Program of the Demonstration Session

DGCI 2013

Demonstration 1

Title
Bioinspired parallel 2D or 3D skeletonization

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Abstract
Algebraic Topology is an useful tool in image Processing. In our case, we will borrow some elements from Algebraic Topology in order to show a parallel algorithm for thinning a binary 2D or 3D image respecting its shape information. The parallelization of the thinning algorithm is based on Membrane Computing, which is a very interesting research area useful in the development of parallel image processing algorithms. We present here the main guidelines of a software implemented on python along with a slight introduction of some required basic knowledge about Algebraic Topology and Membrane Computing.

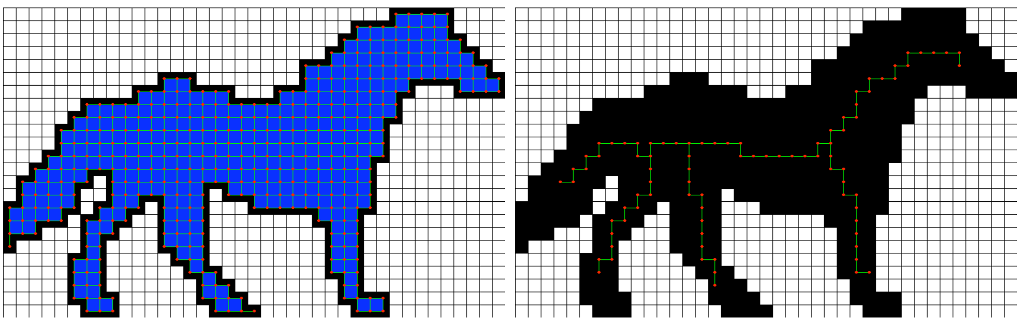

Figure 1. An example. Left, cell scructure for an image. Right, skeletonized image.

Demonstration 2

Title
Calibration in Optical Graph Recognition

Authors
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Abstract
Graph drawing is the process to transform the topological structure of a graph into a graphical representation. Primarily, it maps vertices to points and displays them by icons, and it maps edges to Jordan curves connecting the endpoints. Optical graph recognition (OGR) is the inverse and transforms the digital image of a drawn graph into its topological structure. It consists of four phases: preprocessing, segmentation, topology recognition, and postprocessing. OGR is based on established digital image processing techniques. Its novelty is the topology recognition where the edges are recognized with emphasis on the attachment to their vertices and on edge crossings. Our prototypical implementation OGR^{up} shows the effectiveness of the approach and produces a GraphML file, which can be used for further algorithmic studies and graph drawing tools. It has been tested both on hand made graph drawings and on drawings generated by graph drawing algorithms. Here we report on experiments for the calibration of parameters, which are critical for topology recognition.

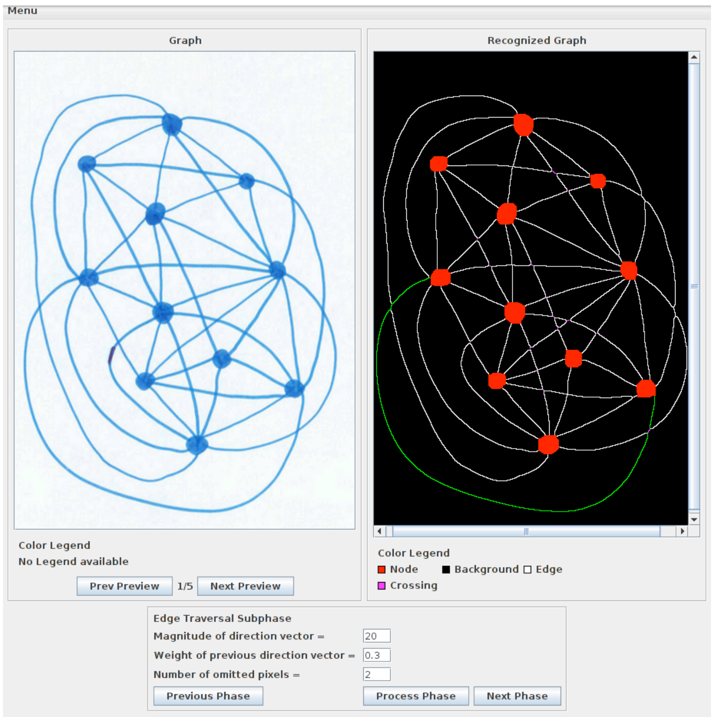

Figure 2. The GUI of OGR^{up} with a drawing of a graph and the recognized graph.

Title
Distributed boundary tracking using alpha and Delaunay-Cech shapes

Authors
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Abstract
We demonstrate real time tracking of systematic failures in sensor networks, using distributed computation of the α−shape derived from the network. More generally, our work may be applied to tracking the boundary of any time varying object, whose data is captured in the form of a point cloud. We also demonstrate the use of a new geometric object called the Delaunay-Cech shape, which is geometrically more appropriate than an α−shape for some cases.
For a given point set S in a plane, we develop a distributed algorithm to compute the α−shape of S. α−shapes are well known geometric objects which generalize the idea of a convex hull, and provide a good definition for the shape of S. We assume that the distances between pairs of points which are closer than a certain distance $r > 0$ are provided, and we show constructively that this information is sufficient to compute the alpha shapes for a range of parameters, where the range depends on r.

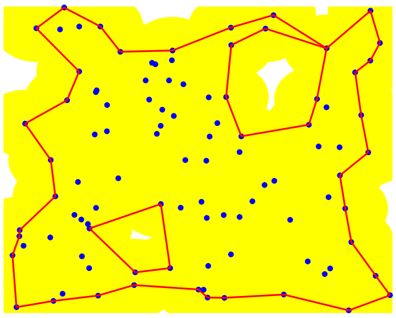
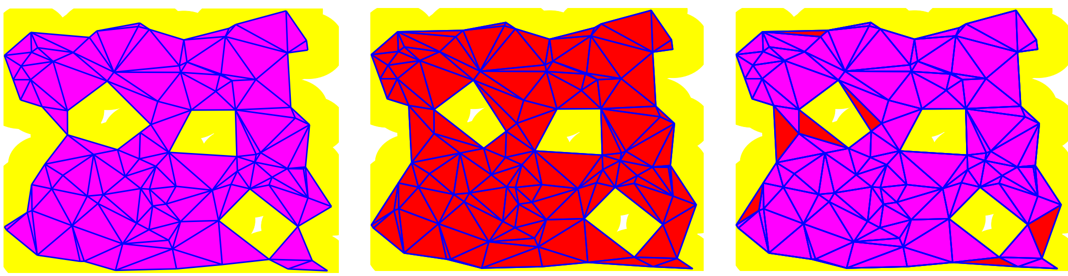


Figure 3. α−shape with parameter rc /2 for a set of points in R2 computed using the algorithm. The shaded region is the union of balls of radius r/2 centered at each point.



(a) $A_{r_c/2}(V)$ (b) $D\check{C}_{r_c/2}(V)$ (c) $A_{r_c/2}(V)$ super-imposed over $D\check{C}_{r_c/2}(V)$

Figure 4. Homotopy equivalentes.

Title
Regular map smoothing

Authors
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Abstract
A regular map is a family of equivalent polygons, glued together to form a closed surface without boundaries which is vertex, edge and face transitive. The commonly known regular maps are derived from the Platonic solids and some tessellations of the torus. There are also regular maps of genus greater than one which are traditionally viewed as finitely generated groups. RMS (Regular Map Smoothing) is a tool for visualizing a geometrical realization of such a group either as a cut-out in the hyperbolic space or as a compact surface in 3−space. It provides also a tool to make the resulting regular map more appealing than before. RMS achieves that by the use of a coloring scheme based on coset enumeration, a Catmull-Clark smoothing scheme and a force-directed algorithm with topology preservation.

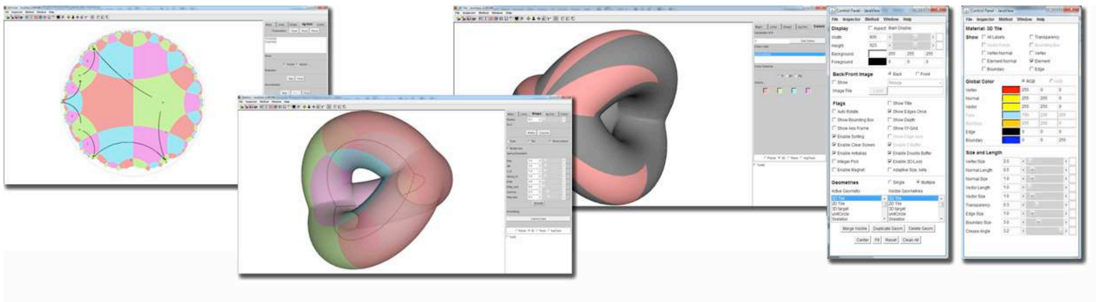

Figure 5. Overview of the user interface proposed by RMS.

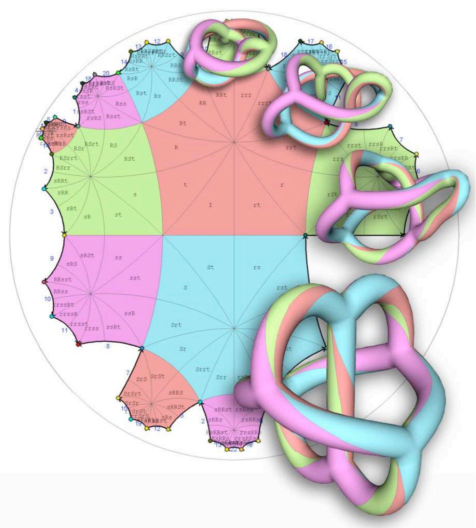

Figure 6. R4.3 {6, 4}, starting from the hyperbolic disc through a first candidate 3D embedding from [5] and smoothed by RMS to give an octahedral looking shape.

Demonstration 5

Title
Implementation of Integral based Digital Curvature Estimators in DGtal*

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Abstract
In many geometry processing applications, differential geometric quantities estimation such as curvature or normal vector field is an essential step. In [1], we have defined curvature estimators on digital shape boundaries based on Integral Invariants. In this paper, we focus on implementation details of these estimators.

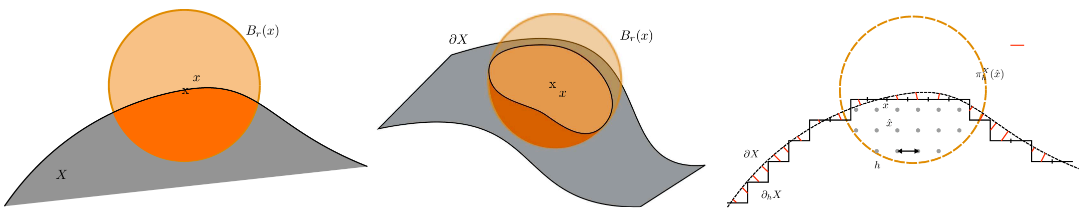

Figure 7. R4.3 {6, 4}, starting from the hyperbolic disc through a first candidate 3D embedding and smoothed by RMS to give an octahedral looking shape.

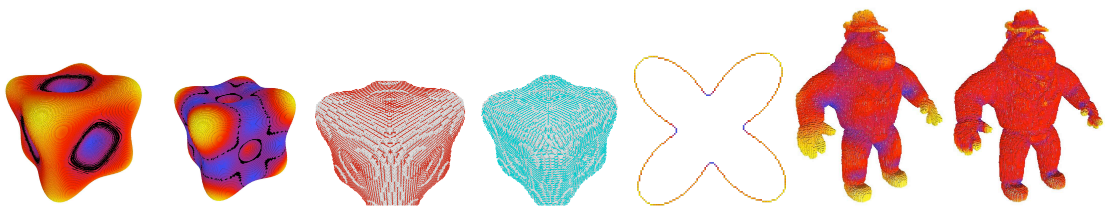

Figure 8. Illustration of curvature estimation.From left to right: mean curvature and Gaussian curvature (back color means zero curvature surfels), first and second principal curvature directions mapped on a blobby cube on a blobby cube, 2d curvature mapped on a Flower2D, 3d Gaussian curvature on Al with a convolution kernel size of 0.2 and with a convolution kernel size of 0.06.

Title

An application for gait recognition using persistent homology

Authors

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Abstract

This Demo presents an application for gait recognition using persistent homology. Using a background subtraction approach, a silhouette sequence is obtained from a camera in a controlled environment. A border simplicial complex is built stacking silhouettes aligned by their gravity center. A multifiltration is applied on the border simplicial complex which captures relations among the parts of the human body when walking. Finally, the topological gait signature is extracted from the persistence barcode according to each filtration. The measure cosine is used to give a similarity value between topological signatures. The input of this Demo are videos with resolution 320x240 to 25f ps. The videos in CASIA-B database are used to prove the efficacy and efficiency. A computer with 2Gb of RAM memory and a DualCore processor were used to test. In this Demo all topological functions have been programmed by the authors in the C++ programming language. OpenCV library has been used for the image processing part.

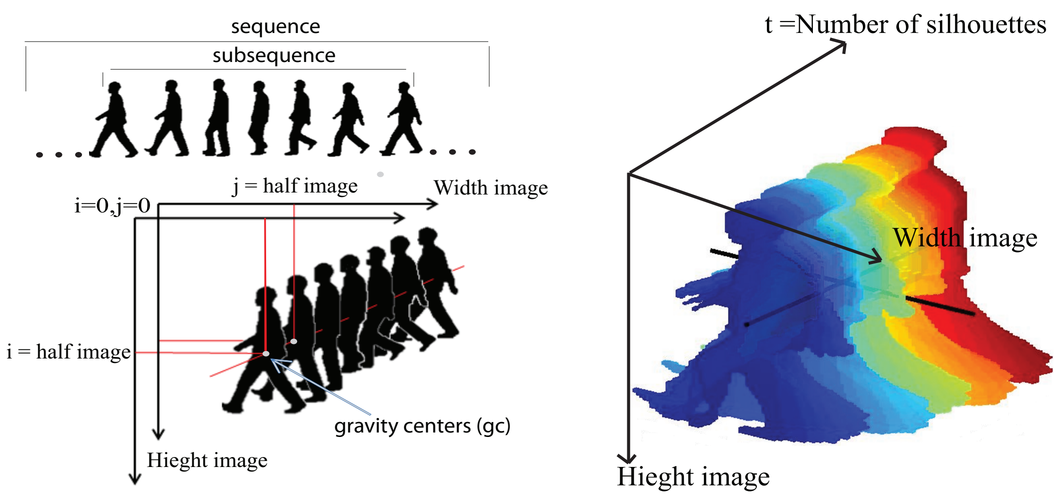

Figure 9. (a) Silhouettes aligned by their gravity centers (gc). (b) The 3D binary digital picture *I* obtained from the silhouettes.

Title

Reconstructing persistent graph structures from noisy images

Authors

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Abstract

Consider a noisy dotted image of a graph on the plane. We present a new fast algorithm for reconstructing a topological structure of the original graph with a high probability. Degrees of vertices in the graph are found by methods of persistent topology.

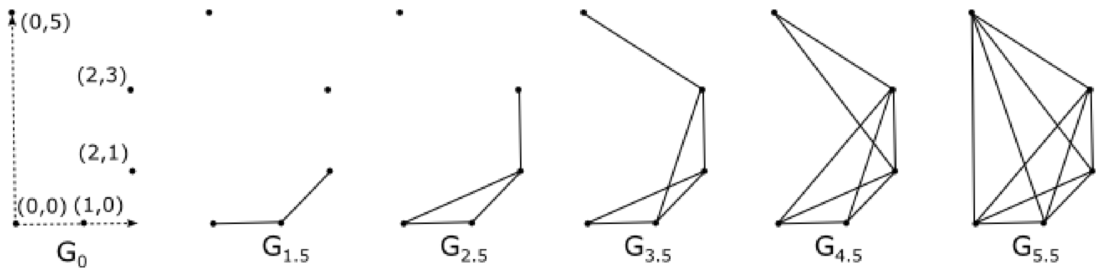

Figure 10. Growing graphs Gϵ for the point cloud of 5 points (0, 0), (1, 0), (2, 1), (2, 3), (0, 5).

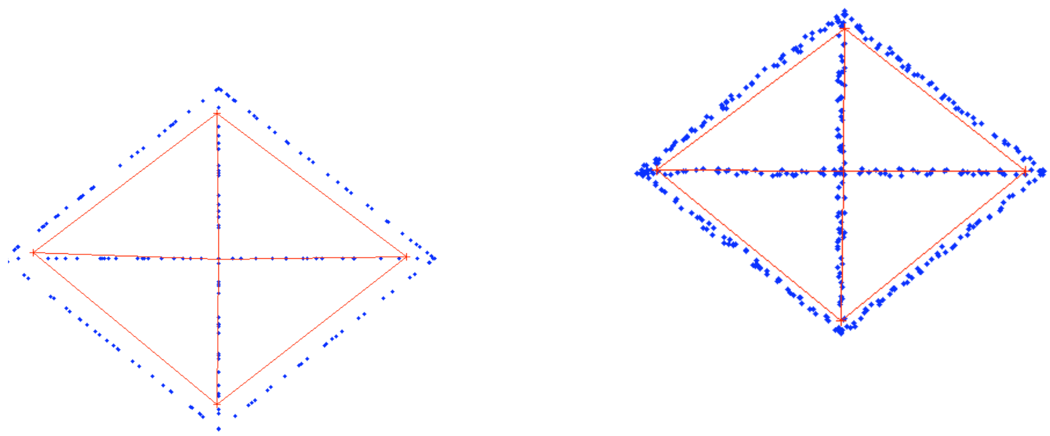

Figure 11. A red graph reconstructed from a blue point cloud around the diamond graph G.

Demonstration 8

Title

Software tool for contrast enhancement and segmentation of melanoma images based on human perception

Authors

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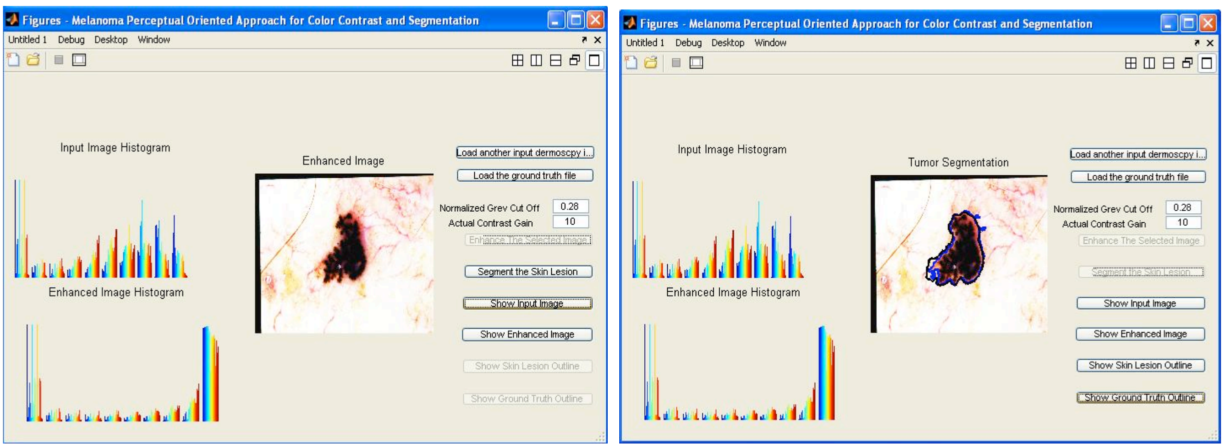
Abstract

In this paper we present a software tool for melanoma border detection (MBD). It has been designed to be incorporated in any Computer Aided Diagnosis Tool (CAD) for early detection of melanoma in mass screening programs. The tool is completely automatic, posses a user-friendly interface and does not require any specific hardware. The main steps followed by the implemented algorithm are: uneven illumination correction, color contrast improvement and color image segmentation. All of them are performedin the uniform color space CIE $L^*a^*b^*$ in order to achieve a complete adaptation to human color perception. The program is able to provide not only the final obtained segmentation result but also intermediate graphical outcomes, guiding the user in the process of melanoma detection. This simple, friendly but powerful interface can serve as a support for the medical personnel in the melanoma diagnostic process. The MBD software and some samples of the dermoscopy images used can be downloaded at http://cs.ntu.edu.pk/research.php.



(a) (b)

Figure 12. The original image is enhanced (a) and the segmentation is performed (b). The final segmentation result is shown in blue along with the ground truth in black.

Title
Interactive display of 2D and 3D discrete quadrics with controlled topology

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Abstract
In this demonstration, we are going to propose an interactive animation of analytically defined discrete conics (quadrics in 2D) and discrete quadrics in 3D. The digitization is performed on the 2D quadratic equation: $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$ and the 3D quadric equation $Ax^2 + By^2 + Cz^2 + Dxy + Exz + F\,yz + Gx + Hy + Iz + J = 0$. We propose 4 and 8-connected discrete 2D conics (naive and standard discrete conics) defined analytically where the user can see the resulting discrete conic while interacting with the parameters A, B, C, D, E and F. In the same way, we propose 6-separating and tunnel free 3D quadrics (naive and standard 3D quadrics) defined analytically where the user can can interactively modify the parameters A, B, C, D, E, F, G, H, I and J.

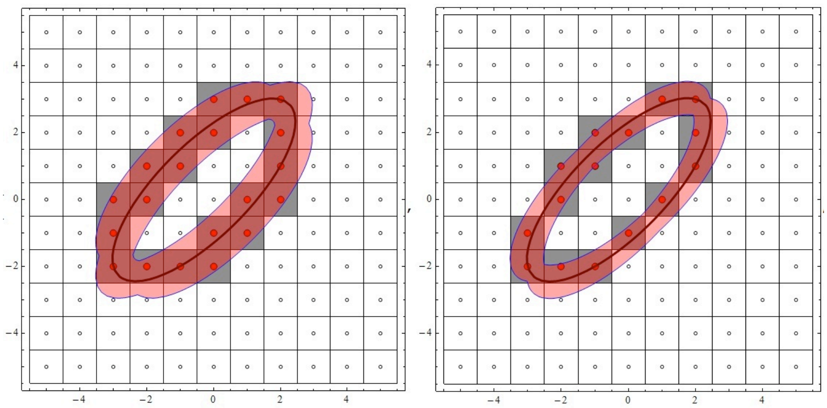

Figure 13. 4 and 8-connected digitized Ellipses of equation $-2x^2 + 3xy - 2y^2 - 2x + 2y + 6 = 0$.

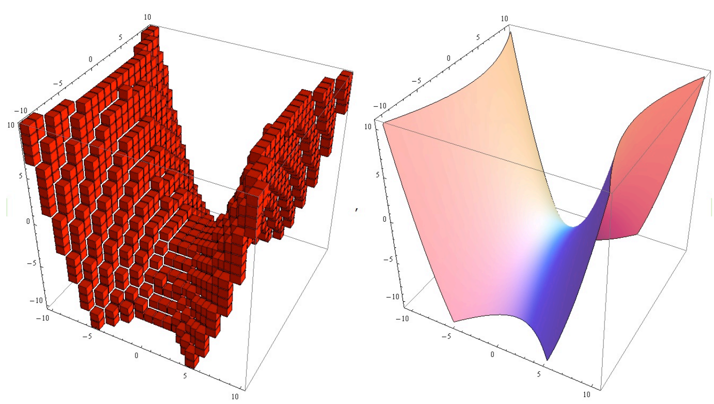

Figure 14. Naive Hyperbolic Paraboloid.

Title
TKDetection: a software to detect and segment wood knots

Authors
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Abstract
TKDetection is a software that proposes to segment knots in X-Ray CT images of trees. It implements algorithms combining tools of image analysis and discrete geometry like connex components extraction, contours extraction or dominant point detection. TKDetection is free and available on Github platform [2].

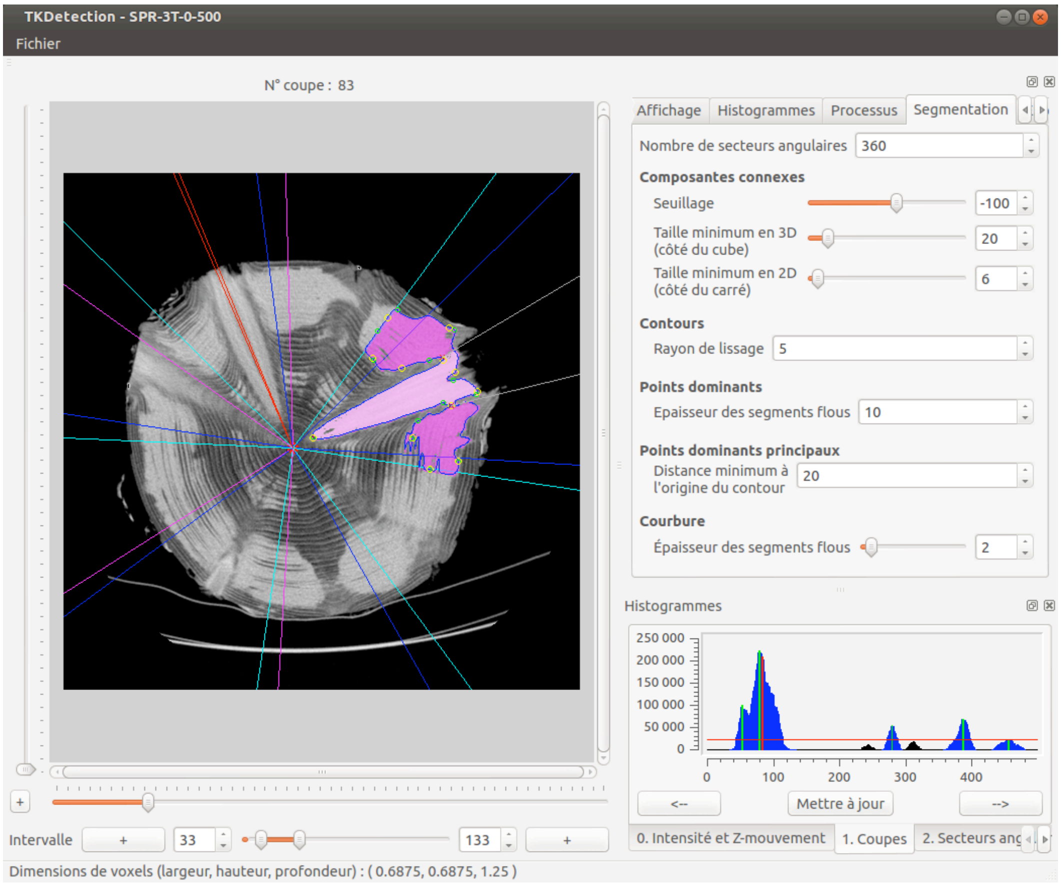

Figure 15. Overview of TKDetection interface.