Development of a methodology for determining the volume of timber using an unmanned aerial vehicle

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Abstract

The developed technique relates to the field of accounting for the volume of timber in the warehouses of logging and wood processing enterprises based on digital image processing methods. The approach to determining the volume of bulk and stacks of round timber using an unmanned aerial vehicle (UAV) contains the stages at which digital aerial photography from UAV of the area where timber is located, photogrammetric processing of digital aerial photography data from UAV, construction of a three-dimensional model of objects of interest, determination of storage and dense volumes timber. The technical result of the technique is to increase the speed and accuracy of determining the volumes of bulk and stacks of round timber.

Equipment

The most important characteristics of the drone in the context of the tasks to be solved are:
- Weight: 249 g
- Dimensions: 55x160x202 mm
- Maximum speed: 65 km/h
- Maximum flight time: 30 minutes
- Flight range: 2000 meters
- Maximum altitude: 3000 meters
- Operating frequency range: 2.400-2.4835 GHz
- Camera resolution: 12 MP
- Type of stabilizer: 3-axis
- Maximum image resolution: 4000x3000 pixels
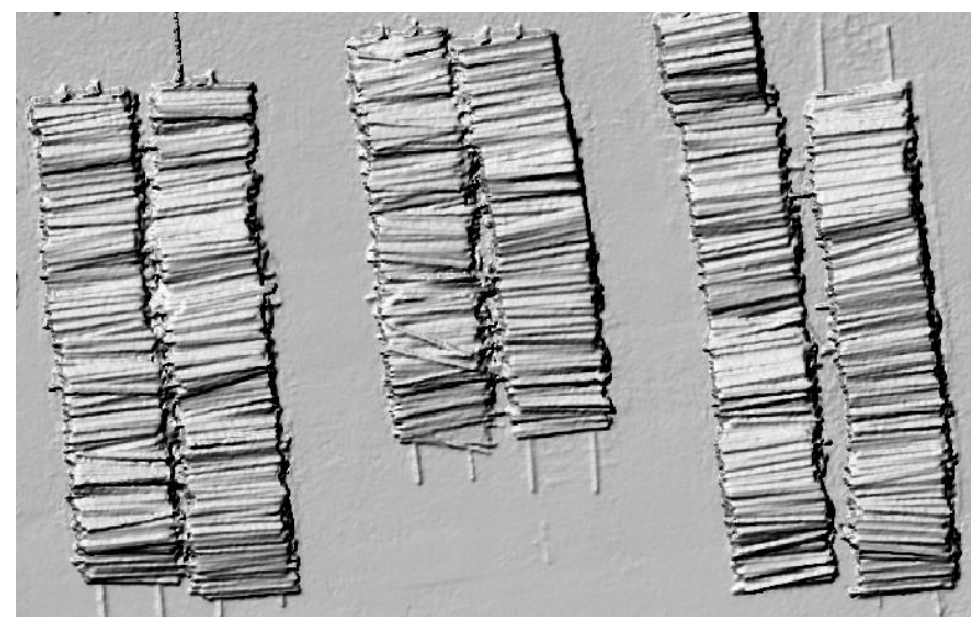- Maximum memory card size: 256 GB

Methodology

1) Digital photography is being carried out from the UAV.

2) Automated photogrammetric processing of UAV digital photography data.

Orthophoto plan of the territory

Digital surface model

3) On the rendered image of the DSM_{sl} points are fixed at the level of the earth's surface (site, road, open ground, etc.) on which there are no objects

Points at ground level

4) The procedure for interpolating the height values at the points noted in the previous stage is performed

5) Pixel values of DSM_{sl} the values of the DEM pixels are subtracted, as a result of which we obtain a digital surface model (height values relative to the ground level) _DSM_{gl}:
$$DSM_{sl} - DEM = DSM_{gl}$$

6) At DSM_{gl} the contours of round timber stacks are fixed and their storage volume is automatically calculated by summing the products of the areas of individual pixels multiplied by their height within the contour:
$$V_f = S_p \times h_p \times n,$$
V_f - storage volume of a stack of round timber,
S_p - the area of an individual pixel (spatial resolution×2),
h_p - the height assigned to an individual pixel within the frame DSM_{sl},
n - the number of pixels within the outline.

7) The dense volume is calculated by multiplying the storage volume by the full-wood factor in accordance with GOST 32594-2013.
$$V_d = V_f \times K_f$$

Species	The ratio of wood content of timber K_p depending on the length of the assortment, m				
	3	4	five	6	7
Spruce, Fir	0.673	0.665	0.660	0.655	0.651
Pine	0.660	0.655	0.652	0.650	0.648
Larch	0.645	0.640	0.637	0.635	0.633
Birch, Aspen	0.670	0.663	0.660	0.656	0.652

Results

Volumes of roundwood

Volumes of bulk timber