
Project: PhD

**3D Shape Analysis for Morphometric Evolutionary Modelling- based on 3D X-ray Tomography and Optical Scanning**
Messer, D., PhD Student, Department of Mathematics
Dahl, A. B., Main Supervisor
Dahl, V. A., Supervisor
Orlando, L. A. A., Supervisor
Technical University of Denmark
01/06/2016 → 10/05/2020
Award relations: 3D Shape Analysis for Morphometric Evolutionary Modelling- based on 3D X-ray Tomography and Optical Scanning
Project: PhD
Big Data Modelling with Applications to Airports
Nielsen, A. M., PhD Student, Department of Mathematics
Clemmensen, L. K. H., Main Supervisor
Dahl, A. B., Supervisor
Ersbøll, B. K., Supervisor
Dahl, V. A., Examiner
Sporring, J., Examiner
Jenssen, R., Examiner
Samfinansieret - Andet
01/08/2015 → 10/04/2019
Award relations: Big Data Modelling with Applications to Airports
Project: PhD

3D Optical Coherence Tomography for Retinopathy and Optic Neuropathy
Lindberg, A. W., PhD Student, Department of Mathematics
Jørgensen, T. M., Main Supervisor
Dahl, V. A., Supervisor
Hammann, S. E., Supervisor
Samfinansieret - Andet
01/12/2014 → 14/08/2020
Award relations: 3D Optical Coherence Tomography for Retinopathy and Optic Neuropathy
Project: PhD

Segmentation and Reconstruction of Multi-Phase Structures using the Derformable Simplicial Complex Method
Nguyen Trung, T., PhD Student, Department of Mathematics
Bærentzen, J. A., Main Supervisor
Dahl, V. A., Supervisor
Van Leemput, K., Examiner
Darkner, S., Examiner
Sramek, M., Examiner
Forskningsrådetsfinansiering
01/11/2014 → 15/08/2018
Award relations: Segmentation and Reconstruction of Multi-Phase Structures using the Derformable Simplicial Complex Method
Project: PhD

Hybrid Techniques for Interactive Photorealistic Rendering
Dal Corso, A., PhD Student, Department of Mathematics
Frisvad, J. R., Main Supervisor
Bærentzen, J. A., Supervisor
Dahl, V. A., Examiner
Unger, J., Examiner
Ritschel, T., Examiner
Technical University of Denmark
01/10/2014 → 15/08/2018
Award relations: Hybrid Techniques for Interactive Photorealistic Rendering
Project: PhD

3D Shape Modelling using High Level Descriptors
Dahl, V. A., PhD Student, Department of Informatics and Mathematical Modeling
Aanæs, H., Main Supervisor
Bærentzen, J. A., Supervisor
Paulsen, R. R., Examiner
Solem, J. E., Examiner
Sporring, J., Examiner
DTU-lønnet stipendie
01/06/2007 → 22/06/2011
Award relations: 3D Shape Modelling using High Level Descriptors
Project: PhD

Activities:
Segmentation and characterization of fibers
Period: 15 Sep 2015
Vedrana Andersen Dahl (Invited speaker)
Department of Applied Mathematics and Computer Science
Statistics and Data Analysis
Documents:
20150915_fibersegmentering

Related event
CT Scanning Erfa-gruppe
15/09/2015 → …
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

Layered Surface Detection in Micro-CT Tetra Pak Data
Period: 7 Oct 2014
Vedrana Andersen Dahl (Invited speaker)
Department of Applied Mathematics and Computer Science
Statistics and Data Analysis
Documents:
ERFA_meeting_20141007_removed

Related event
ERF
07/10/2014 → …
Lund, Sweden
Activity: Talks and presentations › Conference presentations

MEK/Compute seminar
Period: 3 Oct 2014
Vedrana Andersen Dahl (Speaker)
Department of Applied Mathematics and Computer Science
Statistics and Data Analysis
Description
Surface Detection and Segmentation
Documents:
VAND_MEK

Related event
MEK/Compute seminar
03/10/2014 → …
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

Image reconstruction and analysis workshop
Period: 28 Jan 2014
Vedrana Andersen Dahl (Speaker)
Department of Applied Mathematics and Computer Science
Statistics and Data Analysis
Description
Two segmentation methods: 1) multiphase image segmentation using the deformable simplicial complex method, and 2) volumetric segmentation using mesh-based optimal graph search.

Documents:
segmentation_slides

Related event

Image reconstruction and analysis workshop
28/01/2014 → 28/01/2014
Copenhagen, Denmark
Activity: Talks and presentations › Conference presentations