MULTICA SCIENCE AND TECHNOLOGY (MST)
Volume 2, No. 1 (2022) pp. 87-93
ISSN (Online) : 2776-2386
Website: https://journal.universitasmulia.ac.id/index.php/mst
DOI: 10.47002/mst.v2i1.323
Research Paper

Application of Intelligent System with Backpropagation model in Cloud Image Classification

Mulyadi[1,a)] , Muhammad Ichwan[1)] , Muhammad Rizka[1)], Mutammimul Ula[2)]

Author Affiliations
[1]Department of Information and Computer Technology, Politeknik Negeri Lhokseumawe , Aceh, Indonesia
[2] Departmernt of Information Systems, Universitas Malikussaleh, Aceh, Indonesia

Author Emails
[a)] Corresponding author: mulyadi@pnl.ac.id

Keywords:
image processing, cloud, artificial neural network, backpropagation, euclidean distance

ABSTRACT
The clouds have different patterns on each type and each type has different properties. The introduction of the type, shape, and nature of the cloud is indispensable in the weather forecasts so that the clouds can be classified. There are several methods used in the image classification process that is the method of the artificial neural network Backpropagation. The method of Backpropagation is one of the methods used for the classification process, in this research Backpropagation used on the training and testing process for the introduction of cloud imagery aimed at determining the type of cloud, before the second These stages are carried out imagery through the preprocessing process. From the training conducted using the Backpropagation method shows that this method generates the best weight value and saves that value into the database to do the testing process using a neural network Backpropagation. In addition, Backpropagation also has the ability to reduce errors by continuously correcting the weight until reaching the maximum target. Data used for training data as many as 92 cloud type image with each type of 10 imagery. In this study obtained a system success rate of 60.6%.

1. Introduction

Clouds are the initial process of rain, so they are often used as a determinant of weather conditions. Clouds can influence and provide clues to the weather because clouds have different types where each type has different properties [1]. Determination of the cloud type distribution based on the brightness temperature (TBB) – TBB difference was carried out using MTSAT IR1 satellite imagery data. There are 6 (six) cloud types categorized in the TBB-DT diagram, including cold clouds with large optical thickness (Cumulonimbus cloud type/Cb), warm clouds with large optical thickness (Cucumulus/Cu or Stratocumulus/Sc cloud types), cold clouds with small optical thickness (Cirrus/Ci cloud type which is quite dense), warm clouds with small optical thickness (Ci cloud type), and N type clouds which are thin cloud types at low levels [2]. The technique used to view cloud composition in the study area is to use a method developed using infrared satellite imagery MTSAT (Inoue (1987a). So that satellite data can be used as an alternative source for weather forecasts.

Monitoring activities for the presence of potential clouds are usually carried out by observing weather radar products [4] [5]. In principle, the weather radar used in Indonesia is a precipitation radar and many are of the single polarization type where the waves issued are generally aimed at detecting precipitation that is difficult to detect by weather radar. [6] Himawari 8 RGB daytime microphysics scheme to detect the emergence and development of potential cumulus clouds in the TMC area in West Kalimantan in August 2018. Based on the results of the study, it appears that there are potential cumulus cloud characters as shown by the classification results of the RGB daytime microphysics scheme. Himawari 8 on the TMC aircraft seedling route [7]. Statistical values in cloud images are useful for inputting the rain prediction process. Both values are associated with several other parameters, including data on wind speed, barometric pressure, temperature, solar radiation, and water level. The level of influence of each variable can be determined using factor analysis. The result of factor analysis is a variable with a high influence value. One of the methods used to make predictions is backpropagation [8]. Backpropagation to predict the occurrence of rain [9] [10]. Another study predicts the weather in an area that has a very good accuracy value using Backpropagation [11]. The calculation of the success or accuracy of the model formed can use the resulting matrix method showing the number of true or false classifications in each class.

Technologies that can be applied to pattern recognition are voice recognition, face recognition, object character recognition, computer vision, biometrics, and data mining [12]. Pattern recognition cannot be separated from image processing because image processing is a preprocessing process, while pattern recognition is a process for interpreting images [13]. The satellite image used is intended to take two characteristic values with average cloud cover and average cloud temperature. Predict using satellite imagery that represents the cloud top temperature value. Furthermore, data classification is done using backpropagation [14]. The results of the classification process using backpropagation obtained the best results in the distribution of 80% of the training data and 20% of the test data, with the activation function entering the hidden layer and that of the output layer. The results obtained indicate an accuracy rate of 88.283%. Each layer in the neural network has a different relationship or relationship. The weight value states the degree of linkage between layers. The more information that can be conveyed to other neurons, the higher the weight value it has. On the other hand, the value of the weight is smaller if the information conveyed is not conveyed [15] [16].

IR image is a satellite image that produces a picture of the temperature at the top of the cloud. The resulting values are classified using color. Black indicates the absence of clouds, blue indicates there is not too much cloud formation. Green to red indicates temperature. The higher the intensity of the red color, the lower the temperature, and the more potential it becomes cumulonimbus clouds [17]. The neighboring pixels obtained are sorted starting from the smallest and then taking the middle value of the neighboring matrix. the obtained mean value replaces the old value as the corrected pixel value [18]. This method is best used for cloud image segmentation because the presence of clouds is described with a higher brightness value than the cloudless state. Cloud feature retrieval is obtained by looking at the average brightness possessed in an image [19].

2. Literature Review

This research was conducted using cloud images obtained from BMKG. The image is cropped manually with the aim of getting the desired part of the cloud image. The size of the image that is entered is 100 x 100 pixels and then the preprocessing process is carried out on the image. The following are the preprocessing stages shown in the image below.

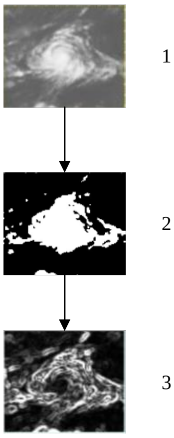

Figure 1. System Preprocessing Process

2.1 cloud image

Cloud images obtained from BMKG in the form of images that have become grayscale. Where the image is used as an input image in the cloud image classification system.

2.2 Convert Grayscale Image To Binary

Grayscale to binary conversion is a decrease in the intensity of the image from grayscale to binary, the aim is to simplify the image structure so that it can be manipulated efficiently without the same calculation process being carried out on each part of the image. A binary image requires 1 bit to represent the value of each pixel.

2.3 Sobel Edge Detection

Edge detection in cloud images using the sobel operator. Edge detection is a process that produces the edges of the cloud image, the goal is to get the patterns in the cloud image and to improve the details of the blurry image, which occurs due to the image acquisition process. The cloud image that has been detected by sobel edges is then normalized to 100 x 100 pixels in size. Normalization with a size of 100 x 100 pixels is carried out so that the results of the sobel edge detection are clearly visible and by using this dimension, the input into the system is not too much so that later it will also affect the processing speed of the system made. The following is the display for the results of the tearing edge detection.[20]

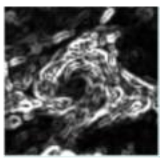

Figure 2. Sobel Edge Detection Results

2.4. Daytime Microphysics RGB Schematic

The RGB (red green blue) composite technique is a technique for presenting information using the concept of color images/images that come from a combination of 3 main colors of light, namely red (red), green (green), blue (blue). The combination of the 3 primary colors produces secondary colors of yellow, magenta, cyan, brown, black, and white [21] as shown in Figure 2.

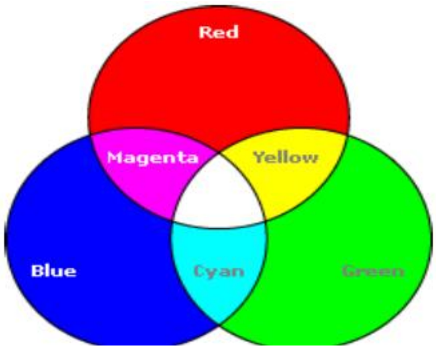

Fig. 3 Image Color composition on RGB image concept

A brightness temperature value of 10.8 m (band 13/IR) is used to provide approximate information about the height of a particle or cloud detected by the satellite. The combination of each information provided by the wavelength channel on the red (red), green (green), and blue (blue) components in the daytime microphysics RGB scheme will produce a color composite along with the physical information obtained as shown in Figure 3. and explained by detail [22].

channel	Brightness Temperature/Reflectance Value		Grayscale Image Gradation		3 Color Image Gradation		Hot cloud top/low level	
	Min.	Max..	Min.	Max.	Min.	Max.	Min.	Max.
0,86 pm (band 4/N1)	0%	100%	Dark/Black	Bright/white	Dark	Red	Thin cloud	Thick clouds
3,9 pm (band 7/I4)	0%	60%	Dark/Black	Bright/white	Dark	Green	Small particles in the cloud	Cloud water/ice cloud
10,4 pm (band 13/IR)	50	-70	Bright/white	Dark/Black	Blue	Dark	Hot cloud top/low level	Cold cloud top/high level

2.3 Backpropagation Neural Network Method

Backpropagation is usually used to train the network in order to get a balance of the ability to recognize the patterns used during training and the network's ability to provide the correct response to the input pattern with the pattern used during training. The backpropagation architecture is composed of 3 layers, namely the input layer, the hidden layer, and the output layer [23]. The backpropagation training algorithm is as follows.

1. Step 1: Initialize the weights with a small random number of values.
2. Step 2: As long as the stop condition is false, do steps 3 to 8.

Feedforward

3. Step 3: Each input unit (xi, i=1,…..,n) receives the input signal xi and is forwarded to the hidden units (hidden layer).
4. Step 4: Each hidden unit (zj, z=1,….,p) adds up the weight of the input signal.

$$Z\_in_{jk} = v_{0j} + \sum_{i=1}^{n} x_i v_{ij} \quad .....(1)$$

By applying the count activation function:

$$Z_j = f(Z\_in_j) \quad .....(2)$$

For example, the activation function used is sigmoid:

$$y = f(x) = \frac{1}{1+e^{-x}} \quad .....(3)$$

and sends this signal to all units on the output unit.

5. Step 5: Each output unit (yk, k=1,…..,m) adds a weighted input signal.

$$Y\_in_k = w_{0j} + \sum_{k=1}^{p} z_j v_{jk} \quad .....(4)$$

By applying the count activation function:

$$Y_j = f(Y\_in_k) \quad .....(5)$$

Backpropagation
Step 6: Each output unit (yk, k=1,…..,m) receives its input training pattern.

Calculate the error information:
$\delta_k = (t_k - y_k) f'(y\_in_k)$ .....(6)

Calculate the weight and bias correction:
$\Delta w_{jk} = \alpha \delta_k x_j$ .....(7)

$\Delta w_{0k} = \alpha \delta_k$

6. Step 7: Each hidden unit (zj, z=1,….,p) adds up its input delta (from the units in its upper layer).
$\delta\_in_j = \sum_{k=1}^{m} \delta_k w_{jk}$ .....(8)

Calculate the error information:
$\boldsymbol{\delta_j = \delta\_in_j f(x\_in_j)}$ .....(9)
Calculate the weight and bias correction:
$\boldsymbol{\Delta v_{ij} = \alpha \delta_j x_i}$ .....(10)

Weight and Bias Fix
7. Step 8: Each output unit (y_k, k=1,..,m) update weights and bias (j=0,1,..p)
$\boldsymbol{w_{jk}}$ **(New) =** $\boldsymbol{w_{jk}}$**(past) +** $\boldsymbol{\Delta w_{jk}}$ .....(11)
Each hidden unit (z_j, z=1,.,p) update the weights and bias (i=0,1,..n)
$\boldsymbol{v_{ij}}$**(New) =** $\boldsymbol{v_{ij}}$**(past) +** $\boldsymbol{\Delta v_{ij}}$ .....(12)
8. Step 9: Tests and Results

I. RESULTS AND DISCUSSION

3.1 Test result

A. Test result
From the results of the tests that have been carried out, it can be concluded that the success rate resulting from this system is as follows:
1. Cumulonimbus Cloud Type
a. Total amount of test data: 5
b. Number of successful test data: 3
Success accuracy = $\frac{3}{5} * 100\%$ = 60%
Success accuracy = $\frac{4}{5} * 100\%$ = 80%
2. Altostratus Cloud Type
a. Total amount of test data: 5
b. Number of successful test data: 3
Success accuracy = $\frac{3}{5} * 100\%$ = 60%
3. Cirrus Cloud Type
a. Total amount of test data: 5
b. Number of successful test data: 5
Success accuracy = $\frac{5}{5} * 100\%$ = 100%
4. Cirrocumulus Cloud Type
a. Total amount of test data: 3
b. Number of successful test data: 1
Success accuracy = $\frac{1}{3} * 100\%$ = 33,3%
5. Cirrostratus Cloud Type
a. Total amount of test data: 3
b. Number of successful test data: 1
Success accuracy = $\frac{1}{3} * 100\%$ = 33,3%
6. Nimbostratus Cloud Type
a. Total amount of test data: 5
b. Number of successful test data: 3

Success accuracy = $\frac{3}{5} * 100\%$ = 60%.

To find out how far the success rate of the cloud image classification system is inputted, it is necessary to test the program. That way to know the level of success and failure of the system. The following is a table of the results of tests carried out on 46 cloud images.

Tabel I
Cloud Image Test Result

No	Image Name	Test	Euclidean distance	Cloud Type	Description
1	CA1	As	0.0000000292915	Cb	Incorect
2	CA2	Cb	0.000000002318	Cb	corect
3	CA3	Cu	0.0000000000849	Cb	Incorect
4	CA4	Cb	0.0000000040	Cb	corect
5	CA5	Cb	0.00000000003	Cb	corect
…	…	….	…	….	….
…	…	….	…	….	….
…	….	….	….	…	….
41	CA41	Cs	0.0000000014935	Cs	corect
42	CA42	Ns	0.0000000000102	Ns	corectr
43	CA43	Ns	0.00000000000001	Ns	corectr
44	CA44	St	0.00000000058052	Ns	Incorect
45	CA45	Ac	0.00000000088182	Ns	Incorect
46	CA46	Ns	0.00000000002633	Ns	Correct

2. Application Implementation

Application implementation is the implementation and testing stage of the application in detecting cloud types based on the pattern as follows:

1) Main Form Display

The main form is the initial display of the cloud image classification application which displays the main menu of the system. The following is a display from the main page as shown in Figure 3 below:

Figure 3. Main Form Display

3.2) System Test

The preprocessing process is a process that is carried out on the image before the artificial neural network training stage. Backpropagation the preprocessing process carried out is a binary process, namely decreasing the intensity of the image from grayscale to binary,

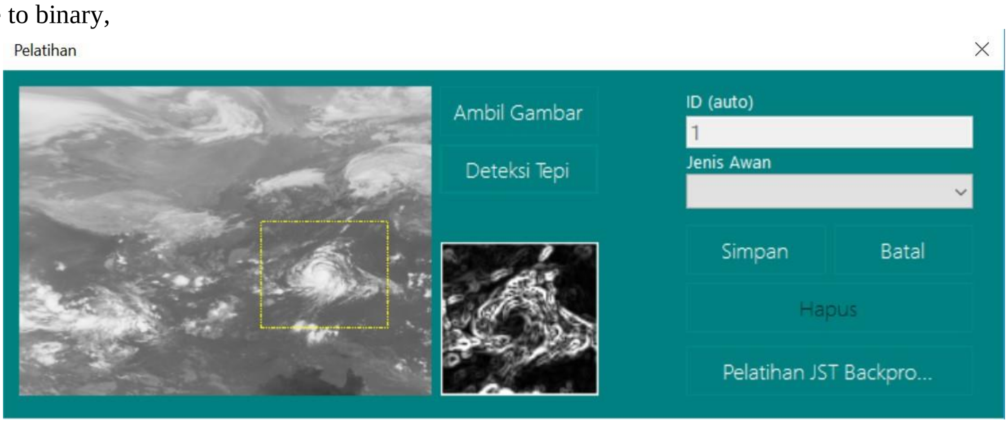

Figure 4. Preprocessing Process

3.3) Cloud Type Classification Results

In the cloud type classification process, the input image comparison stage will be tested with all image data stored in the system training database. In Figure 4.9 shows the data that has been successfully identified on the training data form with cloud image input as follows:

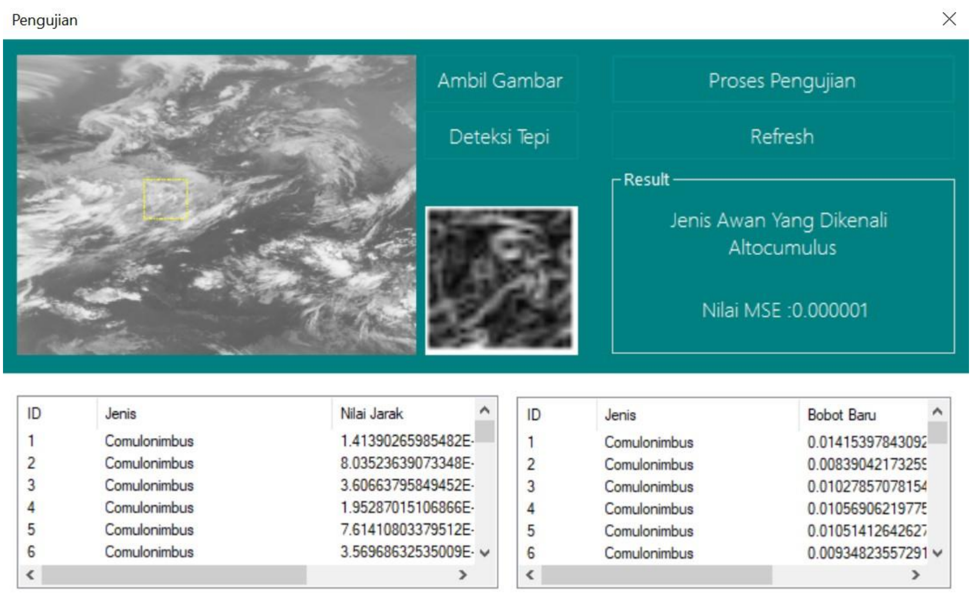

Figure 4. 9 Results of Classification of Cloud Types

5.1 Conclusion

Based on the results of research and analysis of the system, the authors can conclude several things as follows.

1. The data used in this research is cloud image taken at Meteorological Station Class I Blang Bintang Banda Aceh.
2. Cloud image classification system using backpropagation neural network method can classify cloud types by calculating the Euclidean distance between the test image and the training image.
3. Backpropagation artificial neural network method is successful in identifying cloud images, the overall accuracy of the system is 60.6%.
4. The results of the percentage of success with 46 test data in the classification of cloud types are influenced by several factors such as errors when cropping the image and the quality of the image that is inputted into the training data and used as test data.

5. Acknowledgement

In further research, the training data for each area will be more complete and the training data for more types and rainfall so that the more characteristics of the training data will increase the truth of the smart system better.

References

[1] Jobard, Isabelle. (2001). Status Of Satellite Retrieval Of Rainfall At Different Scales Using Multi-Source Data. Scientific Workshop, 1-10.

[2] Dewi, S. (2015). PENENTUAN DISTRIBUSI TIPE AWAN DI PROVINSI RIAU MENGGUNAKAN CITRA SATELIT MTSAT IR1. Jurnal Sains & Teknologi Modifikasi Cuaca, 16(1), 9-14.

[3] Inoue, T. (1987a). A Cloud Classification with NOAA-7 Split Windows Measurements. Journal of Geophysical Research, 3991-4000.

[4] Syaifullah, M.D. (2011). Potensi Atmosfer dalam Pembentukan Awan Konvektif pada Pelaksanaan Teknologi Modifikasi Cuaca di DAS Kotopanjang dan DAS Singkarak 2010. Jurnal Sains & Teknologi Modifikasi Cuaca, 12(1), 9-16. doi: 10.29122/jstmc.v12i1.2185

[5] Syaifullah, M.D. (2012) Penerapan Teknologi Modifikasi Cuaca (TMC) untuk Mengatasi Defisit Inflow PLTA Bakaru Periode 15 Februari s.d 03 Maret 2012. Jurnal Sains & Teknologi Modifikasi Cuaca, 13(1), 25-34. doi: 10.29122/jstmc.v13i1.2207.

[6] Wallace, J.M., Hobbs, P.V. (2005). Atmospheric Science: An Introductory Survey, 2nd edition. Washington: Elsevier.

[7] Pandjaitan, B. S., Rachmawati, A., Hidayat, R., Wirahma, S., & Vahada, A. D. (2019). Pemanfaatan Skema Daytime Microphysics Rgb Himawari 8 Untuk Mendeteksi Awan Cumulus Potensial Dalam Kegiatan Teknologi Modifikasi Cuaca. Jurnal Sains & Teknologi Modifikasi Cuaca, 20(2), 91-103.

[8] D. C. Rini, “Klasifikasi Sinyal EEG Menggunakan Metode Fuzzy C-Means Clustering (FCM) Dan Adaptive Neighborhood Modified Backpropagation (ANMBP),” J. Mat. “MANTIK,” vol. 1, no. 1, p. 31, 2015.

[9] N. S. Kapadia, D. P. Rana, and U. Parikh, “Weather Forecasting using Satellite Image Processing and Artificial Neural Networks,” Int. J. Comput. Sci. Inf. Secur., vol. 14, no. 11, p.1069, 2016.

[10] S. Hardwinarto and M. Aipassa, “Rainfall monthly prediction based on artificial neural network: A case study in Tenggarong Station, East Kalimantan-Indonesia,” Procedia Comput. Sci., vol. 59, pp. 142–151, 2015.

[11] M. Narvekar, P. Fargose, and D. Mukhopadhyay, “Weather Forecasting Using ANN with Error Backpropagation Algorithm,” in Proceedings of the International Conference on Data Engineering and Communication Technology, 2017, pp. 629–639.

[12] Michael, N. (2005). Artificial intelligence a guide to intelligent systems.

[13] Solomon, C., & Breckon, T. (2011). Fundamentals of Digital Image Processing: A practical approach with examples in Matlab. John Wiley & Sons.

[14] Novitasari, D. C. R., Supatmanto, B. D., Rozi, M. F., Farida, Y., Setyowati, R. D., Junaidi, R., ... & Fatoni, A. R. (2020, March). Rainfall Prediction Based on Himawari-8 IR Enhanced Image Using Backpropagation. In Journal of Physics: Conference Series (Vol. 1501, No. 1, p. 012011). IOP Publishing.

[15] P. J. Braspenning, F. Thuijsman, and A. J. M. M. Weijters, Artificial neural networks: an introduction to ANN theory and practice, vol. 931. Springer Science & Business Media, 1995.

[16] D. C. R. Novitasari, A. Lubab, A. Sawiji, and A. H. Asyhar, “Application of Feature Extraction for Breast Cancer using One Order Statistic, GLCM, GLRLM, and GLDM,” Adv. Sci. Technol. Eng. Syst. J., vol. 4, no. 4, 2019.

[17] J. A. I. Paski, A. Sepriando, and D. A. S. Pertiwi, “PEMANFAATAN TEKNIK RGB PADA CITRA SATELIT HIMAWARI-8 UNTUK ANALISIS DINAMIKA ATMOSFER,” vol. 4, no. 3, 2017.

[18] G. Gupta, “Algorithm for image processing using improved median filter and comparison of mean, median and improved median filter,” Int. J. Soft Comput. Eng., vol. 1, no. 5, pp. 304–311, 2011.

[19] A. Fanani, A. Yuniarti, and N. Suciati, “Geometric Feature Extraction of Batik Image Using Cardinal Spline Curve Representation,” vol. 12, no. 2, pp. 397–404, 2014.

[20] Putra, D. (2010). Pengolahan Citra Digital. Yogyakarta: Andi Offset.

[21]Comet (2013). Multispectral Satellite Aplications: RGB Product Explained. https://www.meted.ucar.edu/training_module.php?id=568#.XjoJz3duLg8)

[22]Lensky, M., Rosenfeld, D. (2008). Clouds-Aerosols-Precipitation Satellite Analysis Tool (CAPSAT). Atmospheric Chemistry and Physics, 8, 6739–6753. doi:10.5194/acp-8-6739-2008

[23]Yudhi Andrian, Erlinda Ningsih. (2014). Prediksi Curah Hujan Di Kota Medan Menggunakan Metode Backpropagation Neural Network. 1-6.