18-month mission in computer science
for a candidate with a master's degree or a post-doc

Algorithms for the traceability of oak logs

Context

Oak is a strategic resource for France. The wood industry is facing a very strong demand for exports to Asia. Since 2015, an "EU transformation" label has been set up to give priority access to oak resources from public forests to customers who commit to process wood or have it processed in the EU[1]. The traceability of wood is becoming a necessity. Different identification systems have been tested by the forest wood chain without giving satisfaction, such as the use of plastic tags (with printed number or barcode) or RFID chips that are too easy to substitute or to falsify. To address this issue of log traceability, there is a need to develop alternative methods to these physical markers that could be used everywhere and that would identify each log individually. Relying on intrinsic characteristics of logs, in the same way that fingerprints identify a human, would be a simple and inexpensive way to achieve this goal (Barrett, 2008).

Objectifs

This study addresses the log traceability problem and aims to develop new methods using image processing techniques and deep-learning approaches.

The size and shape of the cross-sections should be taken into account to facilitate matching (Charwat-Pessler *et al.*, 2016). At the base of oak logs, the shape of the cross-section can be quite irregular. Moreover, many angular points are visible, related to the logging of the tree, and could help to identify the logs (Fig. 1). However, the size and shape information will probably not be sufficient. The pattern formed by the growth rings, more or less visible depending on the texture of the surface, could be exploited. But unlike fingerprints, rings do not have minutiae [2] (except the pith, at the centre of annual rings, which is a particular point) and only certain methods can be used, including those based on texture analysis (Schraml *et al.*, 2015a). One of the difficulties could be to extract this

[1] `https://www.onf.fr/onf/+/1629::proteger-notre-filiere-chene-locale-avec-le-label-transformation-ue.html`

[2] Points of singularity found on the papillary lines.

pattern, or parts of this pattern, from very rough, unprepared surfaces. If the ring pattern is an important element for the identification of the logs, it will also be possible to use other characteristics such as the pith location (Decelle *et al.*, 2021), the sawing marks, the width of the sapwood (Decelle *et al.*, 2023) (area of different colouration visible at the periphery of a cross-section under bark, lighter or darker depending on the case) and all other singularities that may be present on the surface.

Figure 1: Photos taken at the bottom end of oak logs. A black and white checkerboard pattern is placed on the log so that size information can be retrieved. Here, an OpenCV function enables to automatically detect this checkerboard pattern (on the right).

One question will be which singularities can be used? For example, cracks may evolve over time and are not necessarily a good criterion. Cutting marks could be used because they bring a specific identity to the log but this remains to be discussed.

Adapted methods of existing algorithms for fingerprint or iris identification have already been successfully tested at the University of Salzburg (Schraml *et al.*, 2015b) on images taken from the log-ends of softwood logs. However, the most recent work has shown that better performances can be obtained with convolutional neural networks (CNN) using a triplet loss function for training the network (Wimmer *et al.*, 2021).

Other methods should also be tested for keypoint detection and image matching (e.g., SIFT / SURF / BRISK) (Fig. 2). Figure 3 illustrates the result obtained with an algorithm proposed in the literature (Rodríguez *et al.*, 2023) for image pair matching. The second image was taken several weeks apart from the first and the evolution of the radial cracks is clearly visible, as well as a change in coloration visible on the color images (not shown).

Work plan

The first step will be to understand and test on oak log-ends the algorithms developed by our Austrian colleagues for softwoods.

Very quickly it will be necessary to develop methods capable of identifying oak logs. Perhaps by allowing the use of a certain number of singularities at first and then restricting them later. Several types of algorithms could be considered, including adaptations of the most efficient CNN.

For this purpose, a database of 10,000 to 20,000 images of oak log-ends, which is currently being built up, can be exploited.

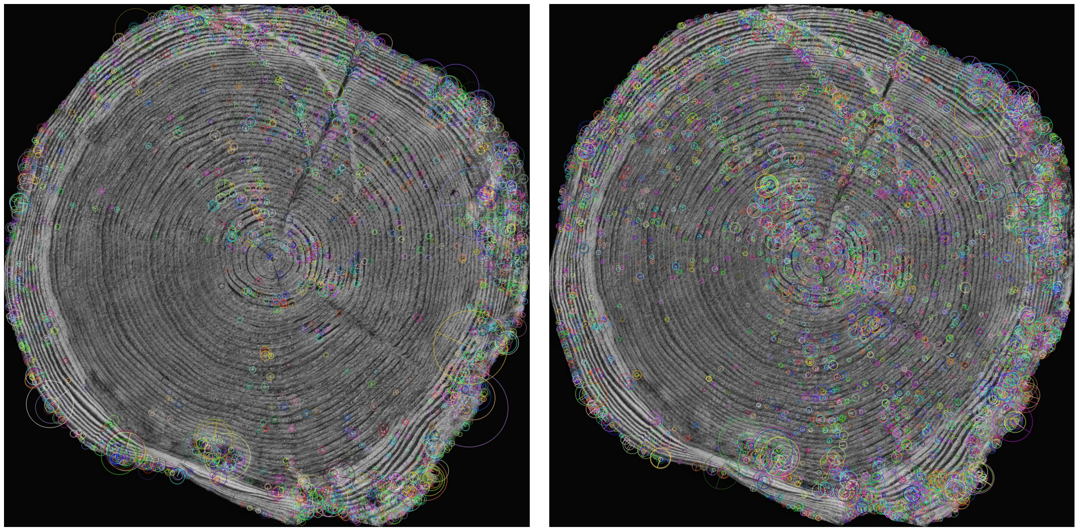

Figure 2: Example of keypoint search on wood section images using SURF and BRISK methods implemented in OpenCV.

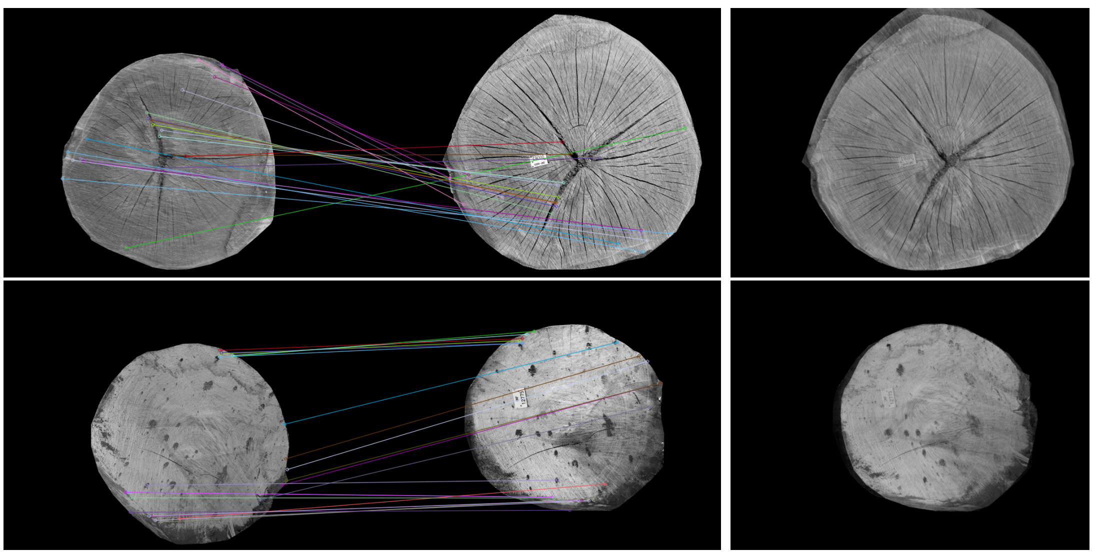

Figure 3: Two examples are presented. On each line: Two images of the same log taken several weeks apart; Application of a keypoint search algorithm to compute a correspondence between the two images ; Selected corresponding points and result of the superposition of the two images after application of the transformation.

Required skills

Ph.D. or Master's degree in computer science. Good programming skills (C++ and/or Python), experience with image analysis and processing, and scientific writing skills are expected. A good knowledge of CNN would be appreciated.

Practical information

The duration of the mission is 18 months.

Remuneration according to experience.

The candidate will be co-supervised by Phuc Ngo and Isabelle Debled-Rennesson (Loria), Fleur Longuetaud and Frédéric Mothe (INRAE), and Alexandre Piboule (ONF).

The person will be based at Loria in Nancy (North-East of France).

A short stay at the University of Salzburg with the Austrian colleagues is planned at the beginning to appropriate the existing algorithms developed for softwoods.

Deadline for application: July 31, 2023.

Contacts :

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