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IMAGE PROCESSING AS A POSSIBILITY OF AUTOMATIC QUALITY CONTROL

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***Abstract**:*
This poster displays the definition of the age of trees cut down. The objective is to be able to automatically detect the number of annual rings in the test image, approaching from a given centre to a particular point with a maximum detection error of two, despite the bias of the image, presuming that cracks in the cross-section of the rings total less than twenty degrees. We are aiming at making our algorithm profitable in business and education as well.

***Keywords**:*
Image processing, quality control, annual rings of trees

1. INTRODUCTION

Computer aided image processing has been steadily developing in the past thirty years. However, there is a long way to go. Despite the solutions available in the subdomains, the particular approach or software applicable on every field has not yet been found (Géza ÁLLÓ et al, 1993).

In our domestic economic situation an annual human work costs about one million HUF for the employer. If we accept the hypothesis that every application which is refund in five years can be considered economical, then to develop computer systems for a maximum of five million HUF is subservient in case it can substitute at least a man's work. This means a half year work for a good informatics specialist (including the expenditures of the use of technical means).

This poster displays the definition of the age of trees cut down, considering the fact that the issue of size measurement, wood type and wood defect detection has already been solved.

2. THE GOAL

Our subject is the definition of the age and quality of trees cut down with power saw; this definition and other wood features (like wood size, wood type and quality) would provide profitable information to the management of wood yards and foresting companies — if the information gained is with 90% accuracy.

By computer aided image procession, using a section of the woody stem, wood age can be defined. For trunk is accessible in trees cut down, it is practicable to examine annual rings (fig. 1). If the tree in question was not cut down in level but by wedging, the image to be processed should be properly transformed. Determining the actual age of a live, standing tree is also possible (e.g. by wood tomography), but this one is a rather expensive procedure.

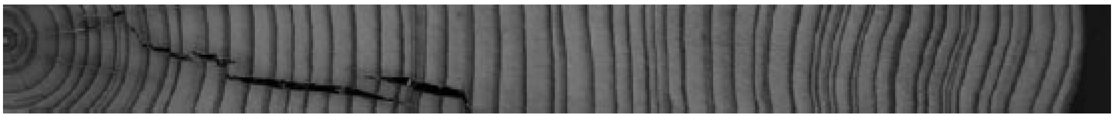

Fig.1. *The classic fair quality sample image to count annual rings. The image was converted to greyscale. To be analyzed easier the left side was cut.*

3. THE METHODS

For this reason, there seem to be four approaches to determine age:
- The isolation of annual rings from "the noise" by the methods of "weak artificial intelligence" and the definition of the number of rings.
- Image processing (filtering and colour transformation) to construct the binary image by filtering the noise to get an exclusive image of the annual rings and then counting the rings.
- Problem solving without complex approaches (e.g. finding the most pale-to-dark transitions forming a right angle to a line).
- The combination of these methods.

4. THE ANALYSIS OF METHODS

The first one of these approaches should be thrown out for the lack of time (seeming to be the most accurate approach, the first one needs a considerable investment). We had a go at the second approach first (contrast and brightness balancing, linear filtering with symmetric edge detection, threshold cutting and edge counting), but on the current level of implementation, this approach failed to be a robust one. The third approach worked fine.

5. THE DEGREE OF ROBUSTNESS

The mentioned robustness was measured by loading the available image with different noises (sharpening, smoothing, adjusting contrast and brightness, adding Gauss noise, adding salt and pepper) and then the available functions were tested on the image obtained. Unfortunately the method was only insensitive to sharpening (which is very rare in reality). With further corrections the system might have been able to register contrast and brightness alignment, but even with this it would not have been more efficient than the third method.

6. THE PRACTICAL PROCESS

In practice one should start with measuring the diameter of the tree and the relief of the surface with a suitable tool. Then based on the photo or another image that can be digitally processed, the image transposed to plane is generated with the background cut out (greyed uniformly with the grey given by the average of the pixels not to be cut out from the image). From the generated image it is possible to find the outline of the tree with simple methods, so the surface area can be easily calculated.

The next task is to locate the centre of the tree to count the annual rings from there (assuming that a centre-independent algorithm is used) (fig. 2). The weak artificial intelligence can be used for this – or according to KISS – the geometrical centre can be considered to be the centre of the tree.

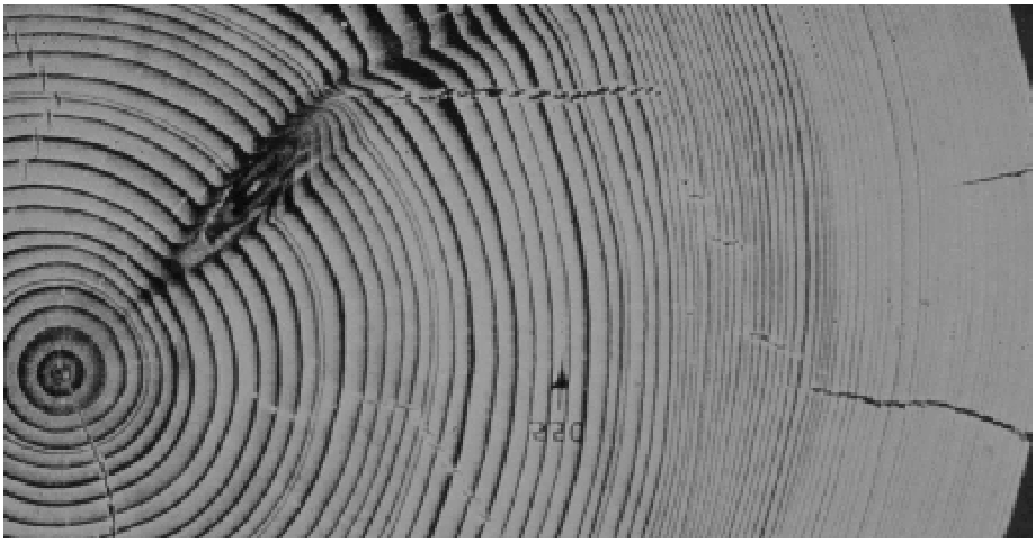

Fig.2. *Low resolution picture of a big trunk. With it the algorithm's sensitivity on thin annual rings can be well tested.*

The centre-independent algorithm is, for example, when an image cleared somehow of noise is cut through with dense lines along one side (for example by the average annual rings distance which comes directly from the resolution). Along these lines the annual rings can be counted and then the highest calculated can be considered the age of the tree (fig. 3).

By repeating the process on another perpendicular side (assuming sufficient calculating power) taking the minimum of the acquired results we can probably also eliminate the interference. This can only be realized if the lines which are near perpendicular to the slicing line are counted.

Considering the deformity of the annual rings this came about 20 degrees. Cracks can appear only in two views in a gradient of 20 degrees while annual rings can be seen in all four views because of their shapes (fig. 4).

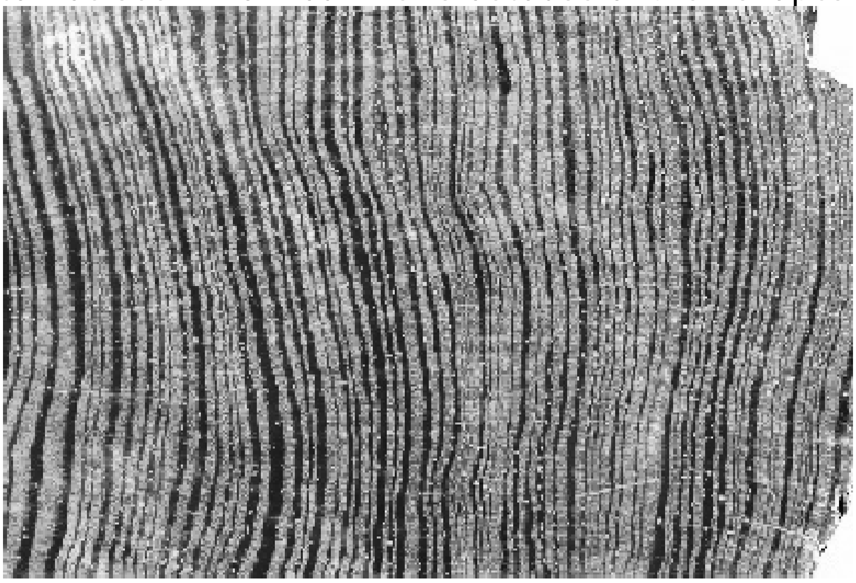

Fig.3. *A very bad resolution picture heavily loaded with noise. It was originally converted from orange-red colours. The image is practically useless without histogram alignment.*

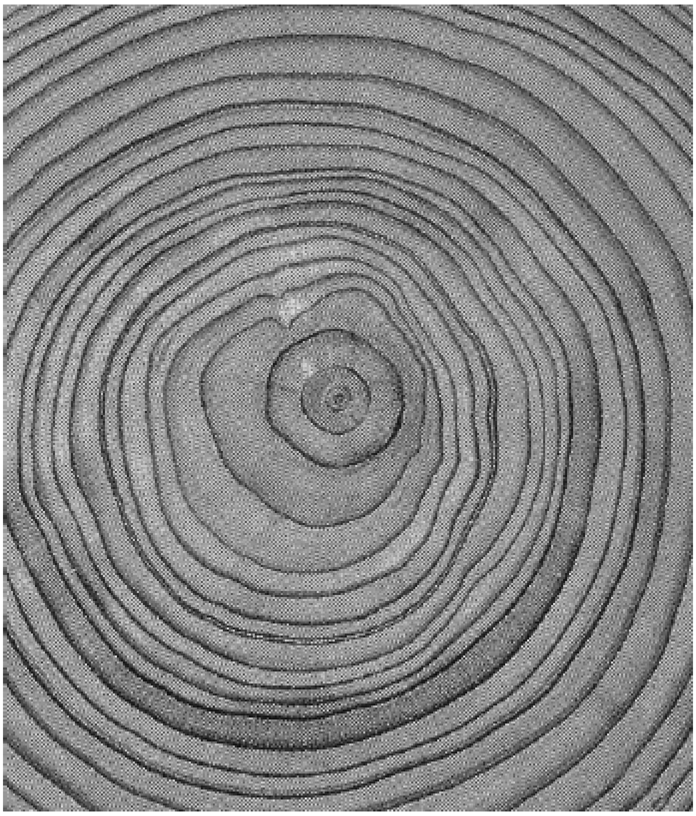

Fig.4. *A relatively high resolution image which has been heavily loaded with noise after using classic image compression and processing methods.*

Problems can occur in the case when there are at least four cracks on the tree which do not form a circle (a good weak artificial intelligence can handle this). The four cracks are at maximum 20 degree angles to four different axes. In this case however the wood possibly cannot be used. Prepared for this case we can examine whether the annual rings are even or odd.

7. THE TOOLS

Considering that because of the trunk's size taking a photo in front of the suitable background is almost impossible, this possibility can be excluded. The size of the tree and the speed of processing practically exclude the possibility of mechanical scanning. So the technology to measure rebounding time of directional beam remains. The most appropriate tool – for the first approach – is the laser knife or the millimetre accurate sound radar.

In regard to sawdust an automatically cleaned industrial camera is suitable for the eventual target application which is capable of taking high resolution black and white photos. In the experimental and analysis phase an image also available on the Internet is used.

The suitable platform for the eventual target application seems to be the C/C++ language, for example under UNIX/Linux operating system. The freely accessible image programme running under Java Virtual Machine is the suitable platform of the experimental and analysis phases.

My advice for application refers to storing on hard disk and 24-pin dot-matrix printer because of the thrift and the reliability. The suitable output in the experimental and analysis phase seems to be a window created in Java.

8. THE OBJECTIVE

Now, the objective is to be able to automatically detect the number of annual rings in the test image, approaching from a given centre to a particular point, with a maximum of two detection errors despite the bias of the image, presuming that cracks in the cross-section of the rings are less than twenty degrees. Bias is simulated by sawdust and the noise of the CCTV camera. We are aiming at making our algorithm profitable in business and education as well.

9. THE ALGORITHM

The robustness of the applied KISS algorithm highly surpasses the classical image processing approach. The basic idea was given by the fact that if the dark stripes on the bright background can be counted in the filtered image, the darker stripes can also be counted on the brighter background in the original image. By aligning the brightness and contrast we can get an image where the annual rings grown in the winter is in the

0-25 scale of colours, while the summer part is in the 26-255 scale of colours.

The objective is to find as many as possible point triplets (A, B, C) along the line where it is true that points A and C are in the 26-255 scale of colours, point B is in the 0-26 scale of colours and there is a line through point B which is in a gradient of 20 degrees of AC line and eight from the ten closest points on the line are in the 0-25 scale of colours. From the possible ABC divisions we are looking for as many as possible divisions which do not overlap along a line, that is the AC distance has to be minimized.

Considering the alignment applied in the first step, the algorithm is immune to brightness and contrast offset (except for extreme over and under expose which does not occur in case of industrial cameras) and because of this it is more or less immune to the lighting so it can also be used in open air. This algorithm does not use (derivate) edge detection so some specific noise does not cause big errors during the image processing. As it does not use cutting after edge detection, no points are lost from the lines. It does not search for edges, thus it is resistant to blurring, moreover applying a median-filter in advance, it is also immune to salt and pepper type noise without detectable efficiency decay.

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