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Detection and Localization of Pumpkin by UAV System

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1. Introduction

It is reported that Japan is now facing a problem of super-aging, accompanying with which is a labor shortage on agriculture. This puts a burden on farmers especially when harvesting heavyweight crops. Under this situation, the automation of agricultural machinery becomes an urgent need. With the wide spread of smart agriculture in Japan, people can now use robotic tractors to implement precision agriculture. This research is the first step for realizing an automatic pumpkin harvesting system, which is to get a position map of pumpkins before harvesting. In this study, a pumpkin detection and localization system was implemented based on a UAV system and a post-processing of machine learning.

2. Methods

The study was conducted in the pumpkin field of Hokkaido Agricultural Research Center, Sapporo. Flight experiments were conducted during August and September in 2019. The UAV system consists of an agricultural drone mounted with a multispectral camera, which can record 5 bands of light spectrum, Blue, Green, Red, Near Infra-red and Red-Edge. After the acquisition of data, photos were mosaicked into complete maps cover the whole field. A machine learning process of logistic regression was run with samples taken from these maps. The 5 bands' spectral information were taken as 5 features in the model. With the machine learning process finished, parameters were exported and then taken into calculation of hypothesis with each map pixel. Based on the hypothesis, we were able to classify each pixel as pumpkin or background. After a denoising, the detection section was finished with a binary map outputted. For the localization section, the "regionprops" function was used to get the centroids of pumpkin regions in the binary map. Centroids of pumpkins were saved in a CSV format file. After that, a converting from image coordinate to geographic coordinate was operated. Then the GPS information of pumpkins was finally created.

3. Results and Discussion

In the georeferencing section, a comparison was made to evaluate the effect of georeferencing. It proved that doing georeferencing improves the accuracy of mosaicked map significantly. In the post processing section, precision-recall was chosen as evaluation indexes to the detection performance. Comparing the result of different varieties revealed the importance of data balance between different kinds of samples. The result under different scales showed that low resolution maps are less likely to classify small area noises as pumpkins but more likely to lose pumpkins which are covered a lot. It also showed the system has a good robustness to scale change. Comparison among different growth conditions showed an influence caused by leaves. The further researches were supposed to solve these problems at first.

4. Conclusions

A detection and localization system for pumpkin was accomplished by acquiring data with UAV system and processing data with machine learning. Result analyses showed the system has a high precision and recall to be feasible. The robustness to scale change was also proved in this research.