Estimation of Wetland in Indonesia with multitemporal satellite Imagery Extraction Model-Based Neural Network (NN), Genetic Algorithm (GA) and Fuzzy Logic

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Key words: remote sensing, estimation, extraction, Artificial Intelligence

SUMMARY

Advantages of remote sensing technology in making estimates through the object image data with satellite vehicle into an alternative decision makers in order to support and obtain information as well as the best solution in determining the steps to determine a reliable decision. This study aims to estimate and predict wetland to determine yields in Indonesia with multitemporal satellite images. Estimation, prediction and image extraction process are done by using a model of Artificial Intellegence (AI), namely Artificial Neural Networks, Genetic Algorithm and Fuzzy Logic, and maximum likelihood. The comparisons showed that the algorithm model using Artificial Intelligence approach is more accurate than the statistical method. This is indicated by the results of the classification accuracy with the field of Artificial Intelligence methods is higher than statistically method (maximum likelihood). The result is expected to be a benchmark solution for the further research in determining the method or model which used in image processing of AI-based classification model is needed to accelerate the process of identification of rice fields in Indonesia. Finally with better accuracy of rice field, government will be able to take a decision or policy related to food, where it is most closely related to national food security.

Keunggulan Teknologi Inderaja dalam melakukan Estimasi melalui objek data citra dengan wahana satelit menjadi salah satu alternatif para pengambil keputusan dalam rangka mendukung dan memperoleh informasi serta solusi terbaik dalam menentukan langkah yang harus diambil untuk menentukan suatu keputusan yang handal.
Keandalan informasi yang dihasilkan dari data citra satelit sangat tergantung pada bagaimana pengolahan citra tersebut diproses secara baik dengan menggunakan model atau metode yang baik pula. Data Citra dapat dimanipulasi dengan serangkaian metode sehingga dapat menghasilkan sebuah informasi yang dibutuhkan terutama dalam melakukan ekstraksi sehingga dapat memprediksi dan mengestimasi objek yang terkandung didalamnya.
Fokus penelitian lebih pada pengamatan dan penerapan model *Artificial Intelligence* yaitu Jaringan Syaraf Tiruan, Algoritma Genetika dan Logika Samar dalam melakukan ekstraksi citra serta dilakukan perbandingan dengan model statistik yaitu *Maximum likelihood*. Model-model tersebut diimplementasikan untuk memprediksi lahan sawah.

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1. INTRODUCTION

Food is very important in life, insufficient food becomes the most important element for the sustainability of life on earth, especially in the aspect of human life. Food becomes an important issue and the subject of much debate in International conferences, One was the issue of the international food was the topic of the G-20 meeting in Cannes, France, World Bank President Zoellick. (2011) says that "The food crisis is still far from completion,".
Required thoughts in a systematic and continuous effort to find the best solution in order to process agricultural management can achieve optimal results, accordance with the national goals of development for food security that is the fulfillment of food for each household as reflected in the availability of sufficient food, both quantity and quality, safe, equitable and affordable
One solution that can be considered by policy makers is how to monitor the production process so that the quantity and quality of agricultural crops can be maximized.
Responding to the challenges of the future, good farm management becomes a necessity, it is necessary to process monitoring in crop productivity to be able to monitor the growth and development of plants of each phase is the initial seeding to harvest, so that the results of such monitoring may be input in predicting national food availability.
The concept of remote sensing technology transfer that can be an alternative that is appropriate in the process of monitoring the productivity of food crops quickly, this technology can provide a picture of the object that correspond to real world objects through an image or photograph information via satellite. (Blaschke, T,2010).
Analysis of satellite images is an activity to recognize the re-appearance of any object that was captured by the satellite carried sensors. The appearance of the image in the presentation of the data is influenced by the level of detail resolution. Resolution is the power split image, the size of the smallest object that is still recognizable image. The smaller the object that can be recognized or the higher the resolution, the better the image quality. (Martono,D.N, 2008)
This study focuses on the estimation Wetland in Indonesia, Model Extraction using multitemporal satellite imagery-based Neural Network (NN), Genetic Algorithm (GA) and Fuzzy Logic, means to outline the research lies in the extraction of satellite image by using the third model of Artificial Intelligence and compare the statistical model is Maximum Likelihood.
Artificial neural networks are computational modeling tools that can be used to classify and predict the data. Artificial Neural Networks have been applied to agricultural research and meteorology in the past with great success (Jain et al. 2003, 2006;. Smith et al. 2007, 2009.).
According to Samir Kumar Bandyopadhyay and Pritimoy Sanyal, (2011), Intelligent

algorithms such as artificial neural networks (ANN), genetic algorithm (GA), fuzzy logic (FL), can be an effective control applications in terms of increasing crop productivity by helping perform data processing in remote sensing imagery.
Results to be achieved in this study is, compare the performance of three models of Artificial Intelligence, Neural Networks, Fuzzy Logic and Genetic Algorithm and Maximum Likelihood statistical models in the process of classification of satellite imagery to estimate wetland with Landsat image data.

2. METHOD

2.1 Introduction

Research is conducted in developing the wetland model by utilizing multitemporal satellite imagery technology to generate information about the state of the distribution of rice fields in Indonesia by sampling image processing in West Java and using Landsat satellite imagery.
Regional studies have been used as a pilot project to study the object samples of rice paddy area in Rancaekek Bandung West Java Indonesia, as shown in Figure 2.1. Area objects are used as training samples of data taken based on the results of the survey.

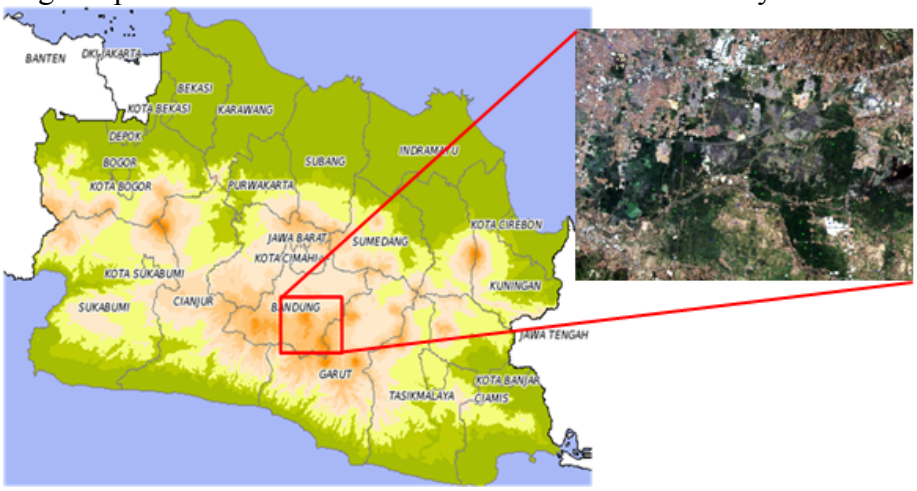

Figure .2.1. Wetland area of the object used in the study

2.2 Stages of Research

Stages of the research can be seen in Figure 2.2. In the Figure shows that the stages of the research is started satellite image data acquisition to determining the estimation process vegetated wetland rice.
The first stage of this research is to conduct pre-processing the image, this is done to obtain the corrected image, both radiometric and geometrically.
The next stage, the image has been corrected, the extraction process is carried out, the object pattern recognition in images, this is done for the early detection of objects contained in the image.

The process of segmentation is done to get the pattern equation object in the image segmentation, it is intended to get the polygon creation process (image object) on the image. Making a polygon in the image based on the parameters that determine the size and diversity of the polygon formed.
Realization of the research that has been done is through the process of establishing the classification results of each model of artificial intelligence, namely the establishment of wetland classification model that is Artificial Intelligence Neural Network, genetic algorithms and fuzzy logic, as well as a comparison with Maximum Likelihood.

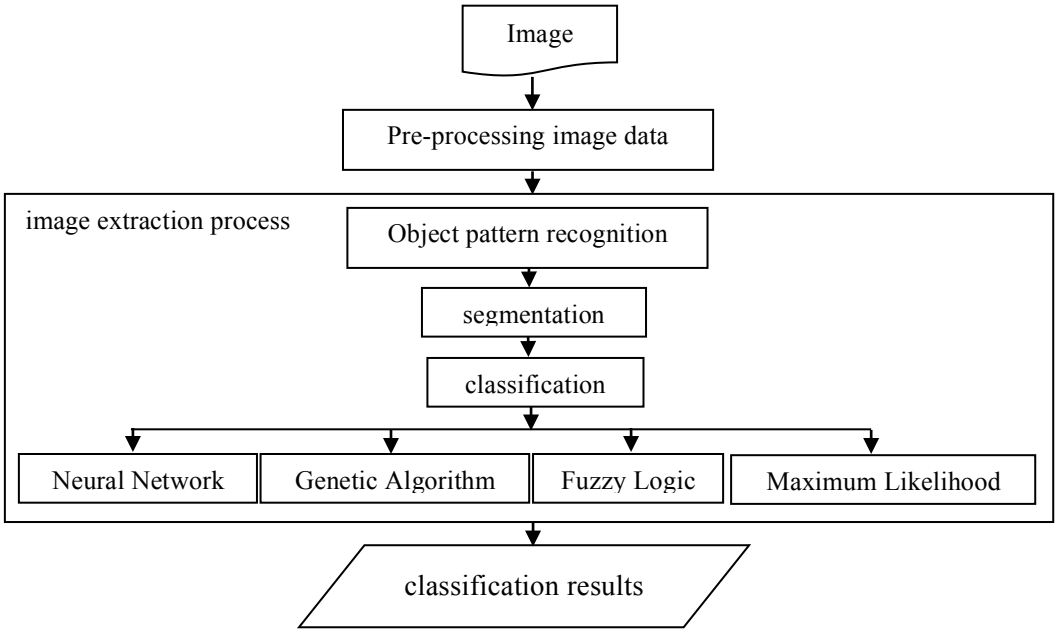

Figure .2.2. stages of research

3. RESULTS AND DISCUSSION

This research is focused on the development aspects of remote sensing technology by performing "Estimation of Wetland in Indonesia with multitemporal satellite imagery Extraction Model-based Neural Network (NN), Genetic Algorithm (GA), Fuzzy Logic and Maximum Likelihood". In this discussion on the classification of the results show the comparison of the model, namely the Artificial Intelligence Neural Network, Genetic Algorithm and Fuzzy Logic and the statistical model of Maximum Likelihood.

3.1 Implementation of Neural Network Model

3.1.1 Algorithm

Neural network method used in this study is the Back Propagation Neural Network. The components of the neural network consists of hidden nodes, learning rate, momentum, minimum error and iteration. The structure of neural network used in this study is :

A. Stage Backpropagation Neural Network classification method as follows:
    a. *Creating* : This function to create and initialize a segment or part of a new neural network to process the Back Propagation Neural Network. In this segment of the neural network to recognize training classes conducted by using Neural Network Train. Training a neural network to classify the image with Neural Network Class program. Image processing with neural network classification is done with the introduction of the class.
    b. *Training*: This command is required for the training area. Training is needed to study the patterns of input data studied.
    c. *Classify*: multi-spectral image classification using Neural Network Back Propagation Neural Network Create performed with and conducted training process with Neural Network Train.

B. Testing the accuracy of classification
    Evaluation of the accuracy of the aim is to look at the percentage of accuracy in classify an area into a wetland classes by counting the number of pixels area, example, (training area) were classified correctly and incorrectly. Accuracy was evaluated by: (1) overall accuracy, (2)producer's accuracy (3) user's accuracy (4) kappa accuracy and the appropriateness of the classification results with reference data. Reference data used include:
    a. Data cek lapang yang diambil secara acak pada areal yang dicakup citra satelit lokasi penelitian.
    b. The data field checks drawn at random on the area covered by the satellite imagery study site.
    c. The area training site that was made before the results of the visual interpretation of satellite imagery.
    d. Digital land-use maps with the size of the data, the spatial resolution and the time of making the same or nearly the same as the date of the satellite image data are used.

3.1.2 Results of Neural Network Classification

Image classification results are processed by using Neural Network models can be seen in Figure 3.1.

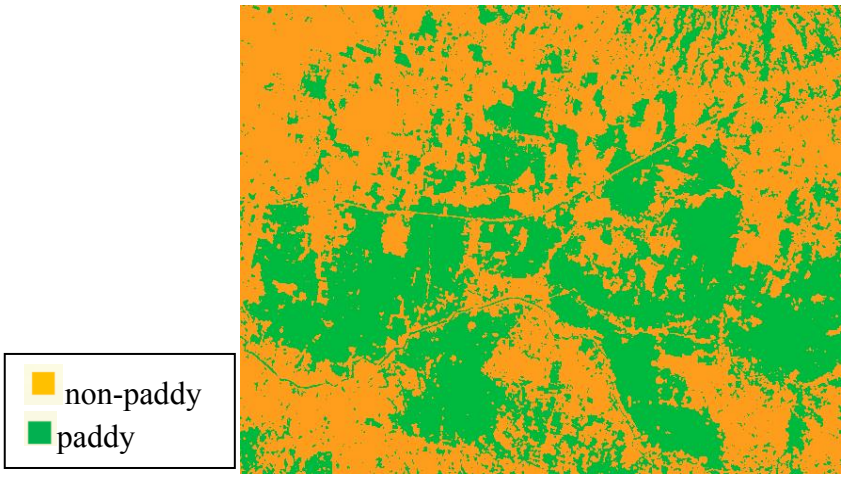

Figure .3.1. Results of classification with Neural Network Model

3.2 Genetic Algorithms

Genetic algorithms are computational algorithms inspired by Darwin's theory of evolution which states that the survival of an organism is affected rules "Strong is winning"(Goldberg, D. 1989).
Darwin also stated that the survival of an organism can be maintained through the process of reproduction, crossover, and mutation. The concept of Darwin's theory of evolution was then adopted into computational algorithms to search a solution of a problem, in this study these concepts are used to perform the extraction of multitemporal satellite imagery to estimate wetland.

3.2.1 Stages of Algorithm

Concepts in Genetic Algorithms image extraction can be explained as follows:

1. Geometric correction and radiometric correction is used to correct errors that occur during data recording.
2. Preparation of samples of paddy and non-paddy objects in the area of research that aims to get the best training area
3. Generate a set of pixels to get the first random population of n individuals.
4. Extraction and evaluation of data samples in order to obtain statistical parameters such as mean, variance and calculate correlations between the existing training area
5. Evaluate the fitness value of each pixel for each individual, which is adapted to the spectral values in the image
6. Form of a new population based on the results of image classification criteria of spectral values selected by the repetition of the following steps:
   a. Selection
      Pick some individuals based on training data area that will serve as the parent of a

population according to the fitness of the resulting image (the larger the fitness value of an individual, the more likely they are to choose from).

b. Crossover
   Having obtained fitness value approaching reference, then the crossover between the parent process to get the new offspring, here is done Initial population of paddy and non-paddy object in the image
c. Mutation
   After the crossover process is completed, the next process is mutation. here we using adaptive mutation to steady state genetic algorithm.
d. Accepting
   Place new offspring in this population as a result of new classification

7. Use the newly established populations are the result of the classification of paddy and non-paddy to run the genetic algorithm selection process further.
8. check if the conditions of the final results of the classification are met, then show the solution of the population.
9. [Loop] Go back to No. 3.
10. formation process of classification
11. classification result

3.2.2 Results of Genetic Algorithm Process

Image classification results are processed by using a genetic algorithm models can be seen in Figure 3.2.

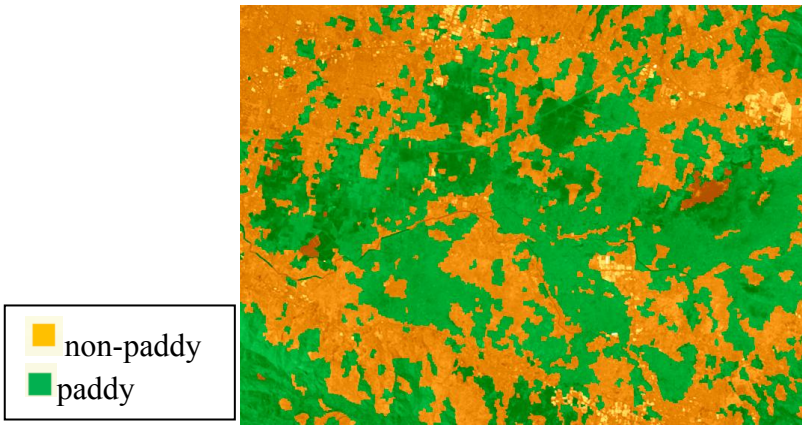

Figure .3.2. Classification results with a model of Genetic Algorithm

3.3 Fuzzy Logic

3.3.1 Stages of Fuzzy Logic

Image classification algorithms using fuzzy logic models used in this study are:

1. Geometric correction and radiometric correction is used to correct errors that occur during data recording.
2. Preparation of samples of paddy and non-paddy objects in the area of research that

aims to get the best training area

3. Extraction and evaluation of data samples in order to obtain statistical parameters such as mean, variance and calculate correlations between the existing training area
4. Modification of training data, when there are two or more samples that have a high enough level of correlation
5. Test classification training data to determine the level of accuracy of sample classification area. The information generated in the form of a correlation matrix that describes the contribution of pixels of each training area to get the object classification of rice and non-rice based on spectral values
6. Image classification when the results of the evaluation of the data area of the sample showed a level of accuracy that is sufficient

3.3.2 The results of the classification of Fuzzy Logic

Image classification results are processed by using fuzzy logic models can be seen in Figure 3.3.

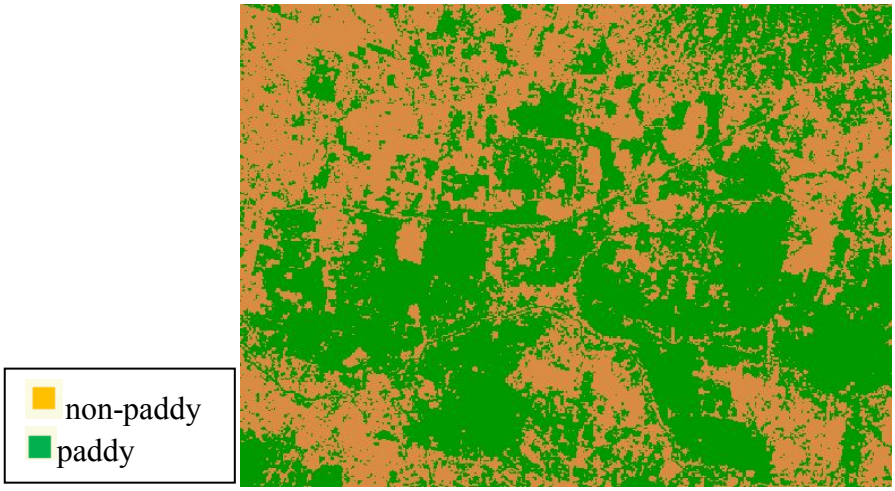

Figure .3.3. Classification results with a model of Fuzzy Logic

3.4 Comparison Between Models

The output generated from this research is a satellite image classification results on the distribution of rice fields in the study area of each model developed.

Based on the resulting output can be done comparing the classification results as Figure 3.4. following

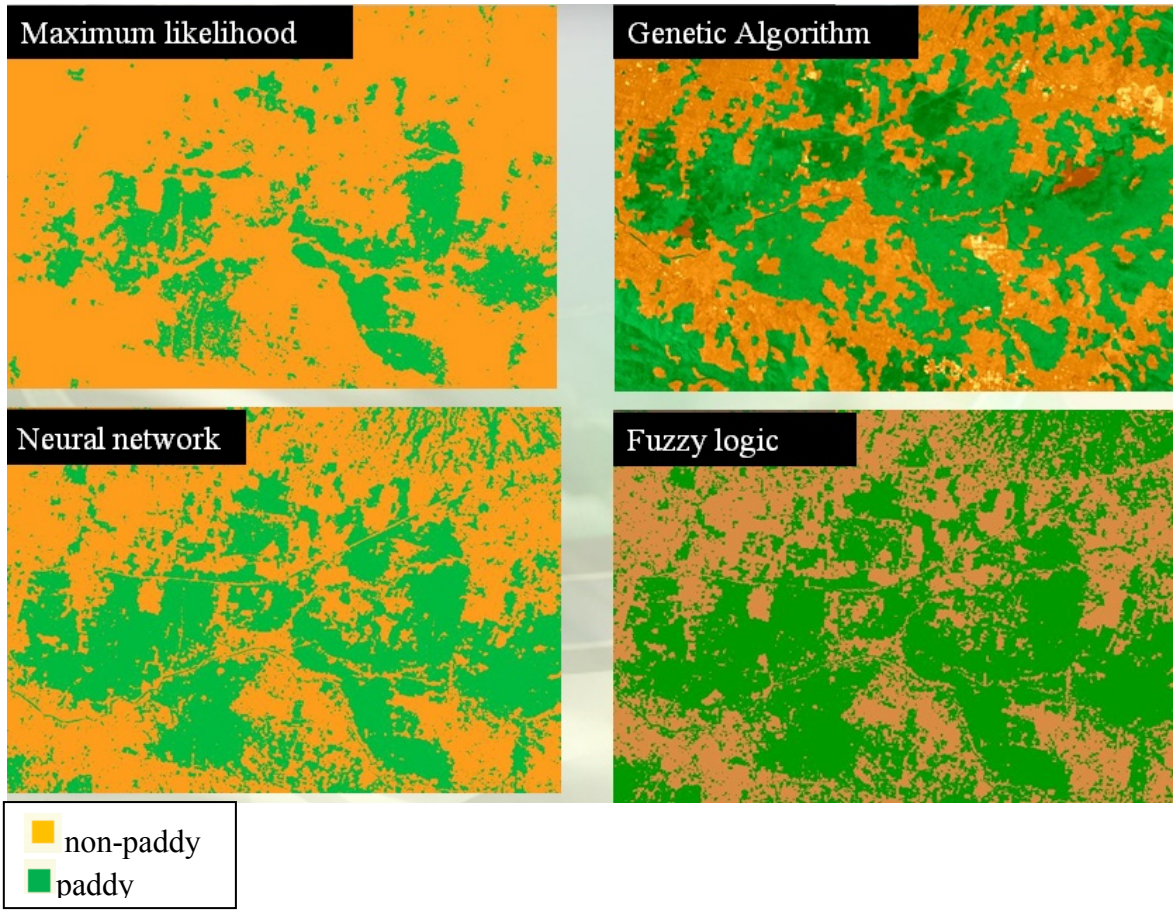

Figure .3.4. Comparison of classification results from each model

classification results of the Artificial Intelligence approach, namely Neural Networks, Fuzzy Logic and Genetic Algorithm performed in this study, coupled with the results of the classification approach to statistics, namely Maximum likehood, this is done to compare the accuracy of the use of Artificial Intelligence models with statistical models.
Based on the accuracy of test results for all four models can be seen in Table 3.1.

Table 3.1. The results of model accuracy test

Model	Overall Accuracy(%)	Kappa coefficient
Maximum Likelihood	84.6457	0.6982
Neural Network	98.7861	0.9756
Genetic Algorithm	94.9447	0.9781
Fuzzy Logic	75.4265	0.5231

The accuracy of the test results can be presented in graphical form shown in Figure 3.5.

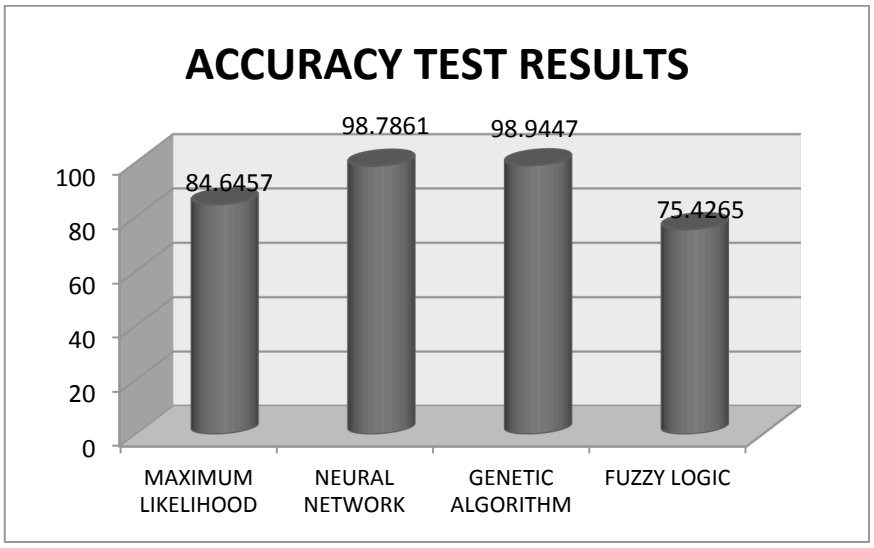

Figure .3.5. Accuracy of test results from each model

The results of the calculation accuracy of the object is seen that the fuzzy logic test results lower than the Maximum Likelihood, this is due to the testing accuracy using fuzzy logic threshold of 0.5.

The threshold value is taken and equated to see the results of the comparison between the model, turns on fuzzy logic model of the determination of the threshold value can not be determined directly, because the threshold on fuzzy logic is more varied between 0.1 to 1.0, not 0 and 1, it can be concluded that when determining the threshold value will be different on each model, for example the use of a threshold value of 0.5 in this study, can be used in model neural networks, genetic algorithms and maximum likelihood, whereas in the model of fuzzy threshold value of 0.5 is considered the maximum value is 1.

Based on the test results and the accuracy of the results of the above analysis, the fuzzy logic model of the data processing can be maximized, if the parameters values are processed by fuzzy logic models can be structured in advance with the structure of a good algorithm, based on the rules of logic are more focused on the process of formation value of the classification of the object.

Comparison of the results of image classification to object distribution of rice fields generated from each model, estimates can be made that, classification models using Artificial Intelligence approach is superior in delivering good results.

4. CONCLUSION

1. Each algorithm has its own approach for classifying non-paddy fields and rice paddies, and generally depends on the characteristics of land cover and land use .
2. The test results accuracy of several models in this study show that, the accuracy of the model by Maximum Likelihood 84.6457 kappa value = 0.6982, Neural Network Model 98.7861, the value of kappa = 0.9756, Genetic Algorithm model 94.9447,

kappa value 0.9781 and Fuzzy Logic models 75.4265, kappa value = 0.5231.

3. The comparison shows that the algorithm model using the approach of Artificial Intelligence (AI), is more accurate than the statistical method. This is indicated by the results of the classification accuracy of rice fields with AI methods, with an accuracy higher than one statistical-based methods (maximum likelihood).
4. Each model has advantages and disadvantages in terms of management and pattern recognition, this will have an impact on the classification accuracy of rice produced. It is necessary to test the classification model from a combination of AI and NN, GA and FL to get the best models through in-depth research.
5. Model AI-based classification approach is desperately needed by the Ministry of Agriculture to expedite the process of identification of raw rice fields in Indonesia. With raw paddy land information is more accurate then the government will be able to take a decision or policy related to food, which it is most closely related to national food security.

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