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Rice crop monitoring using multirotor UAV and RGB digital camera at early stage of growth

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Abstract. The increasing of population in the world lead the Malaysia government to intensification the food supply for the future in efficient way. Sustainable agriculture plays a main role for maintain the food production and preserve the environment from any excessive chemical by usage of technology for the better management. The Economic Transformation Program (ETP) emphasizes on the use of technology to finest aid crop production. Drone applications in crop monitoring are increasing globally and get place among end-users. The objective of this paper is to monitor rice crop by using multirotor Unmanned Aerial Vehicle (UAV) as known as drone and RGB digital camera in Kelantan, Malaysia. This paper will present the spatial analysis using RGB imagery in paddy plot at early stage to improve the management system. Results show that the uneven ground surface is a key element in achievement the higher yield production and improving the irrigation system in the paddy field. The ground management need to take action to make sure the paddy development can be growth in a healthy condition to increase the yield.

1. Introduction

Precision agriculture used for agriculture mapping which concerned with the production of food, feed, and fibre [7]. The key point of PA refers to the holistic management system in a farm operational. The famous “3 R” in PA is applying the input in a right input, at a right time and at a right location. High spatial resolution images and information technologies help to identify the agriculture differences and similarity in the same system [4] [5] [6]. Many farmer dealing with high loss due to natural disaster, and also wrong prediction of weather and poor irrigation system [1]. Some of the major problems



encountered by farmers were the difficulties in monitoring the field at the bigger scale. Therefore, the use of UAV will allow farmers to constantly monitor their crop condition and compare the ground surveying for the validation process in effective way.

One of the crop monitoring that used the PA is paddy. Paddy produce rice (*Oryza sativa* L), which is the main staple food in the world and their cropping pattern, especially in South Asian countries are dynamic in nature as they are strongly influence by the surroundings nature [3]. Research on rice is widely discussed and investigated to maintain the food security and supply especially in monsoon Asia region. Currently, remote sensing application had been widely used in agriculture, and many studies have assimilated remote-sensing data for rice crop classification, yield estimation and phenology analysis. One of the popular platforms used in remote sensing is UAV. It is a versatile device and cost-effective method in collecting high resolution imagery. This technology had been used commonly in agricultural field globally. This study proposes a usage of multirotor UAV and RGB digital camera in rice monitoring at Ladang Merdeka, Ketereh, Kelantan, Malaysia.

2. Materials and method

The study was conducted at Ladang Merdeka, Ketereh, Kelantan which was located at the east coast of Malaysia. The total acreage of the field was 20 acres with well organised plot. The variety of the seed is PadiU Putra that invented by UPM researcher that resistance to leaf blight disease (S1). The experiment was conducted for a single season from January 2018 until May 2018. The new cultivar of PadiU Putra (S1) were transplanted on 30th January 2018. Methodology used in this study as shown in Figure 1 below.

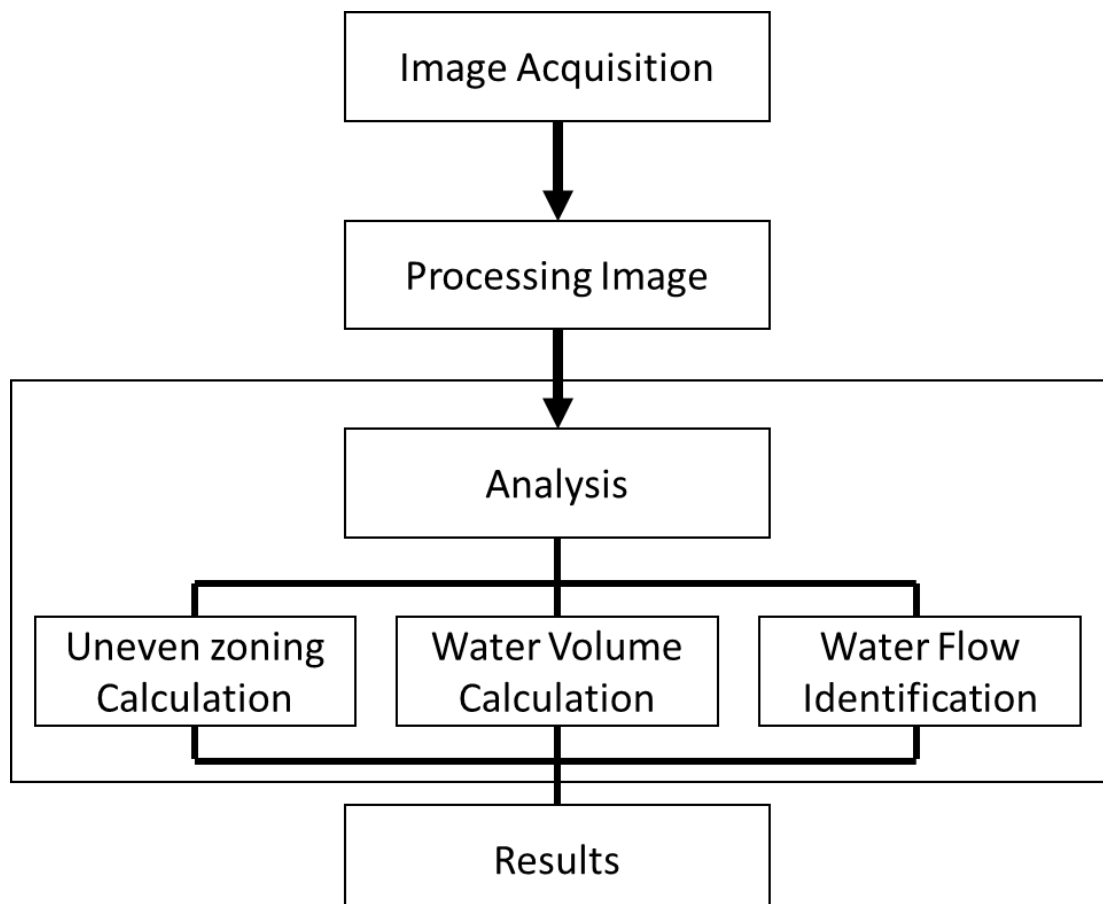


Figure 1. Methodology used in this study

For image acquisition, the multirotor UAV and RGB digital camera was used. The flight planning was design before the data acquisition by using Mission Planner software (<http://ardupilot.org/planner/index.html>). The altitude for data acquisition of RGB images was 70 m equivalent to 2.13 cm spatial resolution. The data collection was conducted in the morning under clear skies and low wind speed conditions between 08:30 in the morning until 12:00 noon at local time on 10th of February 2018 at 11th Day After Planting (DAP). The camera settings was adjusted according to the light conditions and set to a fixed exposure for each flight.

For image processing, Agisoft Photoscan software (<http://www.agisoft.com/>) was used to develop and align the imagery mosaic using Structure from Motion (SfM) algorithms. For each set of images, Agisoft PhotoScan software aligns the images and builds point cloud models of the surface. Agisoft allows generating and visualising a dense point cloud model based on the estimated camera positions to combine into a single dense point cloud [2]. The software provides a user friendly process for mosaicking the imagery. The imagery was added and aligned by using Align Photo function. Then, the imagery generates and visualized a dense point cloud model based on the estimated camera position using Build Dense Cloud function. It calculates the depth information for each camera to be combined into a single dense point cloud [2]. The geometrics of the map are reconstructed due to the poor texture of some elements of the scene and noisy or poorly focused images (Known as outliers among the points) by using the Build Mesh function. The images were used to build the texture exported as a mosaiced orthophoto image [2]. Finally, the mosaicked orthophoto generate a Digital Surface Model (DSM) and import the DSM and orthoimage to build the 2.5 digital models.

3. Results and Analysis

Figure 2 shows the boundary of the study area in this research. The total area was about 20 acres. The RGB image illustrations the whole study area. Users can see the structure and condition of the land by using spatial analysis.



Figure 2. The boundary of the 20 acre area in rice field

From the analysis, several results has been carried out, which is the area of uneven ground zoning, the volume that can be produced, water flow identification, and profiling paddy plot area. From the first analysis, the results show the uneven ground zoning which is 659.10 m² (2D) from total 8793.64 m²

(2D) (Figure 3). The total uneven area is 7% of total area. The solution to this uneven area is to ensure for the next planting season, this area should be taken care of the give more crop.



Figure 3. Uneven surface in rice plot

The second analysis is calculating the volume of water needed for paddy development. The height of water is 5 cm to ensure the paddy will grows well. To ensure the water level, farmer need to monitor the water level every day. From the analysis, it shows, the water needed is 3066 m³ (Figure 4). This calculation is important the water level in optimum height, especially when there’s an uneven ground, which required more water, or less water. This is important because the water level will affect the production of the yield at the spot area and decreasing the quality of the yield.



Figure 4. Water volume of the rice plot

The third analysis is to identify the water flow in the paddy plot area (Figure 5). Because there's an uneven ground in the paddy plot, it will lead the inconsistent of water level condition. Since the water level should be 5 cm levelling, the plants at the area will be affected because of the flooding and their development will be stunted, consequence the declining yields production during the harvesting time. This analysis is important to make sure the water flow is in a good direction.

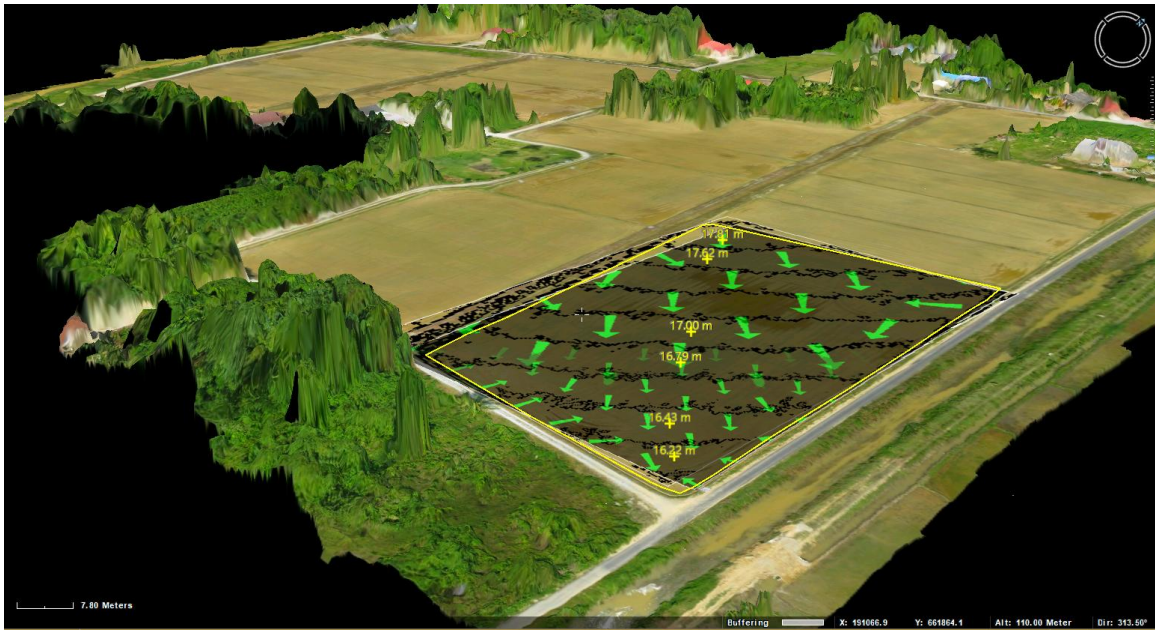


Figure 5. Water flow in the rice plot

The profile of paddy plot can be measured by identify the different of the ground surface (yellow line). It shows that the elevation different from the first point to the last point is 0.12 m and slope is 0.09° (Figure 6). The value is very significant since it will relate to the water flow and the development growth of the paddy in the season.

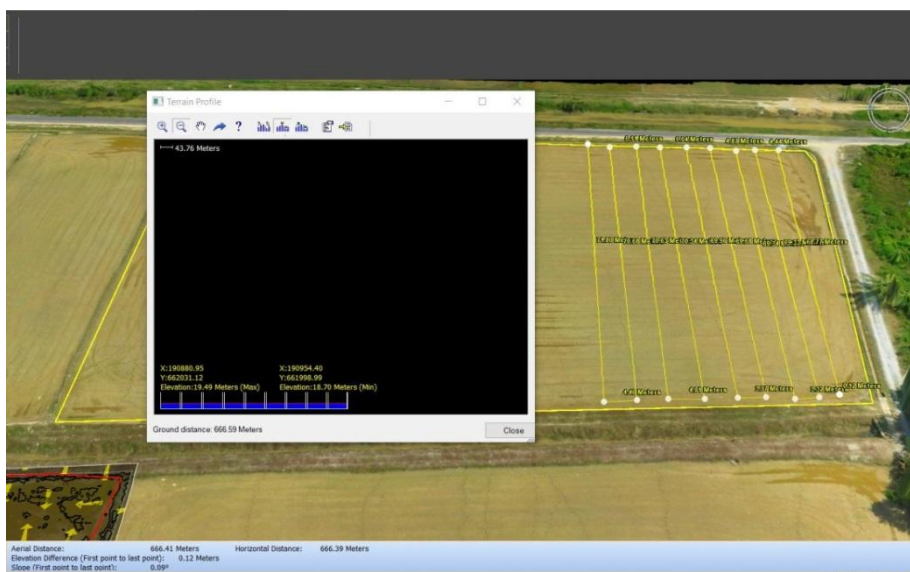


Figure 6. Profile of paddy plot

4. Conclusion

Rice monitoring at early stage is essential so that farmers can identify the problem at the early stage. The fast action can be taken to help plants get optimum nutrient and avoid from the pest outbreak to increase the yield production. Result shows that the RGB digital camera and multirotor UAV was successful collected the imagery at 70 m altitude and produce a tangible result in monitoring rice field in Kelantan. It shows the main problem is the uneven ground surface and poor irrigation system that will affect the plant condition. The well manage and organize ground surface is a serious issue and fast action needed to make sure the paddy plot area has a good surface before planting the seed. It proves that multirotor UAV and RGB imagery can be used in rice monitoring by reducing dependence on foreign labor, minimize exposure of workers to the chemical toxic content used, access to the difficult agriculture areas, diminish the risk of machinery being stuck or damaged during the field observation, and provide a high-resolution image in cost effective. The findings from these results, it is recommended to follow up the rice condition at every stage of the rice growth. The nutrient efficiency analysis should be conducted to check the health condition for the paddy plants in the future research by using multispectral imagery.

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