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# Monitor of the change in number of panicles of paddy rice from low altitude UAV imagery

# (低空 UAV 画像を用いた出穂期穂数モニタリングに関する研究)

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## 1. Introduction

Rice, one of the staple foods, is the primary source of calorie supply in Asia. Owing to the high value of rice, agricultural researchers focus on improving the quality and yield of rice. Panicle, which has vital meaning for phenotyping analysis, quality, and yield, is one of the principal traits of rice. In recent years, accurate detection of panicle is the key to rice research. On the one hand, the widespread agricultural use of computer vision, especially, deep neural network, has shown its superiority on plant classification, detection, and segmentation. On the other hand, given the rising trend of UAV-based phenotyping analysis, UAVs are considered as the high-throughput platform for efficient and effective field-based study. Combining the advantages of both sides, in this study, a flexible system that UAV flown at a very low altitude was proposed and a deep learning-based panicle detection for visualizing the change of rice growth status during the full heading stage were implemented.

## 2. Methodology

A two-year experiment was conducted for data collection and accuracy validation. A deep learning model, Mask R-CNN, was trained for detecting panicles in complex scenes. 13857 images were fed into Mask R-CNN with randomly 80% for training and 20% for validation. Subsequently, 1-dimension linear interpolation and Kalman filter were implemented as pre-processing of flight trajectories. The corresponding logs from trajectories were utilized to provide geographical information and the pose of UAV. Detected panicles were further computed for locations by converting pixel coordinate to UTM coordinate. Eventually, the change in panicle growth status was visualized. A postprocessing method that a density-based clustering, DBSCAN (Density-Based Spatial Clustering of Applications with Noise), was used to remove repeated detections and the sigmoid model was fitted for evaluating the number of panicles.

## 3. Results and Discussion

From the perspective of detector's performance, the accuracy of Mask R-CNN achieved that the scores of precision, recall, and AP (Average Precision) were 82.46%, 80.60%, and 79.46%, respectively. After fitting growth model, the average error between final counted number of panicles and results from prediction was 179.75.

## 4. Conclusion

To this day, agricultural production is facing the revolution on which labor-intensive and time-consuming progress has been transformed into a high technology predominance. The promotion holding agricultural information data-driven methods charges power to begin a new resolution covering all aspects of agricultural production. The proposed system can not only be implemented on phenotyping analysis but also be expected to be one of the multiple sources of data.