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Determination of Fertilizer Doses of Plants Utilizing the Results of Aerial Photographs Using Fuzzy Tsukamoto

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Determination of Fertilizer Doses of Plants Utilizing the Results of Aerial Photographs Using Fuzzy Tsukamoto

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Abstract. Fertilizer dosage can be known through various methods including using digital image results. This study was taken from the results of aerial photographs with NDVI parameters, c-means and Fuzzy Tsukamoto methods which aimed to determine the dosage of fertilizer. The next step is to establish a rule base which is determined by the number of membership clusters in the c-means method and produces data that the quantity of membership cluster can determine the amount of fertilizer dose. The use of this method results in an accurate estimation of fertilizer dosage time of 97.7% compared to the conventional determination process.

1. Introduction

Information about globalization in the development of agricultural or plantation systems requires supporting technology. Most of Indonesia's agricultural systems, in carrying out plant growth monitoring are still conventional, technologies that support this development, for example, using monitoring plants from a distance. These researchers use unmanned vehicles that are used to view plant vegetation remotely using NIR camera (Near Infrared), then the data is processed to find the information or value needed to know the dosage of fertilizer given to plants [1]. Giving doses of fertilizer is one way to improve the quality and yield of crops. Giving proper and appropriate dosage of fertilizer is the right action in balancing nutrients needed by plants because the elements contained in fertilizers are the component that is very fulfilling and provides an indispensable intake to support crop yields[2][3][4]. The author of this paper uses the classification stage of Fuzzy Tsukamoto, in order to determine the dosage of fertilizer needed by plants. This system classification can complete the main goal of the author, namely knowing as the value of a vegetation and the dosage of fertilizer needed by the plant.

2. Fuzzy Tsukamoto

Interpreted in language as a fuzzy or vague value, that has a small value. Fuzzy is often known as the value of membership degrees that as a range of values starting from zero (0) to one (1) [5] .

2.1 Fuzzy Logic Controller

This controller has the main purpose that is to get the output that is considered as a response to the input. The fuzzy logic controller is a system based on the human knowledge that works in accordance with predetermined linguistics.

2.2 Function Membership

The function is a function to map each value crisp to become a membership level in an interval.

1. Function Linear

This function can be said to be a simple function with a straight line. The value on X in members crisp set part of the interval [0.1] based on the definition of a straight line the function linear can be said to be monotonous or up and down. Equation (1) to see a linear rise.

$$\mu\,(x) = \begin{cases} 0; x \le a \\ \frac{x-a}{b-a}; a < x \le b \\ 1; x > b \end{cases} \tag{1}$$

Linear down can be seen by equation (2):

$$\mu(x) = \begin{cases} 1; x \le a \\ (b-x)/(b-a); a < x \le b \\ 0; x > b \end{cases}$$

(2)

2.   Triangle Function

The function of this triangle is basically a combined value between two (values linear). This function has only one value x for membership degree which is equal to 1, it can be seen in equation (3).

$$segitiga(x, a, b, c) = \begin{cases} 0; x \le a \\ \frac{x-a}{b-a}; a < x \le b \\ \frac{c-x}{c-b}; b < x \le c \\ 0; bx > c \end{cases}$$

(3)

2.3   Fuzzification

Fuzzification is the stage of changing the value that is still crisp input then converted into the form of input fuzzy, where linguistic values are determined based on membership. This method has ruled in the form of algorithms If-Then, which must be presented with sets fuzzy that have the same membership.

- Fuzzification
  Rules used in this study are 25 rules.
- Defuzzification
  The defuzzification process is to find the value of Z, where the value is the total value or value - average, it can be calculated using equation (4).

$$Z = \frac{\alpha\_pred_1 * Z_1 + \alpha\_pred_2 * Z_2 + \alpha\_pred_3 * Z_3 + \alpha\_pred_4 * Z_4}{\alpha\_pred_1 + \alpha\_pred_2 + \alpha\_pred_3 + \alpha\_pred_4}$$

(4)

3.   Cantaloupe

Vines are very widely found in Indonesia, plants cantaloupe very suitable for tropical climates, the fruit produced is very much used as a processed fruit, besides that the short harvest period caused many to be developed [1].

Table 1 The dosage of fertilizer used.

No	The dosage of fertilizer	Amount of weight / Planting area	Type of fertilizer
1	20	Gram / M^2	NPK
2	45	Gram / M^2	NPK
3	80	Gram / M^2	NPK
4	120	Gram / M^2	NPK
5	150	Gram / M^2	NPK

4.   NPK Fertilizer

Fertilization is one way of cultivating plants that are closely related to crop production. Provision of appropriate doses of fertilizer is an action that must be done because the nutrients contained in fertilizers are the required intake of soil [4].

5.   Dose of Fertilizer

The fertilizer dosage used is the fertilizer dose used in previous studies by Sriwijaya University agricultural students, in their research looking at the effect of fertilizer dosing on kailan plants. Dose fertilizer applied in this study is shown in table 1

6.   Research Methodology

Stages of image enhancement are the first step in digital image processing by contrast contrasting and Gaussian smoothing. The results obtained in the image enhancement are then reprocessed using the NDVI parameter. The NDVI parameters obtained will be grouped into a cluster.
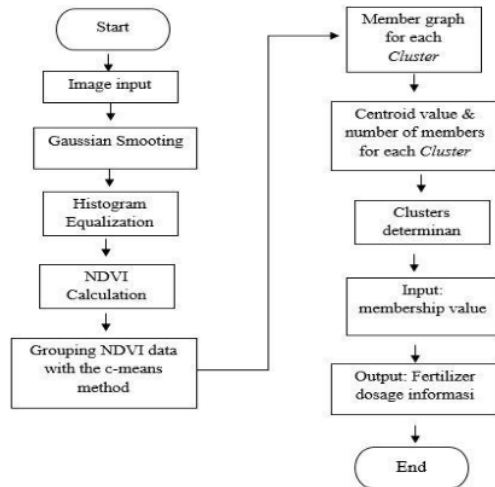

Figure 1 Block diagram for determining fertilizer dose information.

Figure 1 describes the steps to determine fertilizer dosage, the initial stage is the image taken using a non-camera and then resized to the specified size. The next stage determines the value of the cluster, so the last stage we know the information on the fertilizer dosage needed by the plant.

7.   Result and Discussion

The testing phase with the algorithm is Fuzzy Tsukamoto carried out under 2 conditions, including:

1.   Testing at the beginning of the planting period.

Photographs taken at the beginning of the planting period are useful to see how much the plants need fertilizer so that the yields are produced according to the target. The distance used in taking photos is 2.5 meters, 3 meters, 3.5 meters, 4 meters, 4.5 meters, and 5 meters. The experimental results can be seen in figure chart 2.
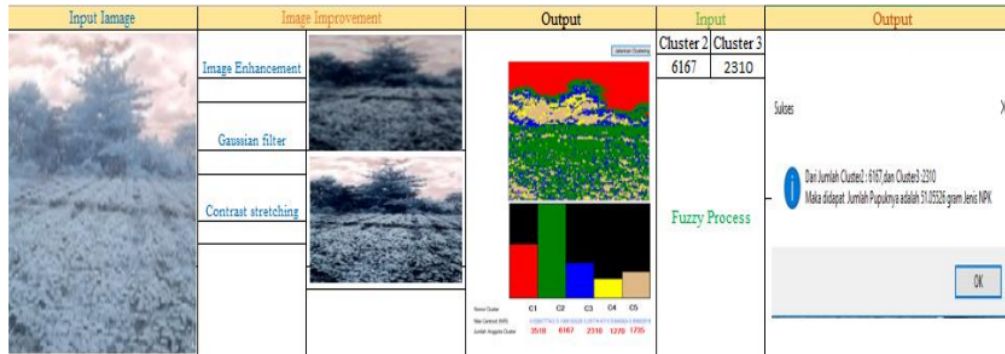
Figure 2 Process graph to determine fertilizer dosage on the system

Image enhancement technique by the system herein aims to produce sharper image and eliminate noise in the image. The image of plantation land only had 1 negative cluster and sometimes even none at all. This negative cluster identified the image in which there was a cloud when the image was captured. Plantation areas usually have the most members in clusters 2 and 3. The inputs applied in this study were cluster 2 and cluster 3, since cluster 2 had the largest value of the vegetation centroid and cluster 3 had another supporting value such as land, road and water as seen from the centroid value of each cluster and depended on the point of view while capturing the images and the condition of the land. The results of fertilizer dosage obtained in this study can be observed in table 2.

Table 2 Value of the results of the initial experiment on planting.

No	2,5 Meter			3 Meter			3,5 Meter			4 Meter			4,5 Meter			5 Meter		
	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)
1	6167	2310	51,055 Gram	6096	2748	46,760 Gram	8440	2317	50,148 Gram	8598	2995	37,09 Gram	4503	1936	44,425 Gram	10051	2550	45,1 Gram
2	7605	2963	37,666 Gram	3426	1241	31,393 Gram	6809	2513	45,898 Gram	8791	3027	36,514 Gram	9365	2257	50,407 Gram	9120	3145	34,39 Gram
3	6690	2250	50,404 Gram	3573	1421	34,825 Gram	9185	2692	42,544 Gram	3815	1570	37,562 Gram	3186	1538	36,962 Gram	3475	1874	43,26 Gram
4	6697	2347	49,816 Gram	5521	1932	44,35 Gram	2983	1142	37,306 Gram	1866	756	43,112 Gram	3815	1570	37,562 Gram	2613	897	43,96 Gram
5	3681	1472	35,725 Gram	4877	2882	39,124 Gram	3809	1371	33,831 Gram	1816	748	42,137 Gram	2828	952	49,096 Gram	2658	1119	34,156 Gram

Table 3 Results of the value of the Experiment entering the harvest period.

No	2,5 Meter			3 Meter			3,5 Meter			4 Meter			4,5 Meter			5 Meter		
	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)	Cluster 2	Cluster 3	Dosage of fertilizer (NPK)
1	8077	3588	31,633 Gram	7460	9319	50,139 Gram	2197	9319	50,139 Gram	7044	3160	43,225 Gram	7771	2469	47,064 Gram	6500	3190	59,374 Gram
2	5341	2792	40,744 Gram	5363	2353	49,734 Gram	7143	2908	42,141 Gram	8026	2646	43,375 Gram	7030	3346	43,412 Gram	7831	2696	37,558 Gram
3	3055	1323	36,01 Gram	7112	2773	42,49 Gram	7105	2440	47,925 Gram	4714	2279	50,375 Gram	8026	2646	43,472 Gram	3397	1380	34,00 Gram
4	3302	1584	37,825 Gram	3292	1279	32,206 Gram	7479	2687	42.634 Gram	4253	1746	40,862 Gram	4602	2239	50,583 Gram	8071	2694	42,508 Gram
5	3681	1472	35,725 Gram	7640	2836	39,952 Gram	4783	5171	20,097 Gram	953	9498	25,993 Gram	3438	7831	34,401 Gram	1132	9918	29,35 Gram

2.   Testing when the plant has entered the harvest period.

Photographs taken at the time the plant enters the harvest period is useful to see if plants need fertilizer larger or smaller so that the yields are produced according to the target. The distance used is 2.5 meters, 3 meters, 3.5 meters, 4 meters, 4.5 meters, and 5 meters. The value of the experimental results can be shown in chart 3.

Experiments carried out 60 times at the beginning of the planting period and nearing the harvest period, can be analyzed for the results of the experiments carried out on the software with manual calculation. As for the accuracy of the method in determining plant fertilizer doses by 97.7%

The value is obtained from the calculation of each experimental result by using the formula to calculate the level of accuracy.But the certainty of this method must consider the tradeoff of a computation that determines the accuracy and precision of an analysis that can be calculated by the computing device architecture [6].

8.   Conclusion

Testing from the simulation results can be concluded as follows:

1. The results of experiments with the Fuzzy Tsukamoto method are able to be applied to determine the dosage of fertilizer plants.
2. The guidance for determining fertilizer dosages in plants depends on the value of the cluster that is inputted into the system. The rule base is determined by the number of membership cluster in the c-means method and produces data that the quantity of membership cluster can determine the amount of fertilizer dose. Then the dose was measured according to what has been determined by the system, where the results released on the system are the results that ought to be given to the plant, based on fertilizer dosage guidelines carried out in previous study at the faculty of agriculture of Sriwijaya University.
3. The use of this method results in an accurate estimation of fertilizer dosage time of 97.7% compared to the conventional determination process, During the process of determining the fertilizer dose
4. The purpose of capturing images with different distances was due to prove that the fuzzy method was capable of detecting the value of vegetation and the fertilzer dose even though carried out at different distances.

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