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Research paper

Implementation of Digital Image Processing for Rice Field Harvest Time and Area Size Estimation using Images Taken from Autonomous Aerial Harvest Surveillance

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Abstract

Problem faced by Indonesian farmers is the low price of the unhulled rice which happened when several region has the same harvest time. Indonesian Ministry of Agriculture encourage the farmers to do crop diversification to keep the crop price high. In order to support this policy, we provide estimation data so that local departement under the Ministry of Agriculture can give advice to farmers in their area to choose the right crops to plant. By using an Autonomous Aerial Harvest Surveillance (AAHS), we take images of rice fields to estimate the harvest time. The AAHS also provide global positioning system data while flying through its waypoint mission. These data are sent directly to the ground station (GS). By analyzing the RGB color space, and classification using backpropagation neural network, we have the average accuracy for harvest time estimation on real time flight testing is 82,73%, while the average accuracy for area size estimation is 73,92 %. Based on the feedback we received from local agriculture department, the accuration result is enough to help them forecasting the harvest result in their area.

Keywords: *Autonomous Aerial Harvest Surveillance, RGB Color Space, Backpropagation*

1. Introduction

Drone is an interesting topic in Indonesia since 2000. At first the growth of drone technology is very limited due the sporadic development. Soon after the consortium of drone development in Indonesia involving

PT. Dirgantara Indonesia, Lembaga Elektronik Nasional, BPPT and LAPAN are formed, the drone technology development in Indonesia is growing rapidly. The current president of Indonesia state that one of the government focus is the development in maritim sector. One of the program to support this agenda is the implementation of drone to monitor the Indonesian sea area. Drone can also be used as Aerial Harvest Surveillance (AHS) to support the agricultural sector in Indonesia.

Problem faced by Indonesian farmers is the low price of the unhulled rice which happened when several region has the same haverst time. Indonesian Ministry of Agriculture always encourage the farmers to do crop diversification in order to keep the crop price good. To support this policy, we develop a system which can provide estimation data so that the local department under the Ministry of Agriculture can control the crop production by estimating the harvest time in their area.

The size of an area can be calculated by using a digital image processing technique. By analyzing the pixels, the size of an object in digital image can be calculated. Measurement of an object in digital image has been done to find the size of bacteria (Massana et al., 1997), betel leaf area measurement (Patil & Bodhe, 2011), predict the disease affected of paddy leaf (Islam, 2015) and to quantify areas of soil and vegetation (Chaves et al., 2015). By using digital image processing technique, AHS can be used to monitor agricultural area.

The implementation of digital image processing in the field of detection and measurement using Unmanned Aerial Vehicle (UAV) has been done before. It can be used to detect fire based on digital video color space (Abdullah, Wijayanto, & Rusdinar, 2016). Fire generally close to the red color and by analizing the digital image in RGB color space (S. Noda, 1994). Image processing technique also can be used to do object detection based on RGB color space (Kusumanto & Tompunu, 2011). By using the same technique, we are able to detect green color of the rice field. Image processing technology gives us advantages in calculating area from a satellite image (Gusa, 2013).

2. Research Methodology

a. Aerial Harvest Surveillance System
Aerial Harvest Surveillance System used in this research is an autonomous quadcopter type “H”. The communication system between AHS and ground station (GS) is done directly by the flight controller module, Pixhawk. The AHS is equiped with sensors such as: accel-

erometer, gyroscope, barometer, compas and global possitioning system (GPS). The GPS is used to determine the waypoint and AHS position during a surveillance mission based on longitute and latitute.

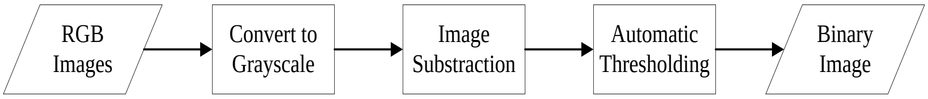

Fig 1: Preprocessing Process

The AHS carry a camera to do monitoring and capturing images from rice fields. The image is stored in Raspberry pi and being transfered directly to GS by using File Transfer Protocol (FTP). In the GS, the received data is processed to determine the age of the rice and estimate the harvest time. The sistem also calculate the rice field area, this information is needed by the local government to predict the total crop production in the area.

b. Image Preprocessing

The image preprocessing process consist of convertion to grayscale image, followed by image substraction (Resmi, 2013). Automatic thresholding using otsu method is used to get binary image.

$$g(x,y)=\begin{cases}1 & if \quad f(x,y)\geq T\\ 0 & if \quad f(x,y)<T\end{cases} \tag{1}$$

$g(x,y)$ is the binary image of grayscale image $f(x,y)$ while T is the threshold value. The Otsu method automatically divide the gray level image histogram into two different directions without knowing the threshold value (Liu & Yu, 2009).

To find the weighted within-class variance we use equation 2

$$\sigma_w^2(t)=q_1(t)\sigma_1^2(t)+q_2(t)\sigma_2^2(t) \tag{2}$$

The probabilities of the class and the means are estimated as:

$$q_1(t)=\sum_{i=1}^{t}P(i) \qquad q_1(t)=\sum_{i=1}^{t}P(i) \tag{3}$$

$$\mu_1(t)=\sum_{i=1}^{t}\frac{iP(i)}{q_1(t)} \qquad \mu_2(t)=\sum_{i=t+1}^{t}\frac{iP(i)}{q_2(t)} \tag{4}$$

Thethreshold value can be determined by maximize the following equation

$$\sigma_B^2(k)=max_{1\leq k<L}\,\sigma_B^2(k) \tag{5}$$

$$\sigma_B^2(k)=\frac{\left[\mu_T\omega(k)-\mu(k)\right]^2}{\omega(k)\left[1-\omega(k)\right]} \tag{6}$$

The feature extraction used in the system is a vector based calculation. We calculate the average pixel using a 10×10 matrix windowing to obtained a pixel references. The output from this process is a 1×480000 matrix which used as the feature of the image.

a. Backpropagation Neural Network

The classification method we use in this system is Backpropagation Artificial Neural Network. Backpropagation is known as one of the most popular neural network algorithm. The basic concept of this method is about changing the weight and biases in a network. According to (Rojas, 1996) backpropagation algorithm could be decomposed into four main steps:

i. Feed-forward computation
ii. Output layer backpropagation
iii. Hidden layer backpropagation
iv. Weight updating

These process is stopped when there is minor error function. The calculation of the weight in process iv is given by: (Makin, 2006)

$$\Delta w_{kj}(n)=\alpha\delta_j y_k+\eta\Delta w_{kj}(n-1) \tag{7}$$

Where:

- α is learning rate, the value is between 0 and 1;
- y_k is activation of the node in layer k ;
- n is the epoch;
- η is the momentum, the value is between 0 and 1;
- δ is node error after the weight

b. Area Size Estimation Technique

The area size estimation is calculated by combining the data from the AHS with the information from Google Map. The process is shown in figure 2. The measurement of the area is obtained by combining the coordinate calculation from AHS and Google Map.

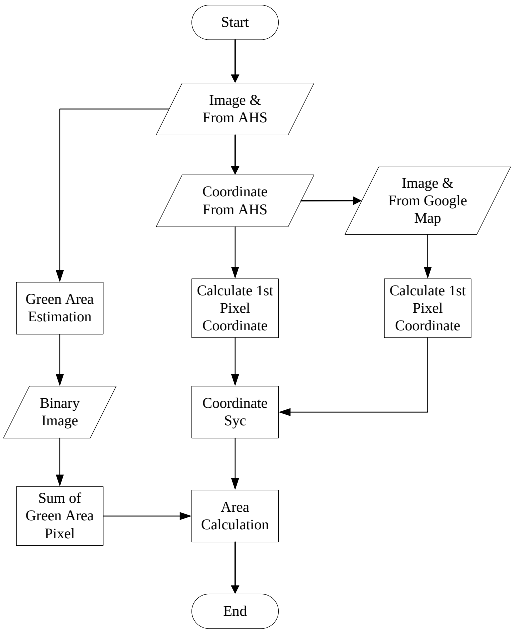

Fig 2: Area Size Estimation Process

The image obtained from Google Map is processed to calculate the actual length and wide of the area. The ratio for each pixel with the real size is calculated using equation 7

$$Pixel\_Ratio = \frac{Image\_Width \times Image\_Length}{Actual\_Width \times Actual\_Length} \quad (m^2) \tag{7}$$

3. Implementation

a. System Design

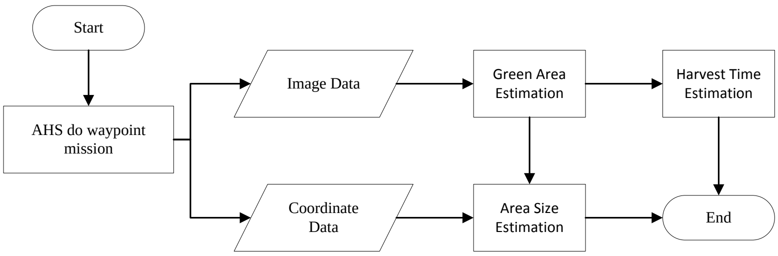

Fig 3: System Design

The proposed system showing that AHS is gathering image data and provide coordinate in each rice fields where the mission held. The image and coordinate data are stored temporary in the AHS and periodically being sent to ground station. In the ground station, the image data is being processed to calculate the green area from the images. After separating the green area of the image, the system then estimating the age of the rice by classifying the green color using backp-ropagation neural network. From the classification result, the system then estimate the harvest time of the rice field.

Ground station also process the coordinate data received from AHS to calculate the area size. By combining the coordinate from the AHS and Google, we can estimate the rice field area size.

b. AHS Communication

The communication between AHS and the ground station is using File Transfer Protocol. The result of the data transfer test is shown in table 1. The furthest range to communicate between AHS and GS is 202 meter. We provide notification if the AHS is flying to far from GS.

Table 1: AHS Communication Test

No	Range	Quality of Data	Quantity of Data	Delay
1	10 m	100%	100%	2 s
2	60 m	100%	100%	4 s
3	110 m	100%	100%	10 s
4	202 m	100%	100%	22 s

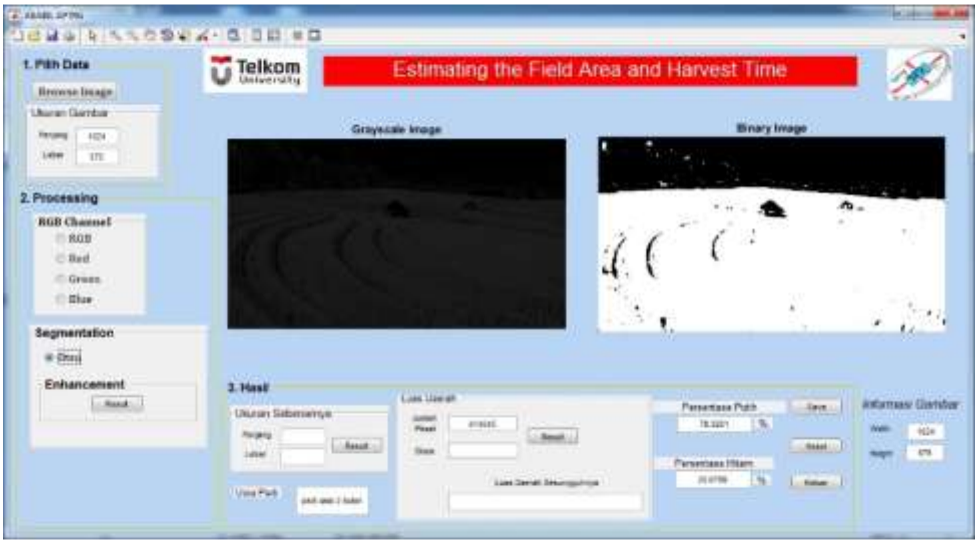

Fig 4: Sytem GUI

c. Green Color Detection

The sample of green color detection result is shown in figure 5. The RGB image received from the AHS is being processed into grayscale image. Then, the green color substraction result is done to get the green area of the image.

Fig 5: Green Detection Result: Green Area = 70%

After the green area is detected, the next step is estimating the rice age using Backpropagation Neural Network. The estimating result is refering to table 2.

Table 2: Rice Age Range

Percentage Range	Age Estimate (month)	Information
85 - 100	1	Not ready for harvest
55 - 84	2	Not ready for harvest
45 - 54	3	Not ready for harvest
35 - 44	4	Not ready for harvest
25 - 34	5	Not ready for harvest
15 - 24	6	Ready for harvest

From 100 images collected from real time testing, the average accuracy for the rice estimation age is 82,73%. The accuracy is obtained by using equation 8. Table 3 show result examples from the age estimation process.

$$Accuracy = \left(1 - \frac{|Real\_Data - System\_Data|}{Real\_Data} \right) \times 100\% \quad (8)$$

Table 3: Age and Area Size Estimation Result

	Age Estimate	Actual Age	Accuracy	Estimated Area (m^2)	Actual Area (m^2)	Accuracy
Data 1	5 months	5 months	100%	52854.3	57321.1	92.20%
Data 2	2 months	2 months	100%	5641.4	5576.9	98.84%
Data 3	1 months	1.5 months	66.67%	3926.9	3126.5	74.39%
Data 4	3 months	3.1 months	96.8%	2478.1	2397.7	96.64%
Data 5	3 months	3 months	100%	4089.2	5000.1	81.78%
Data 6	4 months	4 months	100%	3791.2	3621.8	95.32%
Data 7	6 months	5.3 months	87%	7931.2	7412.5	93.00%
Data 8	2 months	1.8 months	88.89%	9525.9	9777.1	97.43%
Data 9	5 months	5 months	100 %	1365.8	1200	86.18%
Data 10	2 months	3 months	50%	7421.5	7006.4	94.7%

d. Area Size Estimation

Data from table 3 show examples of area size estimation result. From 100 data processed, we got the average accuracy result is 73,92%

4. Conclusion

The test result show that the proposed system is working properly. The system can detect the green color of the images to identify the rice with accuracy is 82,73%. Meanwhile the average accuracy for rice age estimation is 82,73% and the accuracy for area size estimation is 73,92%. The system performances indicates that the system can be used to give suitable data for local departement under Ministry of Agricultural to forcast the harvest result in their area.

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References

[1] Abdullah, M. F., Wijayanto, I., & Rusdinar, A. (2016). Position Estimation and Fire Detection Based on Digital Video Color Space for Autonomous Quadcopter Using Odroid XU4. In The 2016 International Conference on Control, Electronics, Renewable Energy and Communications (ICCEREC) (pp. 169–173).

[2] Chaves, A. A., La Scalea, R. A., Colturato, A. B., Kawabata, C. L. O., Furtado, E. L., & Branco, K. (2015). Using UAVs and digital image processing to quantify areas of soil and vegetation. Journal of Physics: Conference Series, 633(1), 12112–12115. http://doi.org/10.1088/1742-6596/633/1/012112

[3] Gusa, R. F. (2013). Pengolahan Citra Digital untuk Menghitung Luas Daerah Bekas Penambangan Timah. Jurnal Nasional Teknik Elektro, 2(2), 27–34.

[4] Islam, R. (2015). An Image Processing Technique to Calculate Percentage of Disease Affected Pixels of Paddy Leaf, 123(12), 28–34.

[5] Kusumanto, R. D., & Tompunu, A. N. (2011). Pengolahan Citra Digital Untuk Mendeteksi Obyek Menggunakan Pengolahan Warna Model Normalisasi RGB. Seminar Nasional Teknologi Informasi & Komunikasi Terapan 2011, 2011(Semantik), 1–7.

[6] Liu, D., & Yu, J. (2009). Otsu method and K-means. Proceedings - 2009 9th International Conference on Hybrid Intelligent Systems, HIS 2009, 1(2), 344–349. http://doi.org/10.1109/HIS.2009.74

[7] Makin, J. G. (2006). Backpropagation, 1–8.

[8] Massana, R., Gasol, J. M., Bjørnsen, P. K., Black-Burn, N., Hagström, Å., Hietanen, S., … Pedrós-Alió, C. (1997). Measurement of bacterial size via image analysis of epifluorescence preparations: description of an inexpensive system and solutions to some of the most common problems. Scientia Marina, 61(3), 397–407. http://doi.org/10.1017/CBO9781107415324.004

[9] Patil, S., & Bodhe, S. (2011). Betel leaf area measurement using image processing. International Journal on Computer Science …, 3(7), 2656–2660. Retrieved from http://www.enggjournals.com/ijcse/doc/IJCSE11-03-07-087.pdf

[10] Resmi, S. (2013). Implementasi Metode Image Substracting Untuk Mendeteksi Gerakan Objek Dengan Warna Pada File Video. Fakultas Teknologi Informasi, Universitas Stikubank, Semarang.

[11] Rojas, R. (1996). Neural Networks : A Systematic Introduction. Neural Networks. Springer.

[12] S. Noda, K. U. (1994). Fire Detection in Tunnels Using an Image Processing Method. In Vehicle Navigation & Information Systems conference proceeding (pp. 57–62).