HIGH TECHNOLOGIES IN MEASURING PROBLEMS OF FORESTRY COMPLEX ON THE BASIS OF A METHOD IN THE ANALYSIS OF SCENES AND IMAGE RECOGNITION

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The complex of programs on automation of process research in a forest mensuration is developed. It is experimentally confirmed, that the offered algorithms allow to reduce on two and more order time of carrying out of measurements in comparison with the applied not automated methods at maintenance of demanded accuracy of results.

Introduction

Methods of the analysis applied in a forest mensuration often are based on research of appropriate images of objects. Here it is possible to carry methods of the analysis in fertility dynamics for soils on the basis of measurements by the sizes of areas early and a latewood by means of a microscope; methods of research the tendency of growth perennial plants on the basis of face measures projecting cover on pictures; methods of an estimation of illuminance of the lower vegetative storey through crowns of trees. The enumerated methods by true time are not automated and labour-consuming, that considerably retards process of obtaining of new scientific and industrial results. True operation also is devoted questions of automation of carrying out of the given researches.

The work purpose:

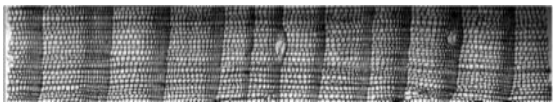
Develop optimal or suboptimal analysis algorithms of maps in the taxation objects ensuring an essential expedition of measurements at saving of set accuracy.

Solved tasks:

1) synthesis of optimal algorithm of boundaries detection early and a latewood on digital images wood saw cut;
2) synthesis of optimal algorithm for color image segmentation, areas of a researched projecting cover on statistically inhomogeneous background [2];
3) synthesis of optimal algorithm for segregation of a solar lookthrough areas and crowns of trees;
4) design of the program complex realising given algorithms and documenting of results of their operation.

Results of synthesis of algorithms:

As a result of the analysis of statistical and correlative properties of images, characteristic for enumerated above tasks (fig. 1 see)



a – digital image of wood saw cut

b – digital image of foliar cover plants

c – digital image of trees crowns

Fig. 1. Representative pictures of biological objects

synthesis of analysis algorithms of images has been fulfilled. The received algorithms are grounded on detection of impulses of luminance, color segmentation and segmentations of multi grey-scale images [1].
Statistical characteristics of observable maps for the first algorithm, prove acceptance of their following mathematical model:

$$z(x,y)=v(x,y)\sum_k c_1\cdot p_k(x-x_k)+\xi(x,y)+c_0, \quad (1)$$

where c_0 - the average level of luminance corresponding to area of a latewood, c_1 - the average level of luminance corresponding to area of an early wood, $\xi(x,y)$ - the centered symmetric normal noise process with average squared error σ_ξ, $v(x,y)$ - an illuminance cumulative distribution function on frame square. The mechanism of operation of the first algorithm is reduced to implementation of following steps (fig. 2):
1. Compensation of non-uniformity of an image illumination on frame square:

$$q(x,y)=\frac{1}{v(x,y)} \quad (1)$$

where $v(x,y)$ — an estimation of allocation of illuminance on the frame square, received at a stage of calibration of television system in the absence of a researched preparation;
2. Optimal by criterion of maximum credibility estimation of luminance of images along boundaries of areas early and a latewood:

$$z(x)=\sum_{y=0}^{N_y-1} z(x,y) \quad (2)$$

where N_y — picture size along a vertical axis. Here it is supposed, that image orientation corresponds to vertical layout of boundaries areas of different brightness.
3. The filtering of brightness countings of the image coordinated to a jump in brightness:

$$g(x)=\sum_{n=0}^{N_x} z(n)h([n-x+x_0]\bmod N) \quad (3)$$

where a filter impulse response

$$h(x)=\begin{cases}1, & \text{if } x\in[0;\tau_0]\\ -1, & \text{if } x]\tau_0;2\cdot\tau_0]\\ 0, & \text{else}\end{cases} \quad (4)$$

τ_0 —the minimum width of area of a latewood, N_x — the size of the observable map on a horizontal axis, $a \bmod b$ — a capture of an integer remainder of division of number a на b, x_0 — offset of the response of the filter in relation to an original signal.
Such filter (fig. 2) ensures a maximum bung signal to noise ratio (SNR), and consequently also the best characteristics of detection.

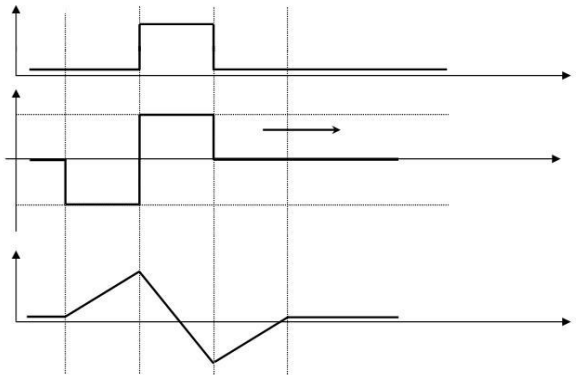
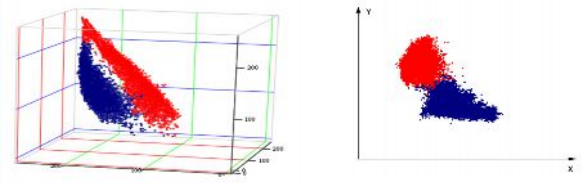


Fig. 2. The mechanism of filter operation:
a — idealized a luminance impulse,
b — the signal-map with which the filter impulse response is coordinated,
c — the filter response to idealized luminance impulse

The second algorithm is reduced to forming at a grade level of sampling distributions of images hue in a researched plant and a background and to construction on their basis of algorithm for two-alternative classification of hue each point of the observable image (fig. 3). For possibility of synthesis of optimal algorithm of segmentation analytically we approximate allocations $W(\bar{I}/H_1)$ and $W(\bar{I}/H_2)$ functions [3]:

$$K(\mathbf{x},i)=\exp\{-\alpha\|\mathbf{x}-\mathbf{x}_i\|^2\}, \quad (5)$$

where α - decrement of damping, $\|\mathbf{x}\|$ - rate of vector $\mathbf{x}$, i – number of a checked hypothesis.



a - Cluster model of a foliar cover and a background in RGB space

b - Projection to the intersecting flat surface

Fig. 3. A foliar cover and a background in 3D and 2D.

For the selected approximating form of allocations optimal, by criterion of maximum credibility the algorithm of segmentation is reduced to following steps:

1. To determine the projection of color for a current point on the selected flat surface by colour space,

2. Calculation the size of likelihood ratio

$$\bar{\lambda}(x,y) = \frac{W(\bar{I}/H_2)}{W(\bar{I}/H_1)}, \qquad (6)$$

(x,y) — coordinates of pixel in a display frame,

3. Normalization the field of ratios credibility to 255 grey gradations for possibility of visualisation;

4. Threshold processing for normalized image $\lambda(x,y)$;

$$U(x,y) = \begin{cases} 1, if \lambda(x,y) \geq \lambda_{\text{threshold}} \\ 0, if \lambda(x,y) < \lambda_{\text{threshold}} \end{cases} \qquad (7)$$

Meaning of a threshold, optimal by the named criterion, makes $\lambda_{\text{threshold}} = 127$.

Operation of the third algorithm, due to high contrast of images in crown and sky districts (fig. 4), consists in search of a global minimum in the smoothed histogram image between two chief modes of mixed allocation of luminance in a frame.

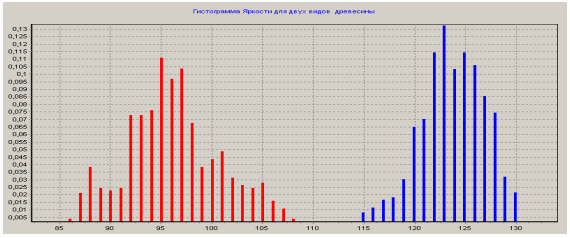


Fig. 4 Two-level luminance histogram for images of a crown and sky districts

Conclusion

1. The developed programs allow to automate process of the analysis and research processing for this type of images, and to ensure a scoring on speed of carrying out of measurements on the average on two and more order.

2. Algorithms realised in programs are optimal by traditional criteria and differ objective character of carrying out measurements.

3. Accuracy of measurements exceeds the hand-held methods used for carrying out of considered taxation researches.

The given programs have certificates on official registration of the computer programs (№2007610624, №2007610623 [Russian Federation])

References

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