

Application and problems of UAV to use for the local government.

*Osamu Saitou¹

1.Ibaraki University

Production and field trials have been made in various scenarios using Uncrewed Aerial Vehicles(UAVs).Efforts of local governments have been promoted intensively.For local governments,staff reduction is a remarkable trend.Such streamlining of organizations for efficient performance is expected to delay the response to and assessment of great disasters.Lack of personnel can become a factor that delays the initial response.Many local governments are planning a review of the Great East Japan Earthquake in 2011,but the lack of personnel and human resource budgets is a daunting social problem.Therefore,UAVs are presented as effective and safe tools.UAV applications can be extended to include aerial photography, pesticide spraying,checking of power transmission lines,disaster prevention,service life of building structures,and disaster prevention and mitigation.

Keywords: UAV, local government, disaster prevention

Solar energy potential assessment and mapping in high-rise building area with UAV spatial modeling

*Myeongchan Oh¹, Jin Son¹, Hyeong-Dong Park¹

1.Seoul National University

Assessment of renewable energy potential in urban areas is treated as important information in many energy design projects and engineering projects due to a surge of interests in global energy issues. Especially, with spatially restricted areas for energy production corresponding to increasing energy demands, photovoltaic (PV) panels sourced by solar energy can be the one of the most promise alternatives. In this study, we calculated solar energy potential, one of the renewable energy, specifically in urban area, which are fulfilled with artificial objects, with applying UAV (unmanned aerial vehicle) to building spatial model. A variety of spatial data to calculate the solar energy potential are required: environment, orography, and climatology factors. In particular, orography in complex area like cities with many high-rise buildings can be highly influenced as shading effect of these area is significantly affected solar energy potential. In past, these data highly consume both time and expenses to be obtained, however, by recent development of UAV technology, spatial model in high resolution can be easily produced. Because of advantages of UAV, such as easy accessibility to the target site, high resolution sensor, GPS (Global Positioning System) and IMU (Inertial Measurement Unit), it is convenient to generate aerial map and DEM (Digital Elevation Map) with lower expenses. DEM is extracted from overlapped aerial images by stereo depth calculation. With the spatial database, which consist of the spatial model obtained by UAV and other factors directly measured or offered from Korean Meteorological Administration, solar energy potential can be estimated. The analysis module is design with Matlab, which introduces multi-variables such as local solar irradiation data, annual cloud ratio, weather, solar orbit, solar panel information and shadow effect. As a result, the map with total solar irradiation map and solar irradiation map considering panel information are composed, which can be used in the stage of decision-making, such as site optimization for PV power plant system and its potential power generation estimation. To summarize, we designed the potential solar power estimation module, particularly for urban areas with the forest of high-rise buildings. It is expected that this study will help people working in renewable energy area calculating solar energy potential and mapping.

Keywords: Solar energy, Energy assessment, UAV

KT200: an experimental autopilot drone below 200 grams

*Kei Tanaka¹, Takashi Nakata²

1.Japan Map Center, 2.Prof. Emeritus, Hiroshima Univ.

UAV (Unmanned Aerial Vehicle) has become very popular in these days and improper use of UAV has become an object of public concern. As a result, the Civil Aeronautics Act is amended, and flight of UAVs over 200 grams is restricted. In order to take low-altitude air photos for research purposes without being mindful of restrictions, we assembled an experimental autopilot drone below 200 grams using commonly available parts in the market, and successfully carried out its maiden flight.

Keywords: Unmanned Aerial Vehicle, Civil Aeronautics Act, below 200 grams, KT200

Evaluation of Foam Plane under 200 grams for Aerial Photo Survey

*Hiroshi Inoue¹, Takashi Nakata²

1.National Research Institute for Earth Science and Disaster Prevention, 2.Hiroshima University

We are conducting experiments for utilizing small UAVs for natural disaster risk assessment, monitoring and response. Japanese Civil Aviation Law was amended on December 10, 2015 to more strictly regulate small unmanned aerial vehicles. Now we cannot fly UAVs above populated areas, beyond visible distances, and before sunrise or after sunset without permissions of Civil Aviation Bureau. The freedom of using UAV has now been considerably limited by the new law.

The regulation applies to, however, 200 grams or larger aircrafts only. Those below 200g are exempt from the new regulations and you can fly them anywhere without permission except airspace near airports and above 150m ground altitude. Also the lighter equipment is the safer when it crashes. Styrofoam plane of pusher type, with a propeller facing rear, under 200 gram is almost harmless when they crash. We therefore need to evaluate the performance of under 200 gram fixed wing foam planes. Our preliminary experiment shows it can fly 5 minutes in 30km/hour at 50m ground altitude. The 2.5km flight range is long enough for small scale surveys.

UAV images of before and after the 2014 Hiroshima debris flow disaster

*Kei Tanaka¹, Takashi Nakata²

1.Japan Map Center, 2.Prof. Emeritus, Hiroshima Univ.

Before dawn of August 20, 2014 debris flow caused by a localized torrential downpour attacked out-skirt of Hiroshima City killing 75 people especially on gentle slopes at the foot of granitic mountain.

We described typical examples of human neglect against debris flow that resulted unnecessary loss lives, based on UAV photography taken before after the debris.

We also counted numbers of houses of different construction period in the debris flow area, demolished houses by debris flow and houses of victims, and came to know that ratio of demolished houses and victims were higher in post- high economic growth period.

Keywords: 2014 Hiroshima debris flow, GIS, Unmanned Aerial Vehicle

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

*Akira Hama¹, Atsushi Mochizuki², Yasuo Tsuruoka², Kei Tanaka³, Akihiko Kondoh⁴

1.Graduate School of Science, Chiba University, 2.Chiba Prefectural Agriculture and Forestry Research Center, 3.Japan Map Center, 4.Center for Environmental Remote Sensing, Chiba University

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 $NDVI_{\text{pure vegetation}}(NDVI_{pv})$ 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

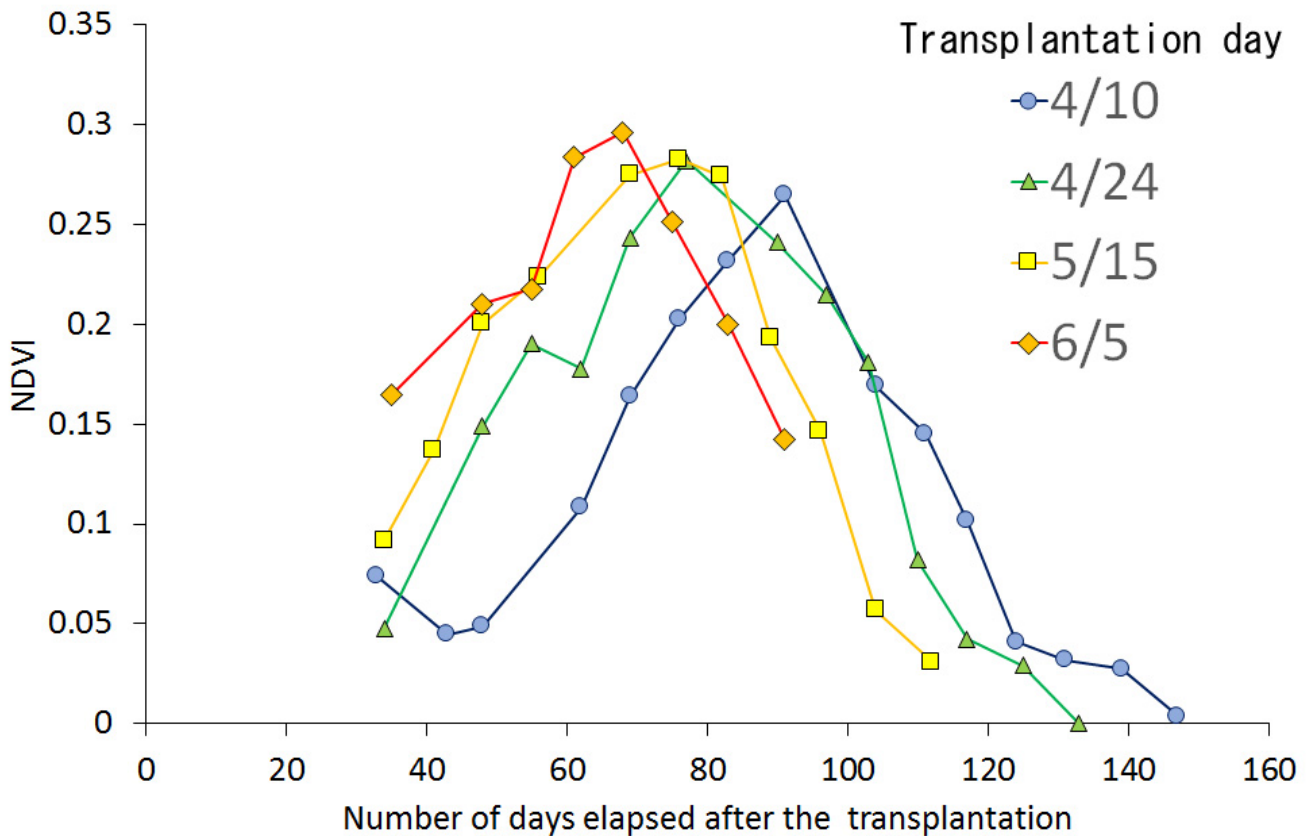
In the time-series change of NDVI, there was a time that the amount of increase in NDVI were temporarily reduced before panicle formation stage. This time was almost the same time as the maximum tillering stage. At the highest tillering stage, some weak stems died without putting the head. And the number 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, $NDVI_{pv}$ 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.

Acknowledgment

In this study, we receive cooperation in other fields such as use various aspects that got the data provided to the Chiba Prefectural Agriculture and Forestry Research Center rice warming laboratory. We thank you for cooperation.

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



Monitoring alien plants by small UAV and TLC in Kanno river, Inbanuma catchment

*Shinya Hamada¹, Akira Hama¹, Akihiko Kondoh²

1.Graduate School of Science, Chiba University, 2.Center for Environmental Remote Sensing, Chiba University

1.Introduction

In a lake of Inbanuma located in northwestern Chiba Prefecture, an alien plant of *Alternanthera philoxeroides* is introduced and breeds. This waterweed is designated as Tokutei Gairai seibutu, and not only losses biological diversity but also invades into rice field and causes the trouble in the drainage work due to being washed ashore drainage facilities in Inbanuma. Therefore Industry-academia-government-Citizen collaboration is making *Alternanthera philoxeroides* exterminated mainly Inbanuma water cycle restoration conference. However, there are few studies about *Alternanthera philoxeroides* in Inbanuma. It is urgently necessary that we know the dynamics of *Alternanthera philoxeroides* communities. In this study, we took pictures of Kanno river, Inbanuma catchment where *Alternanthera philoxeroides* is crowd from the sky at a high frequency. Then, we created high resolution ortho mosaic images that performs a detailed monitoring by using the Structure from Motion / Multi-View Stereo (SfM / MVS). We also use Time Lapse Camera (TLC) to monitor in detail.

2. Methods

We took pictures of Kanno river from the sky (5/30,6/22,7/25,8/26,9/23,10/29). We used a small UAV of enRoute Inc. ZionQC630, and the camera of RICOH Inc. GR. We used the Mission Planner of free software, and made UAV fly with the auto pilot, at 50m height from the ground. We also took pictures from the sky at 1 second intervals. We created ortho mosaic images by SfM/MVS software (Agisoft Inc. PhotoScan Professional ver1.2) based on images taken from the sky by the UAV. Then, we did interpretation of the *Alternanthera philoxeroides* communities. We used the GIS (ArcGIS 10.2), and created the polygon of *Alternanthera philoxeroides* communities that had flourished near the bank at each surveyed time. In this way, we managed the area, location, shape and the like of the each community. TLC is setting at the bridge and taking pictures of river section at 10 minutes intervals.

3. Results and Discussion

Community area in Kanno river, was 1239.8m² in May and 2080.2m² in October. During this time, the extermination of *Alternanthera philoxeroides* communities had been carried out, its area was 740m². In addition, the community that had flowed naturally was about 309.7m² totally. This indicates community practically had expanded by 2.5 times. Community flown during 8/26~9/23 was 168.2m². It is considered that heavy rain by the typhoon No. 18 during 9/6~9/10 was the cause of this outflow. The best growing community's number in the area expand was the greatest during 6/22~7/25, but the period when the each community growth is the best varied. If communities grow and community area expands, the area expand is also increased in proportion. Therefore expanding of community area was bigger late than early during observation period. What has lost the impact of this community size is the rate of expand. Also in the rate of expand, the variation was observed in the period when the rate of expand is the best, during 5/30~6/22, the number of community that was the best in the rate of expand was the greatest. In Kanno river there is variation in the community size, even the same time, and that the growth amount in proportion to the community size became big, it is easy to grow during 5/30~6/22, and gradually growth is worse become a measure of growth prediction. *Alternanthera philoxeroides* extends the roots to riverbank again after the spill. However, while the number of the 12 m² or more of the community flowing out during the observation period is

eight, there is no community to appear newly. In brief, in Kanno river, the relatively large community was difficult to fix again. On the other hand, we can check the communities of less than 2m² in great numbers, that is to say, the relatively small community is likely to be a community of high expansion capacity in Kanno river.

Keywords: UAV, invasive alien species, Industry-academia-government-Citizen collaboration

