

Applying neural network for the segmentation of spike structural elements

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Introduction: The shape and structure of the wheat spike is one of the most important characteristics of cereals associated with their economically valuable qualities such as productivity, the absence of ear fragility and ease of threshing. The study of the genes controlling these traits will allow us to purposefully create new varieties with improved characteristics in terms of yield, ease of thresh and resistance to environmental factors. Evaluation of wheat spike characteristics in most modern studies is performed by an expert based on the visual analysis and measuring practices, which requires a significant investment of time, despite the fact that in modern experiments tens of thousands of plants are analyzed.

Automation of this time-consuming process through the introduction of digital image analysis technologies is relevant for modern science. Important step in wheat morphometric analysis is spike structural element segmentation at body and awns of spike.

The aim of this study is the creation of method to segment ear structural elements.

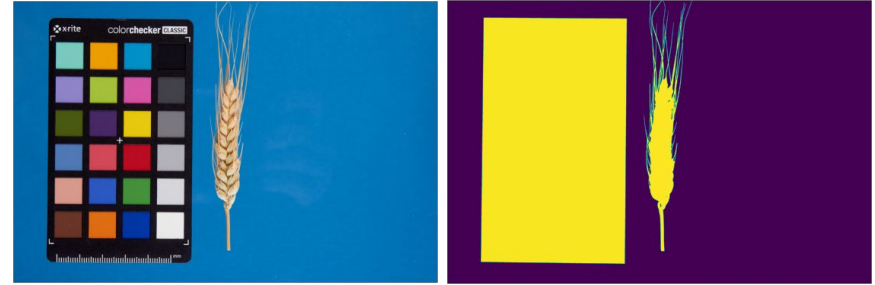


Fig 1: Example of data (left - photoed data by protocol, right - mask of spike structural element)



Fig 2: Scheme of photoing: (left - on table, right - on pin)

Materials: The plants were grown in 2015–2021 by center "Laboratory of artificial plant cultivation" ICG SB RAS, (Novosibirsk). Data were collected by two protocols: on table and on pin. Then data were annotated by expert 93 images and by cv-algorithm [1] 2363 images.

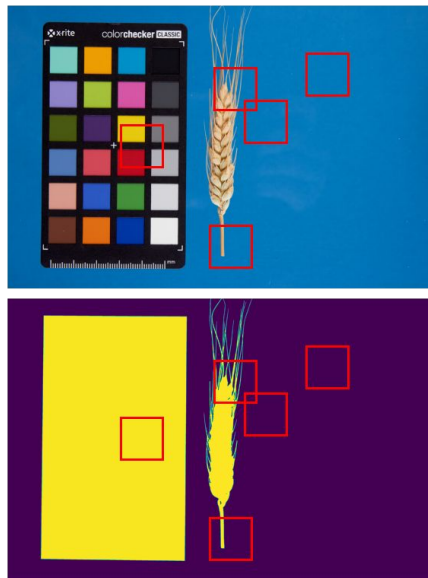


Fig 3: train process sampling

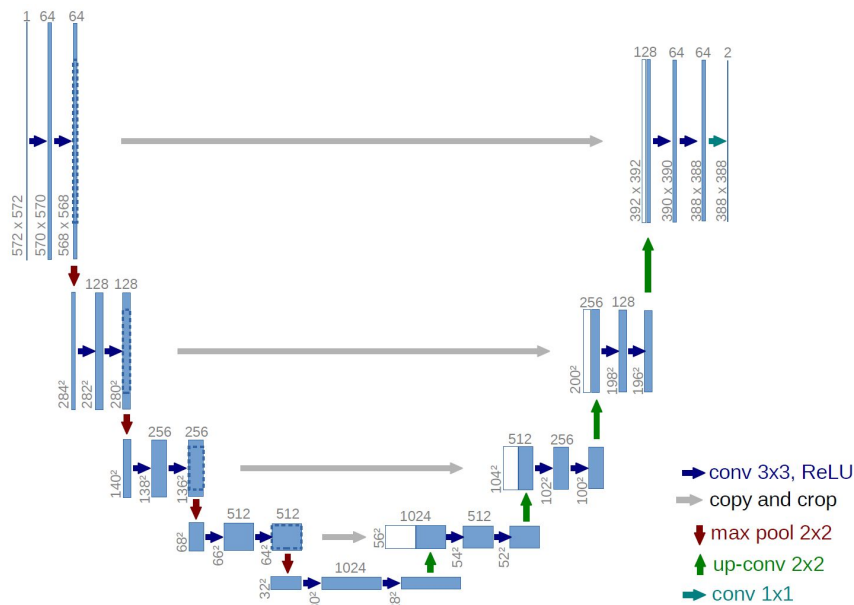


Fig 4: inference process sampling

Methods: It was applied to the solution of the problem based on neural networks. Unet with the resnet34 encoder was chosen as an architecture that has proven itself for solving biological segmentation problems. During training and inference process, in order to preserve the quality of segmentation, the image was not compressed, but splitted into regions as shown in figure 3 and 4. The training took place in two stages: the first on cv-algorithm annotation, the second on the images annotated by expert. The testing hold by on 30 images annotated by expert.

Results:

1. Proposed a method based on neural networks to segment ear structural elements.
2. Achieved accuracy according to the IoU metric **94.73%** for the body and **77.70%** for the awns of wheat, which is 2.23% and 11.70% higher than that of the WERecognizer model posted on wheatdb.org/werecognizer.