Matrix: Jurnal Manajemen Teknologi dan Informatika
Volume 12 Issue 3 Year 2022 Pages 137-146
DOI: http://dx.doi.org/10.31940/matrix.v12i3.137-146
URL: http://ojs2.pnb.ac.id/index.php/matrix

# Improvement of the automatic gamma correction method in cloud image detection

***Bayu Nadya Kusuma* [1]*, *Dian Budhi Santoso* [2]**

[1] *Department of Informatics, Universitas Amikom Yogyakarta*
[2] *Department of Electrical Engineering, Universitas Singaperbangsa Karawang*

*Corresponding Author: *bayu.nadya@amikom.ac.id*

**Abstract:** Clouds become an important part of human life and are studied in several disciplines in the form of important analyses in some applications. Examples of application of cloud analysis on solar panels or photovoltaics, accurate weather forecasts, accuracy of rainfall predictions, application in the field of meteorology, imaging of the sky in some cases, air humidity survey, and the case of turbulence on Aircraft caused by clouds cumulonimbus. The structure and shape of the clouds are continuously changing, becoming an interesting part to detect. The cloud detection process can be done by taking several samples of imagery from the cloud and the image processing process is done. Most research processes RGB cloud imagery into HSV cloud imagery, Some research using the image detection method of flying apply the channel's convolution R-B, R/B, $B–RB+R$, and chroma C = max(R, G, B)-min(R, G, B). Gamma correction has an efficient characteristic of storing and dividing imagery by small bits, thus the study proposed an image detection development using automatic gamma correction, with ground truth being Image data from SWIMSEG Nanyang Technological University Singapore. The proposed method in the proposed study obtained a precision value and better computing time with a precision value of 0.93 and a computational time of 0.71 sec.

**Keywords:** cloud detection, gamma correction, image processing

**History Article:** Submitted 7 July 2022 | Revised 18 October 2022 | Accepted 29 November 2022

**How to Cite:** B.N.Kusuma, and D.B Susanto, “Improvement of the automatic gamma correction method in cloud image detection,” *Matrix: Jurnal Manajemen Teknologi dan Informatika*, vol. 12, no. 3, pp. 137-146, 2022.

## Introduction

Clouds are instrumental in the formation of the climate, with the clouds then excessive energy that is absorbed by the earth can be lowered. Clouds also function as mirrors and can reflect radiation from the sun.

Thus the clouds become an important part of human life and are learned in some of the important disciplines applied to some applications. For example, in the application of cloud detection analysis on solar panels or photovoltaic processes [1], the weather forecasts accurately [2], the accuracy of rainfall prediction [3], applications in the field of meteorology [4], imaging of the sky in some cases [5], [6], [7], air humidity detection [8], and the case of turbulence on aircraft caused by clouds cumulonimbus[9] [10], [11], [12].

The cloud detection process can be done by taking several samples of imagery from the cloud and the image processing process is done. Most research processes RGB cloud imagery into hue saturation value (HSV) cloud imagery, the next research uses a method for processing images by changing the RGB channel into hue saturation intensity (HSI) [13]. In its implementation, in detecting images in real-time, some researchers use a combination of RGB to HSV/ HIS/ HSL and its reverse color space model or use the image detection method of flying apply the channel's convolution R-B, R/B, (B-R)/(B+R), and chroma C = max(R, G, B)-min(R, G, B ) , then there are several other ways to detect clouds by applying the edge detection method [14],[15],[16],[17] and [18].

The method proposed by the researchers used basic gamma correction in 2018 which was improved so that it has a better quality than the previous gamma correction method, the previous gamma correction method produced a precision value of 92% (0.92) compared to the color-based segmentation method with an average precision by 91%, memory with a value of 90% (0.90), and computation time which is better than the color-based segment method. Comparison values between gamma correction and color-based segments can be seen in Table 1.

**Table 1.** Comparison method

| Method | Precision | Recall | Time (s) |
|---|---|---|---|
| Color Based Segmentation | 0.92 | 0.90 | 1.89 |
| Gamma Correction | 0.91 | 0.86 | 0.72 |

Thus in this study, the development of the gamma correction method was carried out to obtain a precision value that was better than the method that had been proposed. Data on the development of the proposed gamma correction method uses the same im-age data from SWIM-SEG Nanyang Technological University Singapore as ground truth.

The model of this method is expected to be able to process images with a better level of precision than previous methods and produce a lower level of computation. The expectation of this method can process images with a good level of precision compared to previous methods and produce a lower level of computation.

## Methodology

This research was done according to the stage of research that involves auto-brightness contrast, split images into 3 channels red, green, and blue, automatic gamma correction, gaussian blur, and finally otsu thresholding as shown in Figure 1.

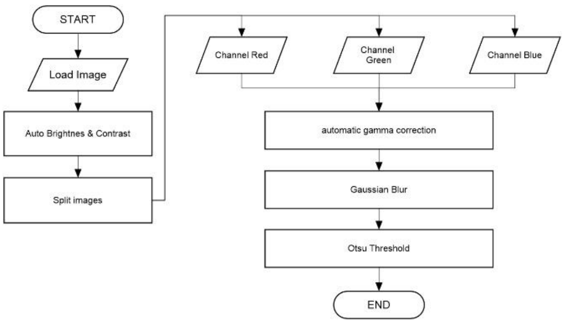


**Figure 1.** Flow diagram consisting of stages

### *Auto-Brightness and Contrast*

The auto-brightness and contrast functions are also called image normalization. The pro-cess of normalizing images from ground truth has different values of light intensity. The image normalization function is done automatically by using the formula:

$$O(x,y) = \alpha * I(x,y) + \beta \tag{1}$$

Where the value of alpha arises from the process of division between the output range and input range.

$$input\ range = Max\ (I) - \min(I) \tag{2}$$

$$\alpha = \frac{output\ range}{input\ range} \tag{3}$$

The input range is the highest value obtained from images minus the minimum value for each image. The output range is obtained from the maximum image value with a value of 255. β value is obtained from the multiplication process of the minimum image value with alpha multiplied by -1.

$$\beta = -\min(I) * \alpha \tag{4}$$

The multiplication of the alpha value functions to adjust the brightness level of the image, and the sum of the beta value functions to adjust the level of contrast level in the image.

Figure 2 and 3, shows the results of the brightness and contrast correction process with better color results.

**Figure 2.** The original images

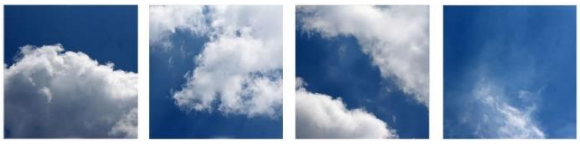

**Figure 3.** The results of brightness and contrast normalization

## *Split Images*

The image extraction stage functions to separate the image into 3 main channels, specifically the red channel, green channel, and blue channel. Three-channel elements can form as many as 16,581,375 color images [19]. Figure 4 is the result of the separation of colors into 3 channels.

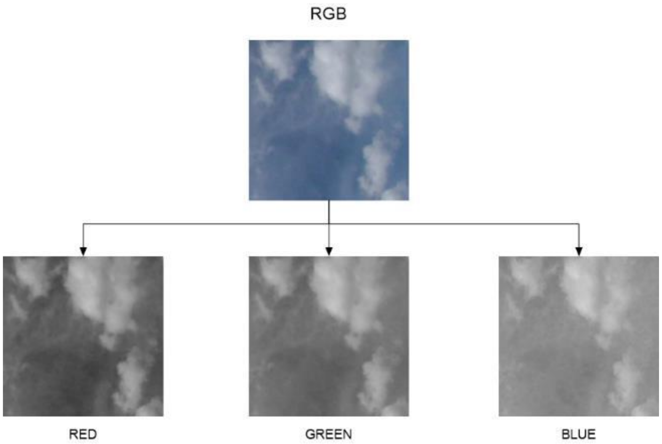


**Figure 4.** Cloud image extraction in 3 channels

## *Improvement Method Formulas Automatic Gamma*

Gamma has important and rarely understood characteristics in almost some digital imaging systems. Gamma is defined as numeric pixels and luminance i.e. mapping the pixel input and received intensity as the output pixel value with the resulting intensity value, in other words, gamma is the method of adjusting the pixel value so that can be represented properly on the output device. Without the gamma color captured by the camera will not look like the color captured by the eyes[14].

In other words, because of the lack of color capture, the gamma correction translates light sensitivity that is translated by the human eye into the digital camera or screen monitor [20]. Gamma is defined with the formula:

$$V_{out} = V_{in} Gamma \quad (5)$$

Where Vout is the output luminance value, and Vin is the actual luminance value. In the process, gamma is capable of storing and dividing image colors more efficiently as it requires a little bit to visualize the range of certain colors. Figure 5 shows a comparison of native color sensitivity, linearly encoded, and gamma.

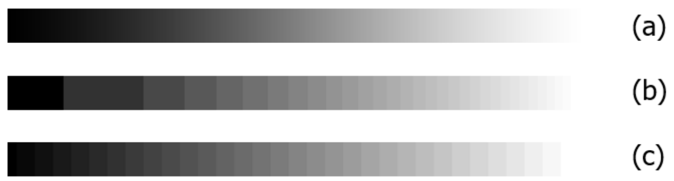


**Figure 5.** (a) Original Bright tones (b), Linearly Encoded (c), Gamma

Gamma correction or also called power transformation is used in image processing in some situations that can be used also in fixing the image brightness by using a nonlinear transformation between the input and output values.

So that between input and output comparable with the inputs raised using gamma, the following example of gamma decoding is the gamma used to process the input into output with the formula:

$$V_{out} = AV_{in}^{\gamma} \quad (6)$$

$$I' = 255\ x \left(\frac{I}{255}\right)^{\gamma} \quad (7)$$

The basis of gamma correction is to improve the brightness of the image between input and output by determining the gamma value of γ. The gamma correction developed by INRA was modified to get the gamma value of γ. The default gamma correction function can be defined as follows:

$$\gamma = log\left(\frac{\gamma}{range}\right) / log\left(\frac{x}{range}\right) \quad (8)$$

Where the range value is the range of values of the image that starts from 0 to the maximum value of 255. The variable x is the mean value of the pixel of the image being processed and γ is half of the range value.

From the above method, automatic gamma correction is developed to produce the image needed for the detection process. The automatic gamma correction function in this study is defined as follows:

$$\gamma = log\left(\frac{\gamma}{range}\right) / log\left(\frac{\left((r-\bar{b}) + (g-\bar{b})\right) - \left((r-\bar{b}) + (g-\bar{b})\right)}{range}\right) \quad (9)$$

Where b¯is the average value of the blue channel that is part of the RGB channel. Figure 6 is the result of implementing automatic gamma correction.

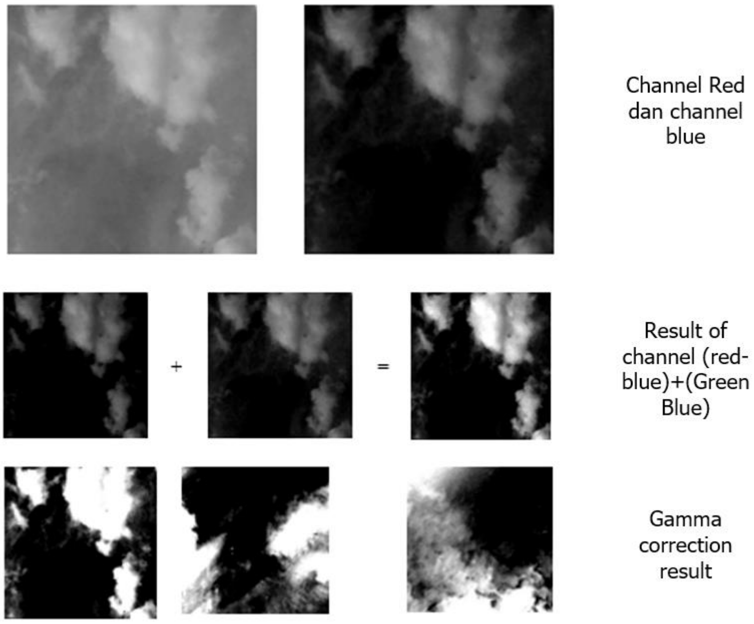


**Figure 6.** Implementation with gamma correction

## *Gaussian Blur*

Gaussian blur can eliminate parts of noise that are not used in the process of cloud image detection, using the Gaussian blur noise method generated from the previous process can be ignored and does not interfere with the thresholding process [21].

## *Otsu Thresholding*

Thresholding segmentation aims to separate objects from the background with simpler values. Thresholding functions to separate a digital image based on the characteristics of the pixels.

The result of this process is the absolute value of dark and light [22][23][24]. Otsu uses a discriminant analysis approach by distinguishing several naturally occurring blocks. Analysis of variables on otsu will maximize the separation of objects from the background. Figure 7 is the result of the implementation of the otsu method.

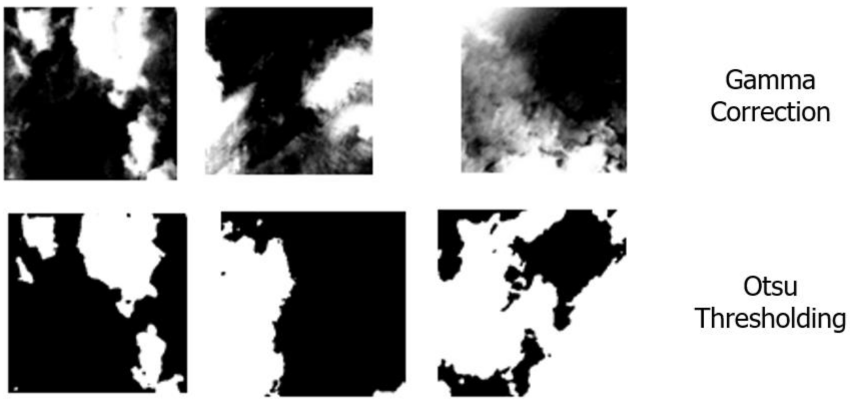


**Figure 7.** Implementation of multiple cloud images using otsu threshold correction

## *Evaluation*

To find out the performance of the system that has been developed, then testing all images tested in this study. The analysis uses 3 assessments namely precision, recall, and timer.

The precision describes the accuracy between the requested data and the prediction results provided by the method, precision value is obtained from testing the image data with tp, and fp values on the processed image. The precision function can be defined as follows:

$$Precision = \frac{tp}{tp + fp} \tag{10}$$

In determining the precision value, a tp value is needed, where tp is a true positive, i.e. the number of pixels in the matrix from the results of the proposed method is detected correctly by the system compared to the pixels in the ground truth. And fp is a false positive where the pix-els in the matrix of the proposed method are correct but are detected wrong by the system based on the comparison of data on ground truth.

The recall describes the success of the method in retrieving information, recall value is ob-tained by calculating the value of tp and fn. The recall testing process can be directly carried out by the formula:

$$Recall = \frac{tp}{tp + fn} \tag{11}$$

In determining the recall value, fn is a false negative where the number of negative data but classified incorrectly by the system base on the comparison from data on ground truth. The computational timer process is calculated from the overall average value of 1013 the number of images processed.

## Results and Discussions

The gamma correction testing process was conducted to determine the performance of the system that has been developed using 3 assessments, namely precision, recall, and timer. 1013 experiment of ground truth imagery, the proposed method obtained information in graphical form as follows:

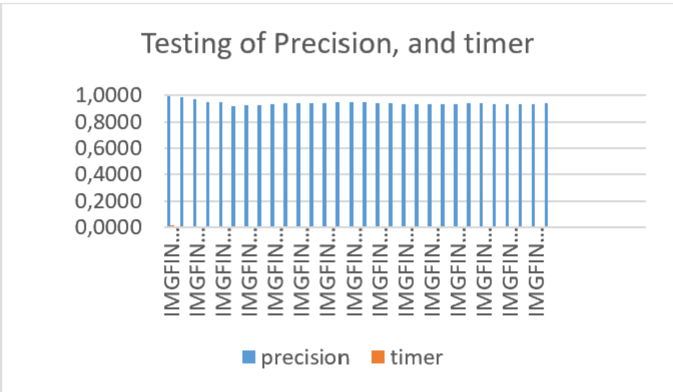


**Figure 8.** Precision testing, and timer of cloud image data based on ground Truth (SWIMSEG)

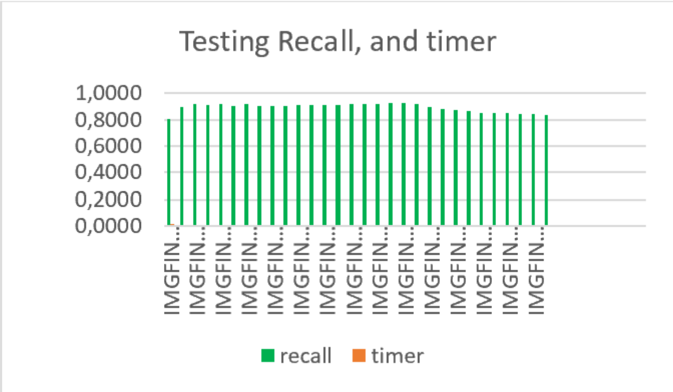


**Figure 9.** Recall testing and timer of cloud image data based on ground Truth (SWIMSEG)

From the above Figure 8 and Figure 9, The precision, recall, and timer test values from the 1013 image can be seen in Table 2.

**Table 2.** Proposed method image data

| Testing | Total | Mean |
|---|---|---|
| precision | 94248.0717 | 93.0386 |
| recall | 81544.6367 | 80.4982 |
| Timer | 720.9480 | 0.7117 |

From the average value of 1013 ground truth images obtained a precision value of 93.0386 with a recall value of 80.4982 and a timer of 0.7 117 seconds. Table 2 shows a comparison of several previous image detection methods with the proposed method. Table 3 and Figure 9 show a detailed comparison between 13 methods from previous research with the proposed method.

**Table 3.** Comparison of between 13 methods

| Method | Precision | Recall | Time (s) |
|---|---|---|---|
| Li et al. | 0.90 | 0.86 | 2.06 |
| Souza et al. | 0.95 | 0.76 | 2.04 |
| Long et al. | 0.71 | 0.98 | 1.83 |
| Mantelli-Neto | 0.70 | 0.97 | 2.16 |
| SLIC + DBSCAN | 0.72 | 0.79 | 5.29 |
| GRAY + SVM | 0.87 | 0.56 | 2.61 |
| LBP + SVM | 0.62 | 0.65 | 4.73 |
| ColorHIST + SVM | 0.81 | 0.64 | 2.63 |
| dSIFT + BOW + SVM | 0.65 | 0.88 | 5.04 |
| Texture + BOW + SVM | 0.82 | 0.71 | 2.74 |
| Color Based Segmentation | 0.92 | 0.90 | 1.89 |
| Gamma Correction | 0.91 | 0.86 | 0.72 |
| Proposed method | 0.93 | 0.81 | 0.71 |

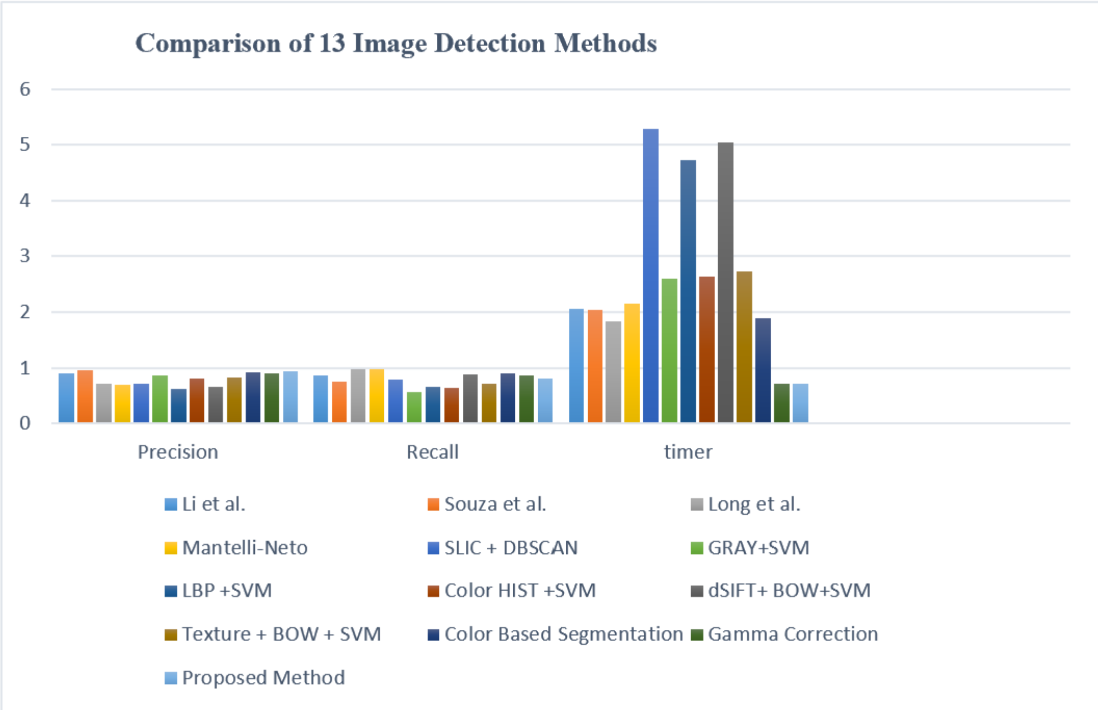


**Figure 9.** Comparison of 13 image detection methods

From the graph information above the highest precision value was gained in the Souza method with a percentage of 0.95, followed by a researcher's proposed method of 0.93, and the third position followed by a color-based segment of 0.92.

The highest recall result is obtained by the Long et al method with a percentage of 0.98, while the proposed method is placed to 7 with a percentage of 0.81. Comparing the computational time of imagery to the thirteen methods, the proposed gam-ma correction development method is at the lowest computing process in the first order of 0.71 seconds.

## Conclusion

For the development of the gamma correction method in future research to overcome the decrease in the recall value which decreased by 0.04 points to 0.86 in the previous method which obtained a value of 0.90, additional methods are needed such as the dilation method before the advanced stage of image processing so that parts of the image that have uneven cloud areas and thin areas can still be detected as full cloud areas so that the level of precision and recall can be improved and research can be continued to develop accuracy values.

## Acknowledgments

Thanks to the Faculty of Computer Science, Universitas Amikom Yogyakarta, and Universitas Singaperbangsa Karawang that helped with this research.

## References

[1] N. Sugiartha, "Energy yield of a 1.3 kWp grid-connected photovoltaic system design: Case for a small house in Bali," *Matrix J. Manaj. Teknol. dan Inform.*, vol. 10, no. 1, pp. 19–25, 2020, doi: 10.31940/matrix.v10i1.1838.

[2] C. Papin, P. Bouthemy, and G. Rochard, "Unsupervised segmentation of low clouds from infrared METEOSAT images based on a contextual spatio-temporal labeling approach," *IEEE Trans. Geosci. Remote Sens.*, vol. 40, no. 1, pp. 104–114, 2002, doi: 10.1109/36.981353.

[3] M. Mahrooghy, N. H. Younan, V. G. Anantharaj, J. Aanstoos, and S. Yarahmadian, "On the

use of a cluster ensemble cloud classification technique in satellite precipitation estimation," *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.*, vol. 5, no. 5, pp. 1356–1363, 2012, doi: 10.1109/JSTARS.2012.2201449.

[4] C. I. Christodoulou, S. C. Michaelides, and C. S. Pattichis, "Multifeature texture analysis for the classification of clouds in satellite imagery," *IEEE Trans. Geosci. Remote Sens.*, vol. 41, no. 11 PART I, pp. 2662–2668, 2003, doi: 10.1109/TGRS.2003.815404.

[5] T. Shiraishi, T. Motohka, R. B. Thapa, M. Watanabe, and M. Shimada, "Comparative assessment of supervised classifiers for land use-land cover classification in a tropical region using time-series PALSAR mosaic data," *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.*, vol. 7, no. 4, pp. 1186–1199, 2014, doi: 10.1109/JSTARS.2014.2313572.

[6] Q. Zhang and C. Xiao, "Cloud detection of RGB color aerial photographs by progressive refinement scheme," *IEEE Trans. Geosci. Remote Sens.*, vol. 52, no. 11, pp. 7264–7275, 2014, doi: 10.1109/TGRS.2014.2310240.

[7] I. H. Lee and M. T. Mahmood, "Robust registration of cloudy satellite images using two-step segmentation," *IEEE Geosci. Remote Sens. Lett.*, vol. 12, no. 5, pp. 1121–1125, 2015, doi: 10.1109/LGRS.2014.2385691.

[8] Y. Chen, L. Cheng, M. Li, J. Wang, L. Tong, and K. Yang, "Multiscale grid method for detection and reconstruction of building roofs from airborne LiDAR data," *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.*, vol. 7, no. 10, pp. 4081–4094, 2014, doi: 10.1109/JSTARS.2014.2306003.

[9] A.Qz M. Model and W. R. F. Arw, "Analysis of weather conditions at the time of the crash of the AirAsia plane QZ8501 using the WRF-ARW model (case study 28 December 2014),." 2015.

[10] M. Janwar, M. Munandar, M. Klimatologi, and B. Klimatologi, "Identify Cumulonimbus Characteristics Clouds Using Satellite/ Identifikasi Karakteristik Awan Cumulonimbus Dengan Menggunakan Satelit." 2016. doi: 10.13140/RG.2.2.12946.17600.

[11] A. Qz, M. Model, and W. R. F. Arw, "Analisis kondisi cuaca saat terjadinya kecelakaan pesawat airasia qz8501 menggunakan model wrf - arw (studi kasus 28 desember 2014)," 2015.

[12] Munandar, M. Janwar, and M. Arif, "Identifikasi karakteristik awan cumulonimbus dengan menggunakan satelit," *J. Meteorol. Klimatologi dan Geofis.* pp. 1–9, 2015.

[13] Q. Zhang and C. Xiao, "Cloud detection of RGB color aerial photographs by progressive refinement scheme," *IEEE Trans. Geosci. Remote Sens.*, vol. 52, no. 11, pp. 7264–7275, 2014, doi: 10.1109/TGRS.2014.2310240.

[14] I. M. O. Widyantara, N. M. Ary Esta Dewi Wirastuti, I. M. D. P. Asana, and I. B. P. Adnyana, "Gamma correction-based image enhancement and canny edge detection for shoreline extraction from coastal imagery," *2017 1st Int. Conf. Informatics Comput. Sci.*, pp. 17–22, 2017, doi: 10.1109/ICICOS.2017.8276331.

[15] T. Sharma, "Performance comparison of edge detection algorithms for satellite images using bigdata platform spark," no. 1, 2016.

[16] G. Saravanan, G. Yamuna, and S. Nandhini, "Real time implementation of RGB to HSV / HSI / HSL and its reverse color space models," pp. 462–466, 2016.

[17] S. Dev, Y. H. Lee, and S. Winkler, "Color-based segmentation of sky/cloud images from ground-based cameras," *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.*, vol. 10, no. 1, pp. 231–242, 2017, doi: 10.1109/JSTARS.2016.2558474.

[18] B. N. Kusuma, "*Proposal Penelitian Deteksi Citra Awan Pada Optimasi Energi Listrik Tenaga Surya Konsentrasi Teknologi Informasi*," 2017.

[19] A. Division, "*The Basis of RGB Image Composites*".

[20] A. R. Smith, "*Gamma Correction*," 1995.

[21] R. Crane, *A Simplified Approach to Image Processing: Classical and Modern Techniques in C*. Prentice Hall PTR, 1997.

[22] D. Bradley and G. Roth, "Adaptive thresholding using the integral image," *J. Graph. Tools*, vol. 12, no. 2, pp. 13–21, 2007, doi: 10.1080/2151237X.2007.10129236.

[23] Y. Li, X. Liu, and Y. Liu, "Adaptive local gamma correction based on mean value adjustment," *2015 Fifth Int. Conf. Instrum. Meas. Comput. Commun. Control*, pp. 1858–

1863, 2015, doi: 10.1109/IMCCC.2015.395.
[24] P. D. Wellner, "Adaptive thresholding for the digital desk," *Xerox, EPC1993-110*, pp. 1–19, 1993.