SIMPLE-GRAPHS FUSION IN IMAGE MOSAIC. APPLICATION TO AUTOMATED CELL FILES IDENTIFICATION IN WOOD SLICES.

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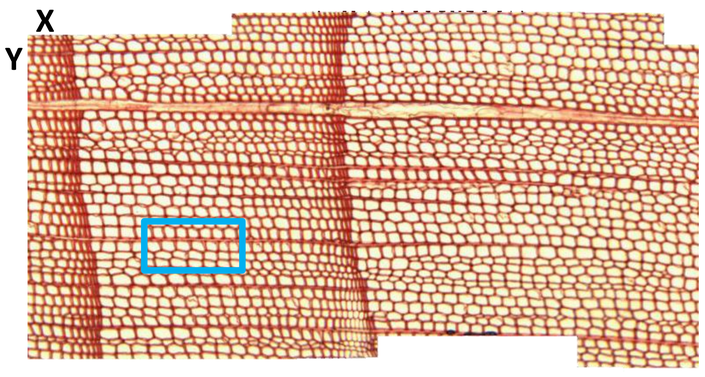
HIGHLIGHTS: Results aggregation by disjoint graph[1] merging is potentially a good alternative to image stitching[2]. During the processing of image mosaics, it allows to be free of radiometric and geometric corrections inherent in image fusion. We have studied and developed a generic merging method of disjoint graphs for tracking cell alignments[3] in image mosaics of wood.

KEYWORDS: graphs theory, graphs fusion, image processing, pattern recognition, cell segmentation, cell organization.

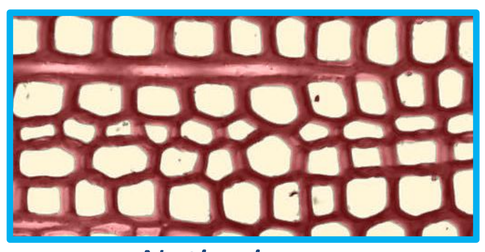
Image acquisition

*Acquisition device with mobile microscope stage: known **coordinates***

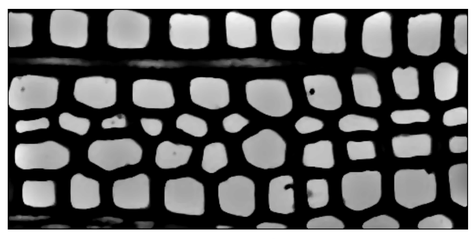


*A **mosaic** of a softwood (6400x8000 pixels) from 4 images*

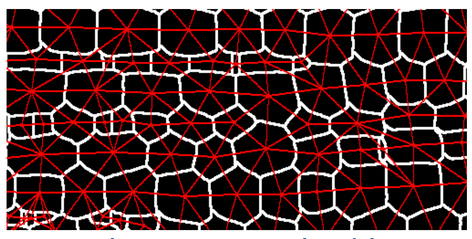
Single image processing workflow



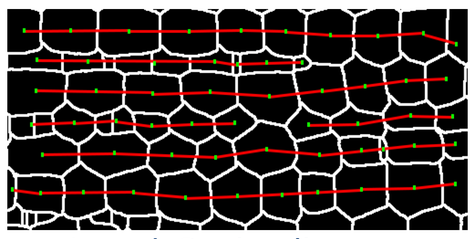
Native image



Multiscale filtering



In white: Watershed lines
In red: Adjacency graph



In red: Basin alignments
In green: Basins center

*For one image, the cell files are inferred from the basin alignments obtained from the **adjacency graph** of cells given by a **watershed algorithm**. But how to merge consistently the cell files extracted in the different images of the mosaic?*

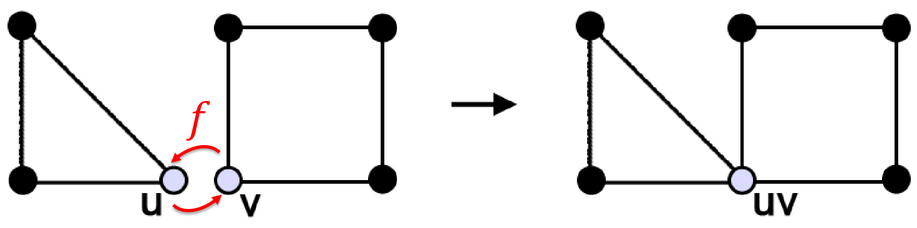
Graph fusion principles

The idea is to **fuse the result adjacency graphs** of the different images

*Let $G_i=(V_i,E_i)$ and $G_j=(V_j,E_j)$ be **two disjoint graphs** with $K_i=(A_i,B_i)$ a subgraph of G_i and $K_j=(A_j,B_j)$ a subgraph of G_j.*

*Let $f: K_i \rightarrow K_j$ be an **involution** between these subgraphs. The vertex set of the graph fusion is defined by :*

$$(V_i - A_i) \cup (V_j - A_j) \cup \{a\ f(a) \mid a \in A_i\}$$

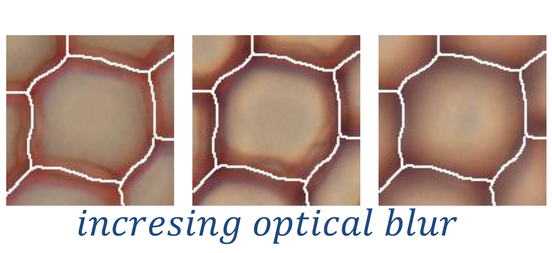


Amalgamation kernel

$$UV = \{uv \mid u \in A_i \text{ and } v \in A_j \text{ and } v = f(u)\}$$

Amalgamation kernel specialization

$$sim_{u,v} \begin{cases} 0 \quad if\ |u,v| > min(r_u, r_v) \\ \underbrace{\left(1 - \frac{|x_u - x_v|}{x_u + x_v}\right)\left(1 - \frac{|y_u - y_v|}{y_u + y_v}\right)}_{\text{Basin position similarity}} \underbrace{\left(1 - \frac{|S_u - S_v|}{S_u + S_v}\right)}_{\text{Surface similarity}} \quad else \end{cases}$$

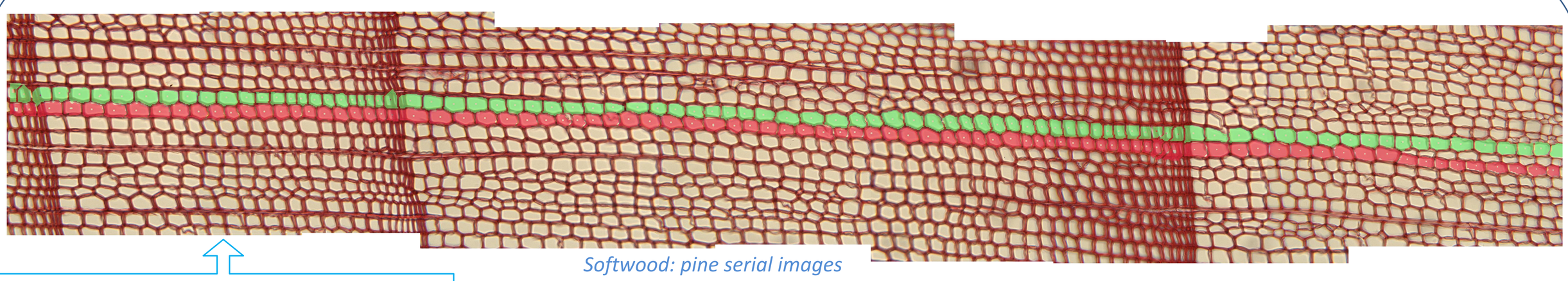


incresing optical blur

***Watershed lines** are insensitive to the optical blur*

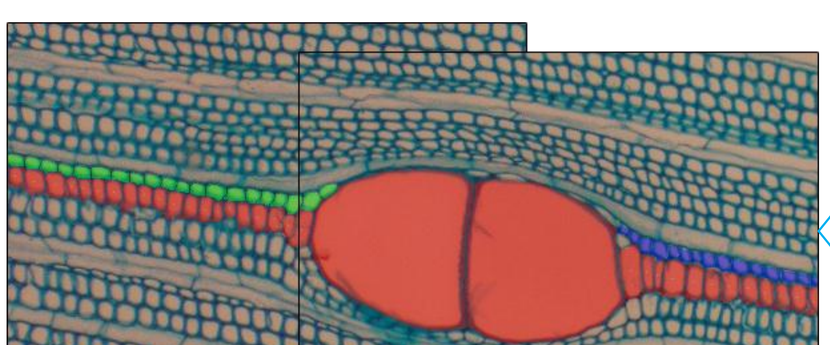
*The amalgamation kernel is **robust** thanks to the watershed **stability** and the microscope stage displacement **precision**.*

Simple graph fusion application results



Softwood: pine serial images

*The transitions between successive rings do **not affect** the graphs **amalgamation process***



Hardwood: mahogany

*A case of high geometrical changes: graphs fusion still performs when (at least one of) the biggest cell is **totally recovered**.*

1- Lézoray, O., Grady, L.. 2012. Image processing and Analysis with Graphs. CRC Press.
2- Brown, M., Lowe, D.G. 2007. Automatic Panoramic Image Stitching using Invariant Features. In: International Journal of Computer Vision, vol. 74, pp. 59-73
3- Brunel G, Borianne P, Subsol G, Jaeger M, Caraglio Y. 2012. Automatic characterization of the cell organization in light microscopic images of wood: application to the identification of the cell files, PMA13, ISBN 978-1-4673-0070-4, 58-65

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