Rice Phenology Monitoring and Growth Parameters Estimation Using High Temporal Proximity Aerial Photos

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1. Introduction
Crops monitoring, for example in the case of biomass monitoring, satellite remote sensing has the advantage for monitoring the large scale farmland. Because remote sensing technic can observe the wide area in the short time with no destruction. But, Satellite observation has the problem of certainly because of the clouds. Furthermore, when the problem of the growth heterogeneity in the field, more high resolution images are needed. So we used electric-powered Multicopter as the Unmanned Aerial Vehicle(UAV)which mounted the digital camera and monitored the phenology of rice using high temporal-resolution images by UAV. Then we also produced rice growth estimation models(LAI,Plant height).
2. Materials and Methods
We observed the two paddy fields in Chiba Prefectural Agriculture and Forestry Research Center between May 2014 and September 2015. These two fields are subdivided 48 compartments. And change the cultivation condition (transplantation day, varieties, amount of fertilizer).Observation equipment were electric-powered Multicopter (enRoute Zion QC630, MEDIX JABO H601G, DJI Phantom2) and digital camera (visible image: RICOH GR, GoPro, near-infrared image: BIZWORKS Yubaflex). Flight altitude was 50m.Ortho photographs and Digital Surface Model(DSM)were created by using the SfM/MVS software Agisoft PhotoScan Professional. The images taken with Yubaflex, after conversion to radiance in software(Yubaflex2.0), and created the ortho mosaic images using SfM / MVS software. After that, we calculated vegetation indexes (NDVI, etc.) using the ortho mosaic photos. At that time, we added $NDVI_{pure\ vegetation}$($NDVI_{pv}$)which pixels NDVI value are over 0 as a vegetation zone, as the one of the vegetation indexes. Actual measurement data of rice growth situation (heading day, plant height, LAI, etc.), using the observed value of the Chiba Prefectural Agriculture and Forestry Research Center.
3. Results and Discussion
In the time-series change of NDVI, there was a time that the amount of increase in NDVI were temporarily reduced before panicle formation stage. This time was almost the same time as the maximum tillering stage. At the highest tillering stage, some weak stems died without putting the head. And the number of stems is reduced. Such a characteristic influenced on the low increasing of NDVI. In this study, we showed the possibility to grasp the highest tillering period from the time-series change of NDVI. There is a difference in the time-series change of NDVI of the compartment for changing the only transplant day in cultivation conditions, the number of days from transplant to record the maximum NDVI became short at the compartment which transplantation day is later. This result is considered to be reflected that growth speed become faster at the high temperature. Furthermore, transplantation day became later, the maximum value of NDVI was increased. High NDVI means the good growth, and generally believed that increased yield. But yield was not increased. In the case of temperature become higher around the heading time, rice cause growth failure(Failure of fertilization, etc.). So we considered that yield was not increased in this study. We calculated the regression models(before heading time) of LAI and Plant height using the correlation between vegetation indexes and actual measurement data. As a result, NDVIpv and GNDVI showed good result. RMSE of the estimated results, 0.053m in plant height, 0.73 in the LAI in

NDVIpv, 0.043m in plant height, and 0.74 in the LAI in GNDVI. We showed the possibility of estimation of the growth parameters using this research method.

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Keywords: small UAV, proximity remote sensing, growth management, SfM/MVS