

# Improvement of Fuzzy C-Mean using Local Laplacian Filter for Image Segmentation

*by* Moch Arief Soeleman

---

**Submission date:** 20-Apr-2020 04:02PM (UTC+0700)

**Submission ID:** 1302464456

**File name:** timurpamungkas2018\_Improvement\_laplacian.pdf (1.75M)

**Word count:** 3422

**Character count:** 17820

# Improvement of Fuzzy C-Mean using Local Laplacian Filter for Image Segmentation

**5** Ansar Timur Pamungkas  
Computer Science Faculty  
Dian Nuswantoro University  
Semarang, Indonesia  
gansar.pamungkas@gmail.com

**8** Rifqi Majid  
Computer Science Faculty  
Dian Nuswantoro University  
Semarang, Indonesia  
rifqi.majid29@gmail.com

**3** Guruh Fajar Shidik  
Computer Science Faculty  
Dian Nuswantoro University  
Semarang, Indonesia  
guruh.fajar@research.dinus.ac.id

M. Arief Soeleman  
Computer Science Faculty  
Dian Nuswantoro University  
Semarang, Indonesia  
arief22208@gmail.com

Ricardus Anggi Premunendar  
Computer Science Faculty  
Dian Nuswantoro University  
Semarang, Indonesia  
ricardus.anggi@research.dinus.ac.id

Ahmad Zainul Fanani  
Computer Science Faculty  
Dian Nuswantoro University  
Semarang, Indonesia  
a.zainul.fanani@research.dinus.ac.id

**Abstract**— the FCM (Fuzzy C-Mean) is one of algorithms used in the background image separation research. This study aims to improve the quality of image segmentation using FCM algorithm with Local Laplacian Filter. Thus, we applied the Local Laplacian Filter into the V (Value) and S (Saturation) component of the image. The result of Laplacian Filter then clustered using FCM method. The result of segmentation using FCM and Local Laplacian Filter will be compared with ground-truths images to reveal the value of the PSNR (Peak Signal to Noise Ratio) and the MSE (Mean Square Error). This study also compared the results of the MSE and PSNR with the FCM and K-Mean algorithms. The image is done preprocessing first by using Local Laplacian Filter which gives the color contrast to the image. So the image becomes sharper and when the image changed to the color space HSV already looks quite striking color differences between objects with the background. The results of this study indicate that segmentation using FCM and Local Laplacian Filter has the best MSE and PSNR results compared to the 2 tested algorithms.

**Keywords**—FCM, HSV, Image Segmentation, Local Laplacian Filter

## I. INTRODUCTION

Image segmentation is one of the methods in digital image processing used to classify an image. Image segmentation goal is to separate an image into many separated regions with every region corresponding to a visual essential object [1]. Image segmentation is used as a fundamental role in many computer vision applications [2].

Implementation of image segmentation can be utilized for various fields of science such as health, economics, medicine, etc. Image segmentation aims to cluster images in accordance with some similar features, i.e. texture, color, intensity, movement, etc. To implement the segmentation method on image, foreground color should be initialized first in RGB and converted the background color to 0 (zero) value for which the distance label is less than 128 [1]. Image segmentation can also applied in video processing by comparing each frames to get a movement object that captured [2]. In its development there are many methods used to implement image segmentation [3], one of them is using Fuzzy C-Mean algorithm [4].

The FCM (Fuzzy C-Mean) is one of methods implemented in the field of image classification and has some advantages, which is widely used in various research and goals. Based on the statement of H. Pei, et al [5], the FCM is an algorithm implemented in the soft clustering, which is based on fuzzy set theory. This algorithm can classify the image by changing the object of the image into the HSV color space [6]. HSV color space is better than the RGB to representing human view, because the HSV has a color range from 0 to 1 [7]. In this color space the FCM algorithm clusters the imagery based on the similarity of color and texture.

In this research the role of preprocessing the image becomes very important to get better image segmentation quality. Therefore the authors propose a method to improve the results of image segmentation using FCM so as to get maximum results. Local Laplacian Filter (LLF) is a method of color image correction that makes the color of the image becomes sharper [8]. The Laplacian of an image is a secondary method of enhancement [9].

Refer to Guangyu Zhang [8] using Local Laplacian Filter as an approach in which quickly make a high quality line drawings. In his research, he construct a local intensity remapping and then construct it into Laplacian Pyramid by computing a Laplacian pyramid of the transformed image.

Satish Bhairannawar [9], in his research, before implementing the Laplacian method he convert the color space from RGB to HSV. He applying the Laplacian filter to Value and Saturation component. To obtain the enhanced Value by stretching the contrast and appropriating the Saturation component, the output of luminance component is subjected to CLAHE (Contrast Limited Adaptive Histogram Equalization). And the last was reconvert from HSV back to RGB.

In this research, authors thought that LLF method is very suitable to be combined with FCM algorithm to get better image segmentation result. As mentioned above that FCM classify HSV component and LLF is stretching V and S component. To test the results of image segmentation using the authors' proposed model, the authors used sample dataset images obtained from Berkeley Segmentation

Dataset (BSD) [10].

Referring from the information above, research that using FCM combined with LLF as a filter is not yet investigated. Applying Laplacian filter to V and S component. Then cluster it using FCM using the image datasets to produce a better result of image segmentation obtained by using the results of the calculation of PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error). Those are often implemented to evaluate the image segmentation results along with its ground truth. From their process, the value then calculated, the lower the value of MSE can be indicated that it is a better image segmentation. On the other hand, the higher the PSNR value, indicates a better image segmentation.

Hence, for the whole process, the MSE and PSNR results through the proposed model will be compared with the results of the FCM and K-Mean algorithms that are widely used in research to perform image segmentation.

## II. FUNDAMENTALS

### A. Image Segmentation

Image segmentation is widely applied in various researches that have many challenges in the field of computer vision [2]. Those researches most often implementing some fast and effective algorithms, which can easily be applied in the image segmentation field.

For several reasons, the main objective of the image segmentation research is to group some pieces of image into regions through its similar properties (i.e. intensity, color, spatial statistics) purposed to create the meaningful image and is easier for the analysis process [1]. The grouping of blocks that associated with similar image features can be called as the result of segmentation. Then, the most significance steps to achieve the successful segmentation is through grouping some schemes and choosing the image features.

### B. Fuzzy C-Mean Clustering

It is said that the FCM is a well-recognized technique and categorized as a Hard K-Means [11]. The FCM is implementing some model of the fuzzy grouping to set up the level or degree of membership in a range at the interval of 0 (zero) to 1 (one) [4]. To count the membership level in a class or a cluster is determined by its membership degree. Here is the formula given (1):

$$I_{fc} = (\max(x_i (y=1) + \min(x_i (y=2))) / 2 \quad (1)$$

Determinating the center of the cluster become the basic concept of FCM method. Restoring repeatedly every membership values and the cluster center will show the center of the cluster precisizing its location [12]. The effectiveness and easy implementation is the reason for using the general algorithm of image segmentation using

FCM. The function membership piece of fuzzy by the pixel of an image to the convinced amount of classes. To start the observed intensity collection in a pixel j, we used the equation (2):

$$y_i = [y_{j1}, y_{j2}, \dots, y_{jN}]^T, j = 1, \dots, M \quad (2)$$

where  $y_i, (i = 1, \dots, N)$  (in the RMI, N is the sum amount of TR/TE), and M is represent the pixel position number. The spectral canal amount can be the pixel intensity of the spectral canal inserted to the N. The minimum iteration between the membership function of fuzzy  $u_j$  and the center of pixel vector in every single class  $v_k$  is calculated in equation (3):

$$|_{FCM} = \sum u_j \sum v_k (G, j) - v_k \quad (3)$$

where  $U_k(i,j)$  is the membership amount in the pixel location (i,j) in the k class is. The q is the content exponent existed in every membership of single fuzzy determined as parameter and the fuzziness amount of the classification outcome. To reflecting degree of similarity between the class center point and the pixel vector of the mentioned location, the value of 8 memberships is ranged from 0-1. Measuring how close the value function to 1 is providing the minimum FCM. The further the pixel intensity from the center is the smaller membership value it get [3].

### C. Local Laplacian Filter

The LLF (Local Laplacian Filter) is one of techniques pf digital image processing, which is implemented often for color image enhancement. The LLF counts the result by calculating the LP (Laplacian Pyramid) independently each layer [9]. Once the Laplacian pyramid computed, the output image can easily be obtained by expanding the LP [9].

The LP is composed with spatially constant Gaussian kernels. It is said that the LP is widely recognized as the poor method to the edge-aware operations and some edges positioning [13].

Particularly, the Laplacian Filter is efficient to find the fine detail in an image. Some researchers conducted previously to train the Laplacian operator to find the enhancement of any feature along with the sharp discontinuity. In this study, to approximate the second derivative in the Laplacian operator, we used equation (4).

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} \quad (4)$$

Before stepping to further processing, the Laplacian filter is implemented to count the S (Saturation) and V (Value) components, which is then used to sharpen the contents of the image. The CLAHE (Contrast Limited Adaptive

Histogram) is implemented to process the enhanced luminance component. By applying the Laplacian filter to the  $V$  and  $S$  components will give the output, shown as  $V_a$  and  $S_a$  [9].

In this research, Local Laplacian filter used for increase the contrast from the dataset images [10]. The result of image segmentation processing was affected by quality of preprocessed images. After that, preprocessed images would be converted from RGB to HSV, then image will be clustering processed using Fuzzy C-Mean algorithm.

### III. RESEARCH EXPERIMENT

This study aims to segment the image to distinguish the object image with background. The following sequence of research process conducted (1):

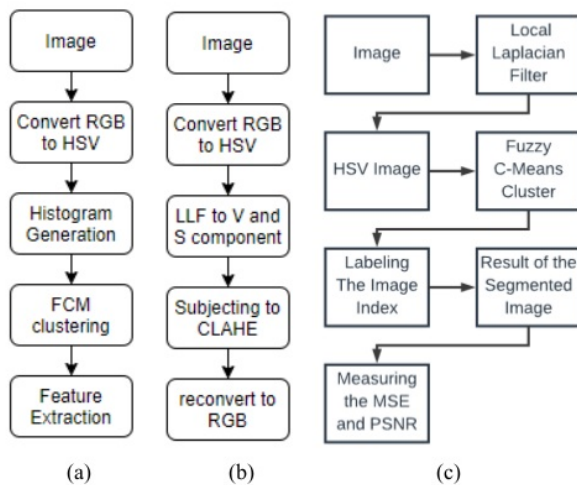


Fig. 1. (a) Research Flow Diagram of Implementing FCM on Image Segmentation by Jie Zhang, (b) Flow Diagram of Implementing Local Laplacian Filter by Satish Bhairannawar, (c) Flow Diagram of Proposed model by Adding LLF before clustering using FCM

Fig 1. (a) shows how the authors of that research implementing FCM on image segmentation, Fig 1. (b) shows hoe the authors of that research implementing Local Laplacian Filter to sharper value of V and S components. In this research, the authors implementing Local Laplacian Filter before FCM to get a better image segmentation result.

The original image to be processed will be enhanced by using Local Laplacian Filter, which aims to make image contrast better. For t implementation, the image will be changed firstly from RGB (Red, Green, Blue) into the HSV (ie, Saturation, Value) color. That changing is clustered using the Fuzzy C-Mean technique by determining the center of the cluster and entering the Hue and Saturation values of the image. The Figure (2) shows the segmentation result.

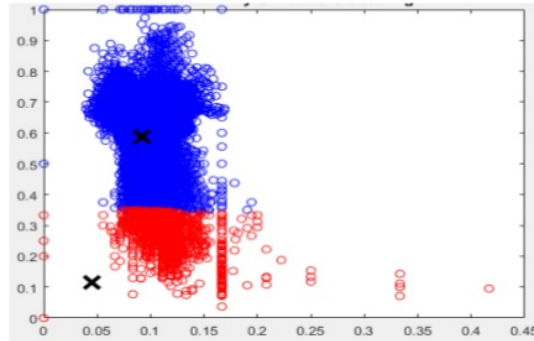


Fig. 2 Graph shown clustering using Fuzzy C-Mean

In the graph (2) it looks Fuzzy C-Mean algorithm successfully segmented to degrade object and background image. Image sequence result of image segmentation process can be seen in figure (3) following:

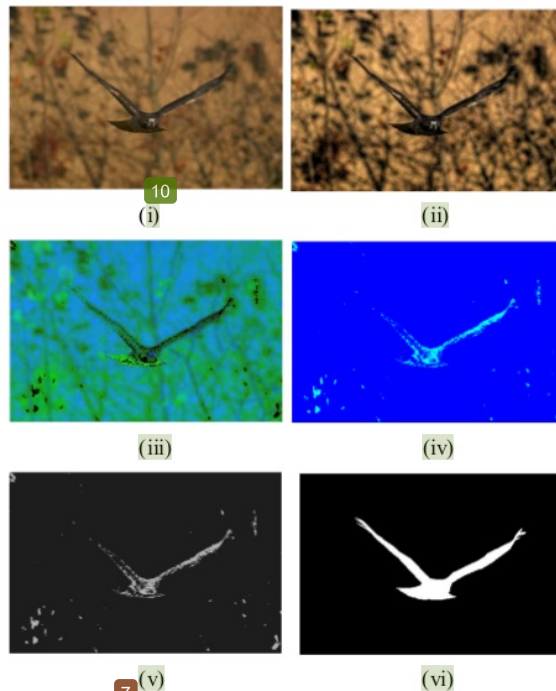


Fig 3. The (i) is the original image, (ii) is the image after processing the Local Laplacian Filter, (iii) is the image in HSV, (iv) is the result of segmented image, (v) is the segmented Image in grey, (vi) is the Ground-Truth Image

In figure (3) shows the process in this research from the selecting dataset images, preprocessing image using local laplacian filter, and then the result is image clustering using Fuzzy C-Mean.

After the image successfully segmented the next step is to compare the image quality of the results of segmentation with ground-truth image. In this study, we use the PSNR (Peak Signal to Noise Ratio) and the MSE (Mean Square Error) to measure the proposed model quality. The MSE

calculation formula can be seen at equation (5) as well as the PSNR calculation is at (6).

$$MSE = \frac{1}{MN} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} [f(i,j) - \hat{f}_1(i,j)]^2 \quad (5)$$

$$PSNR = 10 \log_{10} \left( \frac{255^2}{MSE} \right) \quad (6)$$

MSE and PSNR were selected for this research because previous studies [14] were used to monitor and evaluate the results of image segmentation. Furthermore, this research will compare the value of MSE and PSNR of two algorithms done in previous research with our proposed model. The author compares the results of MSE and PSNR from 10 Dataset Image with 2 other algorithms previously used, Fuzzy C-Mean and K-Mean. Here's the comparison:

TABLE I. COMPARISON OF MSE AND PSNR RESULT USING FCM, K-MEAN, AND PROPOSED MODEL

| Image   | Fuzzy C-Mean |        | K-Mean     |        | Proposed Model |        |
|---------|--------------|--------|------------|--------|----------------|--------|
|         | MSE          | PSNR   | MSE        | PSNR   | MSE            | PSNR   |
| 1       | 28116,7711   | 3,6411 | 36001,7632 | 2,5676 | 25344,2251     | 4,0920 |
| 2       | 41755,8675   | 1,9236 | 40581,1299 | 2,0476 | 41253,5554     | 1,9762 |
| 3       | 37545,8165   | 2,3852 | 39799,6490 | 2,1320 | 26310,4235     | 3,9295 |
| 4       | 36682,2648   | 2,4862 | 27126,4599 | 3,7969 | 28556,1138     | 3,5738 |
| 5       | 39740,7150   | 2,1384 | 33225,0531 | 2,9161 | 33298,1311     | 2,9066 |
| 6       | 32238,1705   | 3,0471 | 26461,7863 | 3,9046 | 22336,7905     | 4,6406 |
| 7       | 31466,1085   | 3,1524 | 32828,3458 | 2,9683 | 29976,4122     | 3,3630 |
| 8       | 38566,0196   | 2,2688 | 33521,2318 | 2,8776 | 25828,7365     | 4,0098 |
| 9       | 38202,6286   | 2,3099 | 28748,8528 | 3,5446 | 27483,8490     | 3,7400 |
| 10      | 39315,7581   | 2,1851 | 27916,6052 | 3,6722 | 37717,7195     | 2,3653 |
| Average | 36363,0120   | 2,5538 | 32621,0877 | 3,0428 | 29810,5957     | 3,4597 |

Based on the experimental result shown in table (1), the authors compare 10 (ten) sample images obtained from the public datasets [15] and compare the results of the segmentation using 3 (three) algorithms, i.e. Fuzzy C-Mean, K-Mean, and FCM + Local Laplacian. The MSE results can be seen in the following figure (5).

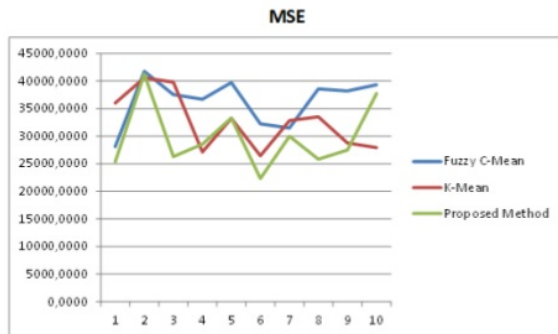


Fig 5. Graph of MSE Results from 3 Algorithms

From the result of MSE in figure (5) it is seen that the proposed model (Fuzzy C-Means + Local Laplacian Filter) has a lower error than the 2 algorithms tested with an average value of 29810.5957 compared with the average value of FCM and K-Mean that is equal to 36363,0120 and 32621,0877. The results show that the implementation of the fuzzy C-Means along with the incorporation with Local Laplacian Filter create the best MSE value compared to other 2 (two) algorithms. Furthermore, this study will make the graph of PSNR value comparison with 3 methods that were tested before. For graph of PSNR result can be seen in figure (6) :

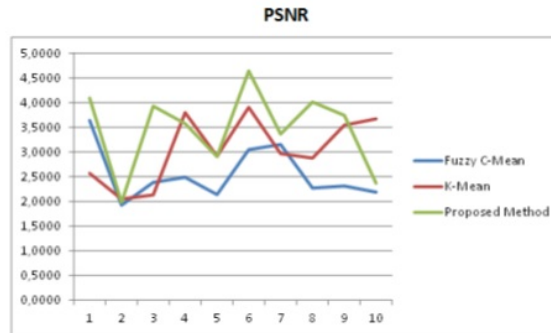


Fig 6. Graph of PSNR Results from 3 Algorithms

From the result of PSNR in figure (6) shows that the proposed model has the highest PSNR value with an average of 3.4597 compared with the mean value of FCM and Kmean that is 2,5538 and 3,0428. From these results it can be concluded that the image of the segmentation result using FCM and Local Laplacian Filter has the best PSNR value compared to the 2 tested algorithms. Comparison of the segmented image between proposed model with FCM and K-Means can be seen in figure (7) below :

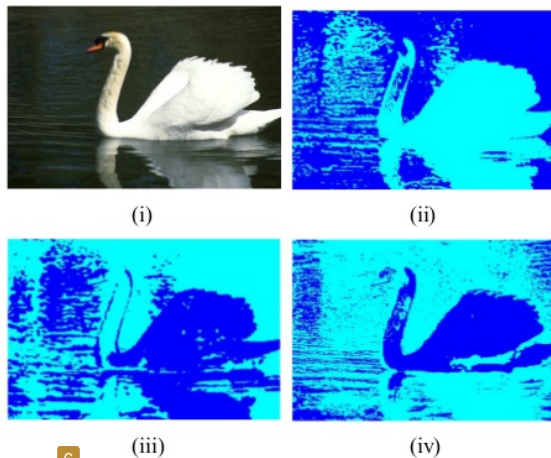


Fig 7. (i) is the original image, (ii) is the segmented image using FCM, (iii) is the segmented image using K-Means, (iv) is the segmented image using the proposed model.

## IV. CONCLUSION

This research has been successful to show improvement of segmentation result using Fuzzy C-Mean and Local Laplacian Filter algorithm compared with 2 algorithms tested, that is using Fuzzy C-Mean and K-Mean. The results of this study provide the best value of MSE and PSNR compared to the 2 algorithms tested because before the image is clustered using Fuzzy C-Mean algorithm, the image is done preprocessing first by using Local Laplacian Filter which gives the color contrast to the image. So the image becomes sharper and when the image changed to the color space HSV already looks quite striking color differences between objects with the background. This results is shown the better method of image segmentation rather than the Fuzzy C-Mean and K-Mean algorithms. With this research the authors hope the future research can be developed into a method that can increase the quality of detection or classification of an object image and bring much benefits for various fields of science.

## REFERENCES

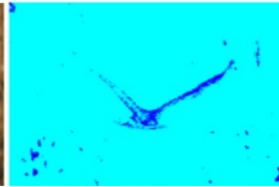
- [1] R. A. Pramunendar, C. Supriyanto, Dwi Hermawan Novianto, Ignatius Ngesti Yuwono, G. F. Shidik, and P. N. Andono, "A classification method of coconut wood quality based on Gray Level Co-occurrence matrices," in *2013 International Conference on Robotics, Biomimetics, Intelligent Computational Systems*, 2013, pp. 254–257.
- [2] F. N. A. Guruh Fajar Shidik, "Time Frame Selection Based Feature Extraction for Fire Detection in Video Surveillance," *J. Comput. Theor. Nanosci.*, vol. 20, no. October 2014, pp. 1885–1889, 2014.
- [3] W. Wang and C. Wu, "Image segmentation by correlation adaptive weighted regression," *Neurocomputing*, vol. 267, pp. 426–435, 2017.
- [4] S. K. Choy, S. Y. Lam, K. W. Yu, W. Y. Lee, and K. T. Leung, "Fuzzy model-based clustering and its application in image segmentation," *Pattern Recognit.*, vol. 68, pp. 141–157, Aug. 2017.
- [5] H. Pei, Z. Zheng, C. Wang, C.-N. Li, and Y. Shao, "D-FCM: Density based fuzzy c-means clustering algorithm with application in medical image segmentation," *Procedia Comput. Sci.*, vol. 122, pp. 407–414, 2017.
- [6] J. Zhang and M. Du, "Fast Image Segmentation of Gold Immunochromatographic Strip Based on FCM Clustering Algorithm in HSV Color Space," no. Cisp, pp. 525–528, 2012.
- [7] G. F. Shidik, F. N. Adnan, C. Supriyanto, R. A. Pramunendar, and P. N. Andono, "Multi color feature, background subtraction and time frame selection for fire detection," *Proc. 2013 Int. Conf. Robot. Biomimetics, Intell. Comput. Syst. ROBIONETICS 2013*, no. November, pp. 115–120, 2013.
- [8] G. Zhang, J. Lin, X. Gao, and M. Liao, "A Fast Local Laplacian Filter for High Quality Suggestive Contours Generation," no. Cisp, pp. 313–318, 2015.
- [9] S. Bhairannawar and A. Patil, "Color Image Enhancement using Laplacian filter and Contrast Limited Adaptive Histogram Equalization," pp. 0–5, 2017.
- [10] J. Z. Hui Li, Jianfei Cai, Thi Nhat Anh Nguyen, "A Benchmark For Semantic Image Segmentation." [Online]. Available: [http://www.ntu.edu.sg/home/asjfc/ai/Benchmark\\_Website/benchmark\\_index.html](http://www.ntu.edu.sg/home/asjfc/ai/Benchmark_Website/benchmark_index.html).
- [11] A. H. Rangkuti, Z. E. Rasjid, and D. J. Santoso, "Batik Image Classification Using Treeval and Treefit as Decision Tree Function in Optimizing Content Based Batik Image Retrieval," *Procedia Comput. Sci.*, vol. 59, pp. 577–583, Jan. 2015.
- [12] K. Mahesh and K. Kuppusamy, "A New Hybrid Video Segmentation Algorithm using Fuzzy C Means Clustering," *J. Comput. Sci.*, vol. 9, no. 2, pp. 229–237, 2012.
- [13] S. Paris, S. W. Hasinoff, and J. Kautz, "Local Laplacian filters: edge-aware image processing with a Laplacian pyramid," *Acm Siggraph 2011*, vol. 58, no. 3, pp. 81–91, 2015.
- [14] M. A. Soeleman, M. Hariadi, and M. H. Purnomo, "Adaptive threshold for background subtraction in moving object detection using Fuzzy C-Means clustering," *TENCON 2012 IEEE Reg. 10 Conf.*, pp. 1–5, 2012.
- [15] C. Fowlkes, "Figure-Ground Assignments in Natural Images," 2017. [Online]. Available: <https://www2.eecs.berkeley.edu/Research/Projects/CS/vision/grouping/fg/>.

### DATASETS

To test the results of image segmentation using the authors' proposed model, the authors used sample dataset images obtained from Berkeley Segmentation Dataset (BSD) [15]. Below is the dataset used for this research and its result from proposed model.



Image Dataset 1



Segmentation Result 1

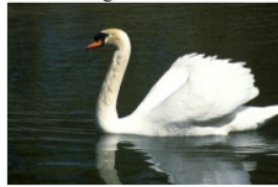


Image Dataset 2



Segmentation Result 2



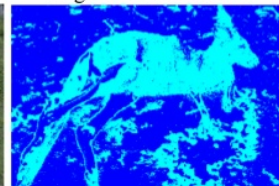
Image Dataset 3



Segmentation Result 3



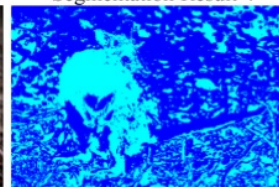
Image Dataset 4



Segmentation Result 4



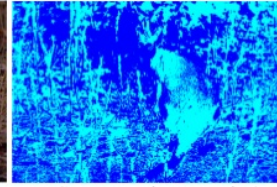
Image Dataset 5



Segmentation Result 5



Image Dataset 6



Segmentation Result 6



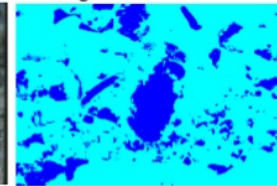
Image Dataset 7



Segmentation Result 7



Image Dataset 8



Segmentation Result 8



Image Dataset 9



Segmentation Result 9

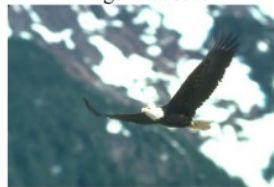


Image Dataset 10



Segmentation Result 10

# Improvement of Fuzzy C-Mean using Local Laplacian Filter for Image Segmentation

---

## ORIGINALITY REPORT

---

|                  |                  |              |                |
|------------------|------------------|--------------|----------------|
| <b>11</b> %      | <b>7</b> %       | <b>10</b> %  | <b>%</b>       |
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

---

## PRIMARY SOURCES

---

- 1** Wildan, Dian Nirmala Santi, Adzhal Arwani Mahfudh, Moch Arief Soeleman. "Image enhancement segmentation Indonesian's Batik based on fuzzy C-means clustering using median filter", 2017 International Seminar on Application for Technology of Information and Communication (iSemantic), 2017  
Publication **2%**
- 2** [www.proceedings.com](http://www.proceedings.com)  
Internet Source **1%**
- 3** Kristiawan Nugroho, Edy Noersasongko, Purwanto, Muljono, Ahmad Zainul Fanani, Affandy, Ruri Suko Basuki. "Improving Random Forest Method to Detect Hatespeech and Offensive Word", 2019 International Conference on Information and Communications Technology (ICOIACT), 2019  
Publication **1%**
- 4** [www.authorstream.com](http://www.authorstream.com)  
Internet Source **1%**



---

|    |  |     |
|----|--|-----|
| 5  | Safira Nuraisha, Fandy Indra Pratama, Avira Budianita, M. Arief Soeleman. "Implementation of K-NN based on histogram at image recognition for pornography detection", 2017 International Seminar on Application for Technology of Information and Communication (iSemantic), 2017<br>Publication | 1%  |
| 6  | <a href="http://www.scribd.com">www.scribd.com</a><br>Internet Source  | 1%  |
| 7  | "Integrated Intelligent Computing, Communication and Security", Springer Science and Business Media LLC, 2019<br>Publication   | 1%  |
| 8  | Fika Ulfa Widowati, Fitriyanto Santi Nugroho, Guruh Fajar Shidik. "Classification of Music Moods Based on CNN", 2018 International Seminar on Application for Technology of Information and Communication, 2018<br>Publication   | <1% |
| 9  | <a href="http://towardsdatascience.com">towardsdatascience.com</a><br>Internet Source  | <1% |
| 10 | <a href="http://krishikosh.egranth.ac.in">krishikosh.egranth.ac.in</a><br>Internet Source  | <1% |
| 11 | <a href="http://0-www-crossref-org.pugwash.lib.warwick.ac.uk">0-www-crossref-org.pugwash.lib.warwick.ac.uk</a><br>Internet Source  | <1% |

---

12

[lecturer.ukdw.ac.id](http://lecturer.ukdw.ac.id)

Internet Source

&lt;1%

13

[www.ijeat.org](http://www.ijeat.org)

Internet Source

&lt;1%

14

[mafiadoc.com](http://mafiadoc.com)

Internet Source

&lt;1%

15

T. Logeswari, M. Karnan. "Hybrid Self Organizing Map for Improved Implementation of Brain MRI Segmentation", 2010 International Conference on Signal Acquisition and Processing, 2010

Publication

&lt;1%

16

Eri Eli Lavindi, Edi Jaya Kusuma, Guruh Fajar Shidik, Ricardus Anggi Pramunendar, Ahmad Zainul Fanani, Pujiono. "Neural Network based on GLCM, and CIE L\*a\*b\* Color Space to Classify Tomatoes Maturity", 2019 International Seminar on Application for Technology of Information and Communication (iSemantic), 2019

Publication

&lt;1%

17

Dinda Aulia Gustian, Nur Laelatul Rohmah, Guruh Fajar Shidik, Ahmad Zainul Fanani, Ricardus Anggi Pramunendar, Pujiono. "Classification of Troso Fabric Using SVM-RBF Multi-class Method with GLCM and PCA

&lt;1%

# Feature Extraction", 2019 International Seminar on Application for Technology of Information and Communication (iSemantic), 2019

Publication

---

---

Exclude quotes      Off

Exclude matches      Off

Exclude bibliography      On