

Using YOLO neural network for segmentation of contiguous wheat grains

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Motivation and Aim: The weight of a thousand grains is one of the most important yield indicators of agricultural cereal crops. Its calculation requires measuring the weight and counting the number of seeds. Counting grains manually is a labor-intensive and time-consuming task. Development of approaches based on image analysis by computer vision methods is relevant at the moment because of low cost and ease of use. Grains in such images are located close to each other, which complicates the process of their recognition. In addition, the characteristics of individual grains, such as length, width, volume, shape, color, and texture, are important in modern breeding and genetic experiments. To measure them in the image, it is important to accurately define grain boundaries.

Methods and Algorithms: The study involved the selection of five genotypes from the ITMI collection, with attention to cover genotypes having different grain colors. The neural network architecture from the Yolo [1] family of the eighth version was chosen to solve the instance segmentation problem. The model was trained for detection and segmentation of individual grains. The training sample size was increased using the image augmentation method. The training and model running parameters such as number of epochs, batch size, optimizer, learning rate, IoU, confidence were selected.

Results: The quality of the model performance on the test sample was evaluated using metrics such as CR (correct ratio) [2] and mAP (mean average precision). CR was used to assess the quality of counting and was equal to 98.3 %, which is a higher result compared to classical computer vision methods often used for solving similar problems. The mAP metrics were computed to evaluate both detection and segmentation quality. The metrics for detection have higher values compared to the metrics for segmentation.

Conclusion: Neural network allows to find contours in images with dense arrangement of grains, in which application of methods of classical computer vision will not give high results. The result of segmenting individual grains can be further processed using neural network models per-designated to solve the semantic segmentation problem or using classical computer vision techniques.

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