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Determination of Tree Annual Rings with Signal Analysis

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Abstract:- In this study, the detection and counting of annual rings were determined by signal processing methods. The surface density graph of the annual ring image was plotted and a signal was obtained. Since the signal contains noise, 1-D filtering processing was applied to the signal. This minimizes the noise and regions that cannot be annual rings. The annual ring numbers and width were determined with a threshold value calculated from the surface graph obtained from the image. Matlab program was used for these operations. The number of annual rings was determined quickly and easily.

Keywords:- *Annual Rings; Signal Processing.*

I. INTRODUCTION

Every year, new cells grow in the tree during the vegetation season. These cells appear in concentric circles, called annual growth rings, which show the amount of wood produced during a growing season. One-year growth represents a ring with a light-colored portion (springwood) and a dark-colored portion (summer wood). Thus, the age of the tree can be determined. Old rings are the ones near the center of the tree. The width of a growth ring depends on the duration of the tree's growing season. Tree growth rings bear the traces and effects of past climatic conditions. Ring width may vary depending on external factors such as age, genotype, climate, altitude, soil, human interventions and mechanical injuries [1].

The annual rings of the tree grow at different rates due to seasonal changes [2]. Many techniques have been proposed for tree ring analysis [3,4,5]. Soille and Misson [6] proposed a mathematical method of morphology to measure ring fields. In this study, softwood annual rings were determined with signal processing methods.

II. METHOD

All trees grow transversely and longitudinally. Growth continues until the tree enters the rest period. The new part that occurs during this growth period is added to the tree trunk which except tropical trees such as palm tree and coconut palm once a year. As a result, the new cambium cell that is formed each year is called the annual growth ring or simply the annual ring. Fig. 1 shows the sample annual rings.

Fig 1:- Sample annual ring images

Annual ring width measurements investigated for growth and development in trees. It is made with the help of incremental pens and special microscopes [7].

In this study, the procedures applied in determining the annual ring is shown in Fig 2. Matlab program was used for these operations.

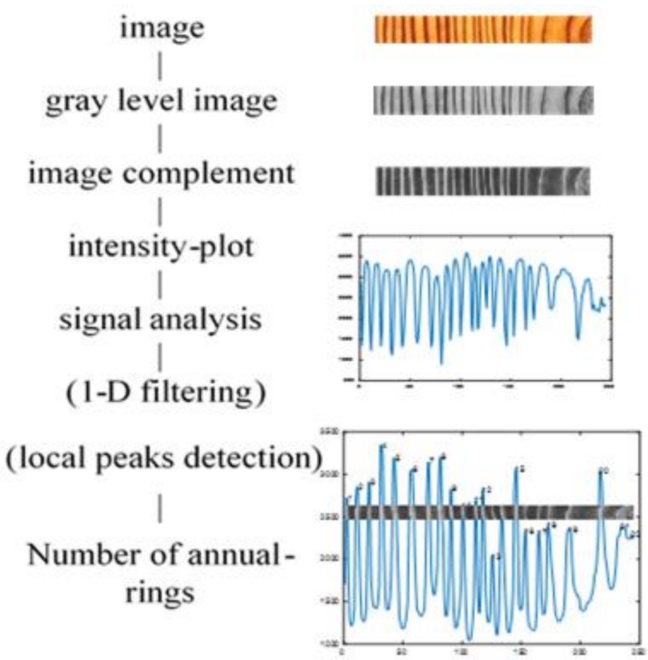

Fig 2:- The proposed method

Density plot and local peak points of an example image are shown in Fig. 3. Each peak shown in Fig 3 is not an annual ring line. There are parts of the signal that contain noise.

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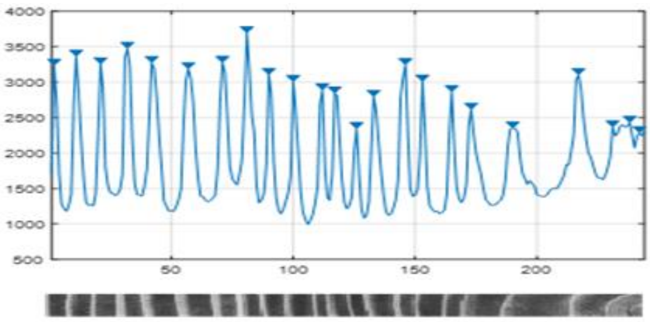


Fig 3:- The density graph and peak points of the image

1-D filtering was applied to the signal in Fig. 3. This minimizes the areas where there may be noise in the image or no annual rings (Fig. 4).

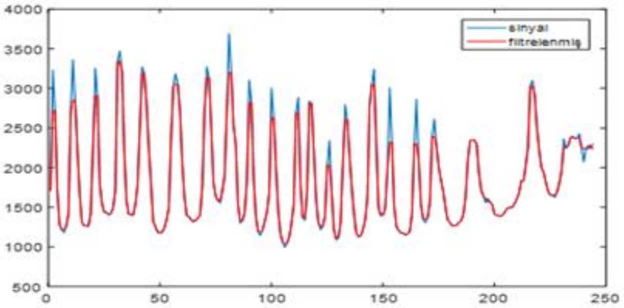


Fig 4:- Display of the filtered signal.

Then, a threshold value was calculated by taking into account the minimum peak distance and minimum peak height-width, etc. (Fig.5) The annual ring numbers were determined using the threshold value calculated from the signal.

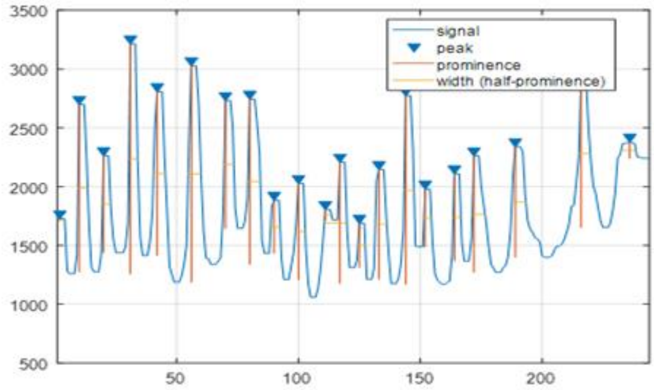
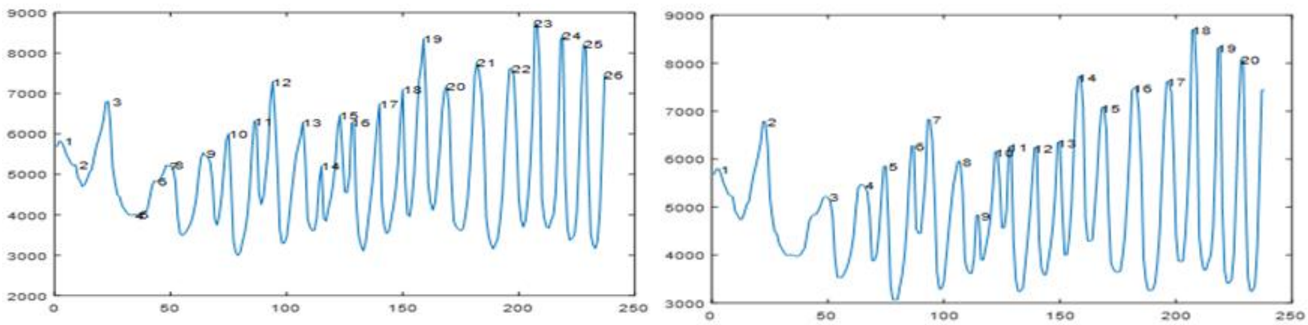


Fig 5:- Signal, Peaks, Peak width-height

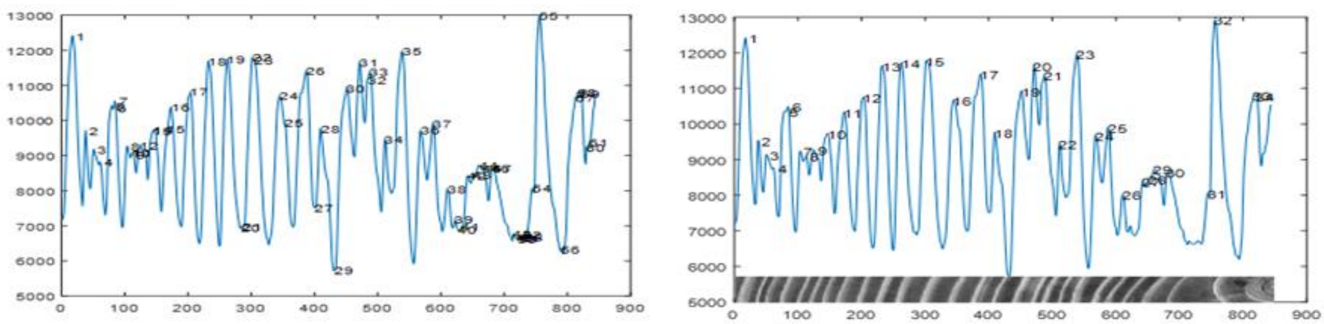
III. EXPERIMENTAL RESULTS AND DISCUSSION

In this section, the image cross-sectional surface graph and the number of peaks are given in Fig. 6-7 (a). The annual number of rings calculated is shown in Fig. 6-7 (b). The peak count of the signal in Fig. 6 is 26, the calculated number of annual-rings is 20.



(a) (b)

Fig 6:- a) The peak count of the signal-1, b) the number of annual rings.



(a) (b)

Fig 7:- a) The peak count of the signal-2, b) the number of annual rings.

The peak count of the signal in Fig. 7 is 61; however, the calculated number of annual-rings is 34.

Two different annual ring images (Fig. 6 and Fig. 7) were examined by the signal processing method. The ages of the trees were found to be 20 and 34. Furthermore, the distance between the peaks in the signal shows us the distance between the rings. This shows us the effect of ecological factors such as fire and drought on the tree.

In determining the limit of spring-summer wood in the annual ring, some researchers averaged the minimum and maximum density values [8]. When the effect of some factors is not evaluated on the annual ring, it is stated that the evaluations made on average values do not reflect the actual effects [7].

The use of an X-ray densitometer for the annual ring makes it possible to determine both the average tree density and annual ring components. The disadvantage of this method is that it is more complex and the device cost is higher [9].

IV. CONCLUSIONS

One of the most well-known methods of tree ring analysis is the fact that an experienced and knowledgeable employee counts the individual rings with a magnifying glass or microscope to determine the number of tree rings. This is full of man-made errors and is time-consuming. The proposed method is more practical than conventional measurement methods. With this method, it is possible to measure more quickly and easily. Measurements can be made in a simple way or more detailed measurements can be made. In the proposed method, the measurement is done automatically and the eye does not get too tired.

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