Recognization of rice damage area on UAV ortho-images

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Abstract

The following research uses Yuanli Township, Miaoli County as an example. The Multi-spectral UAV aerial images used have high spectral, spatial and temporal definition, which provides High-resolution DEM, which can be applied through height bias to recognize the rice damage Range and type. Furthermore, due to the chlorophyll in the crops having higher NIR reflection, when applied with NDVI, the crop growth range and stadium can be clearly explained more easily.

The image processing technique is done by Pix4D and e-GPS measure Ground Control Points to produce a RGB Orthomosaic and NIR Orthomosaic, then using Arc gis to produce interpretation attribute data which is then derived through MATLAB input range values. The result of rice damage will be interpretated by using NDVI images as a major factor and human judgement as a supporting factor.

Key words: Remote sensing UAV,NDVI

Introduction

Rice is one of the main food crop of the Taiwan region. The total rice planting area recorded in 2016 in the region of Taiwan was 79.4 million ha, which is 22.05% of the total farming area. Taiwan is located within a subtropical region and has an island climate, which provides a warm weather and plentiful of rain which is beneficial to the growth of the rice and various crops, yet the fluctuating weather, typhoons and heavy rainfall also cause damage to the rice and severely affect rice production capacity. To protect farmers' rights and interests and ensure the livelihood of the farmers, Council of Agriculture and government departments have established the agricultural natural disasters Assistance to provide government compensation for the damage that is caused to the crop and farmers due to natural hazards, which can go up to several hundred million yuan.

Currently the Council of Agriculture uses artificial site survey combined with taking pictures and artificial circle area to carry out the agricultural Damage Survey for government departments, which is a method that does not provide objective perspectives. Also, after the events of natural hazards such as typhoon、heavy rain or cold damage ,it is not possible to provide an effective and objective disaster investigation within the limitation of time and human resources.

The UAV aerial photography has numerous advantages such as aerial photography has immediately 、 highly maneuverable、Payload elasticity、low-budget and simple operation. It can also be applied immediately after a disaster to provide ortho-images or multispectral images which when combined with precise Geo-referencing program, can produce an objective image that is of high precision and definition.

The following research uses High-resolution elevation model information provided by the UAV multispectral image which can be put through NDVI to calculate the deviation of plant spectral patterns when damage occurs to provide efficient disaster investigation..

Literature review

Remote sensing is a technique that uses various carriers such as satellites and planes to carry sensing instrument to collect multispectral data from the sky without the need of direct contact and be able to analyze and interpret the characteristics of the ground target. This technique can also collect surface terrain information, where the technique has already been applied for security monitoring to provide surface basic data such as fixed in space,time and spectral resolution. While with the improvement of technology, the definition of satellite images has improved to centimeters, the low time resolution, satellite photography cycle of three to five days and aerial photograph being able to be blocked by clouds have a strong influence on the results of satellite images. On the other hand, aircraft aerial photography is highly dependent of the weather at the location, which increases the restrictions and danger when carrying out a aircraft aerial photography after a natural disaster where the weather conditions are poor, making aircraft aerial photography not suitable for ground information collection after a natural disaster. [1]

With the development of Remote sensing, satellite monitoring has become the main means of method for monitoring. This technique has various applications for the agricultural industry, it can be used to identify planting area、growing situation and crop production, however for some crops that have a shorter growth period and have a dispersed distribution area, the method of using drones to photography and monitoring has also been applied. Drones were first used as a military weapon; however, drones have been used for navigation and even as a means of image collection for detection after the Vietnam War. Despite having a conflictive origin, the application of UAV as a civil machinery is slowly becoming a trend. The adaptations for UAV as a means of ground surveying have led to its increased development. With advantages such as lower cost compared to satellite or aircraft aerial photography, more simplistic controls, and faster images acquisition speed, the application has become the main methodology for small area aerial photography.

UAV are also able to have a lower flying height, which results in a higher definition compared to those of a satellite or plane, which can help the identification and clarification of vegetation. When put in comparison with drones used to spray pesticides, the UAV has a lower consumption of energy and is able to use GPS and INS sensors to set its own navigation routes. As stated by Uto et al. (2), using UAV to carry hyperspectral sensor to detect the chlorophyll content of rice field and use the data collected to estimate the quantity of the rice which will then be referenced to the surface data can increase the reliability of the results. Lelong et al. (3) have used an UAV carrying a digital camera that has been calibrated to collect four bands of the image, the RGB and BIR, in an

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Agricultural test area for wheat crops in southern France, in which the collected data will then be put through the NDVI formula to estimate the crop output.

To determine the density of green on a patch of land, researchers must observe the distinct colors (wavelengths) of visible and near-infrared sunlight reflected by the plants. As can be seen through a prism, many different wavelengths make up the spectrum of sunlight. When sunlight strikes objects, certain wavelengths of this spectrum are absorbed and other wavelengths are reflected. The pigment in plant leaves, chlorophyll, strongly absorbs visible light (from 0.4 to 0.7 µm) for use in photosynthesis. The cell structure of the leaves, on the other hand, strongly reflects near-infrared light (from 0.7 to 1.1 µm). The more leaves a plant has, the more these wavelengths of light are affected, respectively.

Nearly all satellite Vegetation Indices employ this difference formula to quantify the density of plant growth on the Earth — near-infrared radiation minus visible radiation divided by near-infrared radiation plus visible radiation. The result of this formula is called the Normalized Difference Vegetation Index (NDVI). Written mathematically, the formula is:

NDVI = (NIR — VIS)/(NIR + VIS)

Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1); however, no green leaves gives a value close to zero. A zero means no vegetation and close to +1 (0.8 - 0.9) indicates the highest possible density of green leaves.[4]

Research Methodology Ddescriptive statistics

Location of experiment

The following experiment has been carried out in the rice field of Yuanli Township, Miaoli County,Taiwan. The selected location is in a subtropical area with an island climate, which provides abundant precipitation and a warm environment which is suitable for the growth of rice and various crops. However, due to the changeable weather, strong winds and heavy rain, the area is subject to natural disasters, therefore the location is selected for natural calamity and crop damage investigation.

Experiment design

The following experiment multispectral image to observe and analyze statistically the change in spectral intensity and data when the vegetation is subject to damage, which will increase the compensation efficiency of the Council of Agriculture and the local government.

Experiment procedure

First, set out a total of 34 e-GPS measure ground control points with plane accuracy of 5cm and take 306 aerial photograph pictures of the designated area which is 258 hectares. Then use Pix4Dmapper to geometric rectification and orthorectification the images collected to produce the RGB Orthomosaic and NIR Orthomosaic. Using ERDAS IMAGINE to commence NDVI calculation and principal components analysis, this will then be put through image mosaicking with the cadaster to cut out rice field. The rice field will then be put through NVDI image to produce the images of both rice damage area and rice undamaged area. The manual survey acquisition area and aerial photography analyzing acquisition area will then be put through excel to calculate the rice damage area difference ratio.

Results

From the results of the NDVI image dissection, it has shown that there is a significant difference in the NDVI of the rice damage area. As seen in Figure 1., the area within the blue block is where the rice has been damaged which shows that the growing situation has been affected in the difference of NIR, which the damage area can be taken from the images, as shown in Figure 1 and Figure 2. The results will then be manual survey for comparison as shown in Table 2.

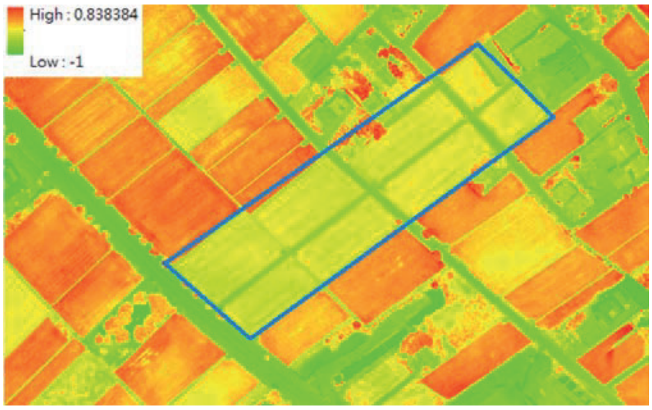

figure 1 rice damage NDVI image

figure 2 rice damage area image

Name	E	N	Area(m^2)
1	219914.753	2695631.629	884.954
2	219888.832	2695651.357	590.854
3	219868.202	2695596.801	1732.838
4	219848.536	2695617.183	1591.677
5	219810.691	2695554.219	1479.712
6	219787.042	2695576.558	1886.193
7	219764.467	2695518.706	1410.392
8	219739.047	2695542.550	1992.662

table 1 rice damage area

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damage area(m^2)			rice damage area difference ratio
image	manual survey	difference	
103.172	100.925	2.247	97.8%
93.804	100.070	-6.266	93.7%
715.665	770.010	-54.345	92.9%
367.278	357.013	10.265	97.1%
680.870	779.857	-98.987	87.3%
482.991	467.890	15.101	96.8%
695.484	714.930	-19.446	97.3%

table 2 rice damage area difference ratio

Conclusions

This research discusses the effect of the application of UAV multispectral image to identify rice damage area. We have analyzed the rice field in Yuanli Township and after comparing image calculation and manual calculation, and have concluded the following results:

1. The use of UAV multispectral image for crop damage calculation, when compared with image calculation and manual calculation, there is a similarity of over 90% which concludes that the method is effective.。
2. The proposed method can provide immediate ground investigation, more efficiency for job execution and increase the speed of response after the case of a disaster.

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