An Automatic Method for Counting Annual Rings in Noisy Sawmill Images

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What?

A method to compute the number of annual rings in a log end face image. End faces are depicted in on-line sawmill production as the logs pass on a conveyor belt. The annual rings are analyzed in a region with a clear ring pattern, which is automatically detected.

Why?

The annual ring width on an end face is related to wood quality in the saw log, i.e., different ring widths represent wood suitable for different usage. In Swedish forest industry the annual ring width is one parameter in quality classification. The number of annual rings is counted in a specific part of the end face: 2 - 8 cm from the growth centre (pith).

How?

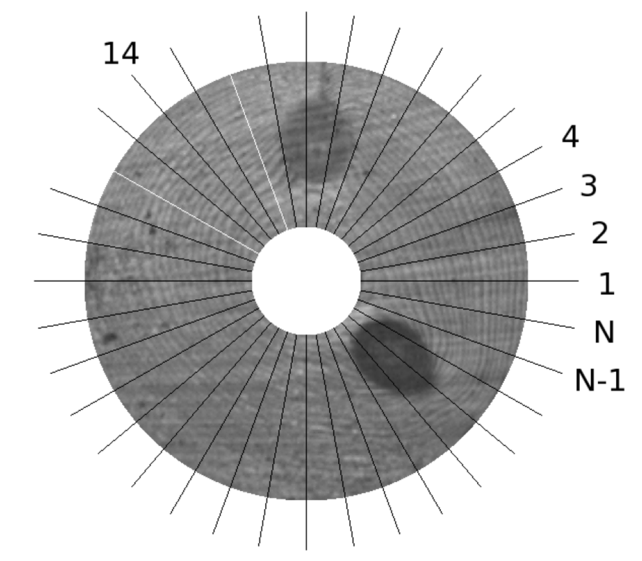
1. Pith detection

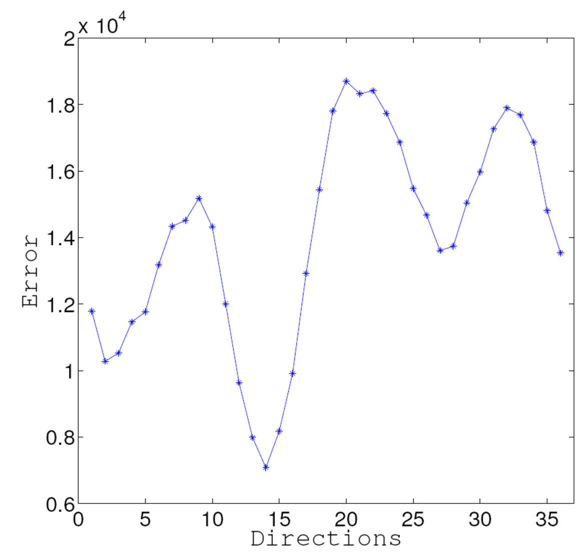
The position of the pith must be known beforehand. We suggest an automatic method for pith detection.

2. Detection of region for measurements

We aim for analyzing the image in a region with a clear and undisturbed ring pattern. Ideally such an area has annual rings that locally resemble parallel lines, with local orientation pointing towards the pith.

The region for measurements is detected by comparing the angle of the local orientation in each pixel with the true angle to the pith. The region minimizing the total difference in angle is chosen for analysis.

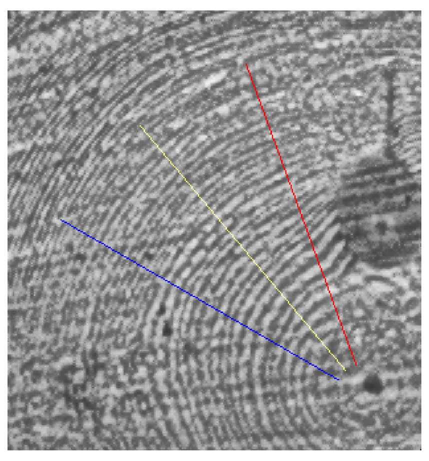




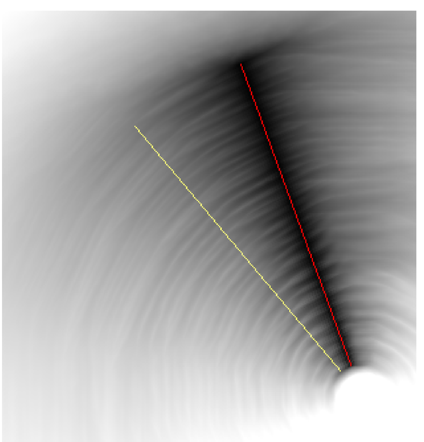
3. Detection of ring pattern

To enhance and smooth the ring pattern we apply the grey-weighted polar distance transform (GWPDT) on a cost image, which is a contrast enhanced version of the original image. The GWPDT will prefer propagation in the angular direction compared to the radial, by using different weights for different directions.

We apply the GWPDT from two directions (red and blue), creating two different distance maps. **Each distance map is analyzed along the interesting direction** (yellow), i.e., we analyze two 1D signals.



Cost image



Distance map

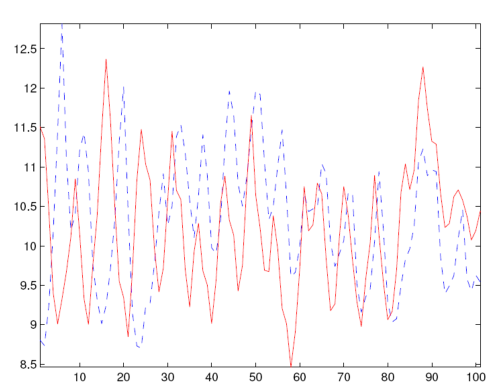
4. Computation of the number of rings

Ideally, each local minimum in the 1D signals corresponds to one annual ring, positioned at the same index in both signals. However, this is not the case due to noise, eccentricity etc.

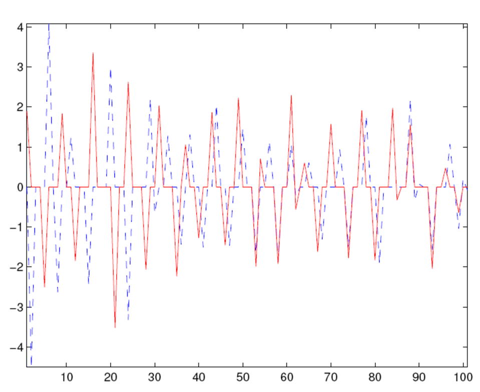
We **register the signals elastically** to determine which minima correspond to the same annual ring. To avoid registering mean signal intensities, signals are differentiated with respect to the extreme values. Signals R and S are registered as

$$C(R_1^i, S_1^j) = c(R_i, S_j) + \min \begin{cases} C(R_1^i, S_1^{j-1}) + g \\ C(R_1^{i-1}, S_1^{j-1}) \\ C(R_1^{i-1}, S_1^j) + g \end{cases}$$

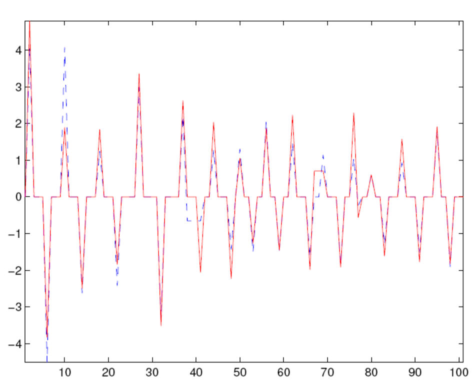
All **local minima registered to the same index are counted as one annual ring**. If both signals has at least one local minimum each between two registered minima it is counted as an annual ring.



(a) Original signals



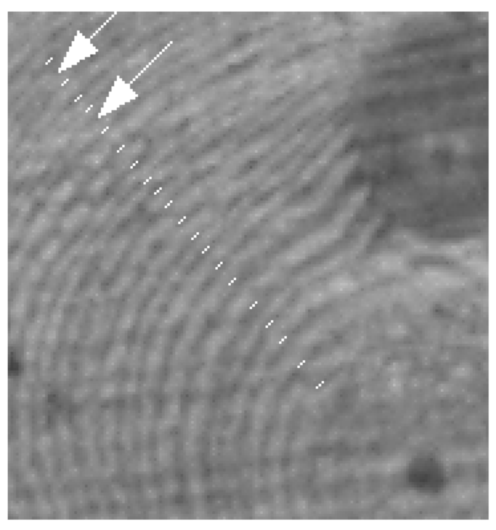
(b) Difference signals

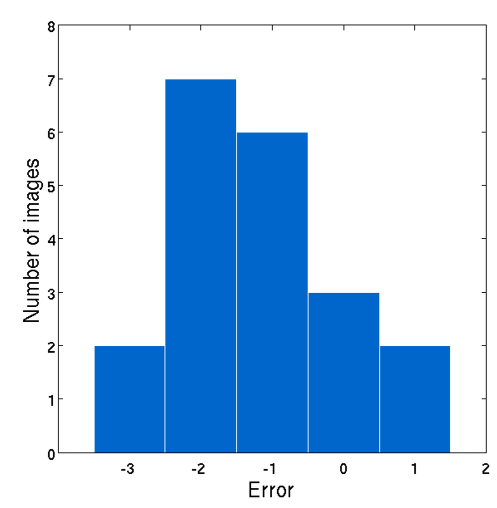


(c) Registered signals

Results

- The method was evaluated on a set of 20 images with end faces depicted in sawmill production. The evaluation set was chosen from images with annual rings clear enough to count manually, at least in some region of the image.
- The number of rings is slightly underestimated. One example of an image with an underestimation by two rings is shown below.
- Next we will compare the result with estimation done by skilled controllers as well as experienced log scalers, both counting exact number of rings and classification into different quality classes.





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