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Photogrammetry in precision agriculture for determining physical parameters

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GOAL OF THE STUDY

The purpose of the study is to test the possibility of determining physical parameters, such as the size of winter wheat using UAV imaging.

METHODOLOGY OF THE INVESTIGATION

The planning of the shooting was done with the software product Pix4Dcapture. A flight plan for a 3D mission was created with the option: Double grid mission. The plots on which the experiment is set are 1.25m x 20m in size. The created flight plan of the test with a double meander is an area of 74 x 53 m in size, at a flight height of 35m. The selected overlap in width and length is 80%.

Pix4D rayCloud is a 3D interface that allows interaction with the original 2D images and the reconstructed 3D object space. This visualization allows analyzing the reconstruction of each individual point. Clicking on a 3D point connects all images that contribute to the reconstruction of this specific pixel of the created map.

MAIN RESULTS FROM THE STUDY

Obtained after processing for Average Ground Sampling Distance (GSD) - 1.01 cm/px. Here we have a better resolution value per pixel than the planned 1.63 cm/px. Dataset - 69 out of 69 images calibrated (100%), all images enabled. For Camera Optimization, 0.15% relative difference between initial and optimized internal camera parameters was obtained. For the images, a median of 78529 keypoints per image was obtained. Matching - median of 18098.2 matches per calibrated image.

Measuring the dimensions of the beds, the set length of 20m (when sowing it is difficult to achieve ideal accuracy) was measured from 19869 to 19986mm. This size also depends on how much the wheat is tilted in a given direction. The width of the beds is set at 1.25m, the size depends on the row spacing. The measured dimensions from the 3D model vary in the range of 1.3 to 1.42m, which strongly depends on the width of the wheat (in Fig. 6b the sideways lying is visible).

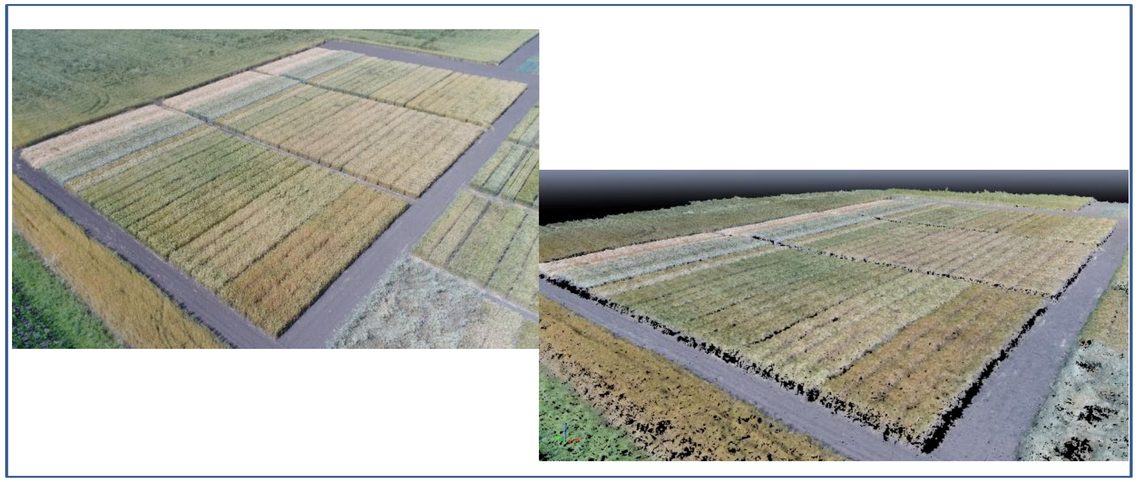

Fig. 1. Photograph of the test area (left), and the 3D model obtained from the processing (right).

The measurement of the crop height from the 3D model is shown in Fig. 1left. In Fig. 1right, a photo of the crop height for the same plot is taken. In the photo, the average height is marked with a red line, which is slightly over 910mm, and the measurement in AutoCAD is 910.27mm.

RESULTS ANALYSIS

When measuring the length of the plots Multiple R= 0.99998 and R Square = 0.99997. Standard Error - 0.126515.

When measuring the width of the plots Multiple R= 0.99969 and R Square = 0.99938. Standard Error - 0.03788.

When determining the height of the stem Multiple R= 0.9994 and R Square = 0.9988. Standard Error - 46.892.

CONCLUSIONS

By using a small UAV, it is possible to obtain an accurate 3D copy of the agricultural terrain and crops from which it is possible to obtain accurate dimensions. The obtained accuracy is between 99.94 and 99.998%.

The dimensions obtained from the resulting 3D model have high accuracy and it is possible to determine physical and geometric parameters of agricultural crops. They can serve for research purposes.

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