25._Extraction_of_Ultrasonography_Images.pdf

by

Extraction of Ultrasonography Images Using Ratio of Geometric Operations

Retno Supriyanti
Jenderal Soedirman University, Purwokerto, Indonesia
Email: retno_supriyanti@unsoed.ac.id

Ades Wahyu Dwi Susilo, Yogi Ramadhani, Arwita Mulyawati, and Haris B. Widodo
Jenderal Soedirman University, Purwokerto, Indonesia
Email: {ades.wahyu, yogi, arwita.mulyawati, haris.widodo}@unsoed.ac.id

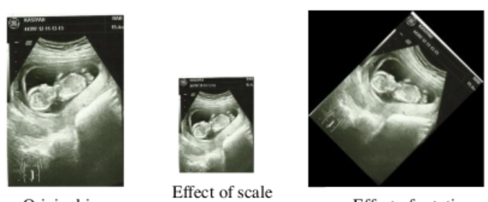
***Abstract*—The use of ultrasonography as a support machine diagnosis in the medical field has been commonly used today. Based on this fact we need accurate information from ultrasonography image. Currently there some kinds of ultrasonography machine such as 2D, 3D or 4D ultrasonography. Although there are many functions of using ultrasonography, however, the largest use of ultrasonography is for prenatal care. In this research we use 2D ultrasonography because this kind of ultrasonography is widely available in the developing countries. In other hand, there many researches about exploring ultrasonography images. In this paper we will do a comparative analysis study for ultrasonography image especially focus on uterus area by comparing moment values produced by central moment, spatial moment and invariant moment. Extraction analysis will be implemented to geometric operation such as rotation, translation and scale. The result show that invariant moments feature is the best choice for exploring information about ultrasonography images especially information about uterus region.**

***Index Terms*—ultrasonography, prenatal care, geometric operation, central moment, spatial moment, invariant moment**

I. Introduction

Today, ultrasonography is one of the most widely used imaging technologies in medicine. It is portable, free of radiation risk, and relatively inexpensive when compared with other imaging modalities, such as magnetic resonance and computed tomography [1]. In the medical field, ultrasonography is used for diagnosing a body part that is built up of fluid. Usually ultrasonography is used in cardiology, endocrinology, gynecology, obstetrics, ophthalmology, urology, intravascular ultrasound, contrast enhanced ultrasound. Although there are many functions of using ultrasonography, however, the largest use of ultrasonography is for prenatal care. By using an ultrasonography, a doctor could monitor a fetus hidden in the womb whether a fetus is at risk or no. If the fetus is at risk, a doctor could make an intervention to save both mother and fetus [2]. Considering the significance of ultrasonography images for diagnosis purposes, it is necessary for extracting all information in the image so there is no wrong diagnosis. One of the methods is to perform geometric operations in the image.

In the field of image processing, an object often assumed as a set of pixels in an image. In order to recognize an object we need to define object properties. Definitions a shape by Larsen [3] is a geometric information remain when the effects of location, scale, and screening is done on an object. Descriptor is a set of parameters that represent certain characteristics of the object, which can be used to declare object features. Fig. 1 describes an example of geometric operation in an ultrasonography image.



Original image   Effect of scale   Effect of rotation

Figure 1. An example of geometric operation

An object features extraction can be done by various methods, both statistical and syntactic. There are several methods for acquiring object characteristics such as central moment, spatial moment and moment invariant. The values of moment could be used as a value for classifying in pattern recognition. Moment values could be used to describe an object in terms of area, position, orientation, and other defined parameters. By getting moment values, an object could be identified even if the object has undergone a shift, rotation and scale changes.

There are some researches about using moment values in the image processing field. Sofyan [4] tested the performance of invariant moments for identifying a number of objects that undergo rotation and reflection. In His research He conducted an evaluation study of two objects with different conditions. The first object using edge area information only whiles the second object using the whole area information. Bahri [5] discussed about comparison between Hu invariant method and

Manuscript received May 1, 2014; revised July 17, 2014..

doi: 10.12720/jomb.4.3.206-212

Fourier descriptor in the field of pattern recognition under variations of image resolution as well as the influence of the scale, rotation and translation of the image recognition. Yap [6] proposed a new set of orthogonal moments based on the discrete classical Krawtchouk polynomials. These properties make the Krawtchouk moments well suited as pattern features in the analysis of two-dimensional images. It is shown that the Krawtchouk moments can be employed to extract local features of an image, unlike other orthogonal moments, which generally capture the global features. Flusser [7] reviewed various types of moments (geometric moments, complex moments) and moment-based invariants with respect to various image degradations and distortions (rotation, scaling, affine transform, image blurring, etc.) which can be used as shape descriptors for classification. Liao [8] In this research He derived the new techniques to increase the accuracy and the efficiency in moment computing. Based on these developments the significant improvement on image reconstructions via Legendre moments and Zernike moments has been achieved. The effect of image noise on image reconstruction the automatic selection of the optimal order of moments for image reconstruction from noisy image and the usage of moments as image features for character recognition are analysed as well. Shu [9] discussed about the basic formulations of moments, a classification and an introductory bibliography. The moment based approaches have a number of interesting features. They have a wide range of orthogonal and non-orthogonal basis functions and are simple to compute whatever the order required. The image sampling can be either rectangular or polar, based on uniform or non-uniform lattices. Their optimal choice to deal with a given problem is however not obvious according to the requirements to face.

According to the explanation above, although there are many researchers discussed about using moment values in the image processing field, but almost these methods is implemented to the ordinary image not to the medical images produced by ultrasonography. This paper will discuss about using moment values to extract all information inside image produced by ultrasonography especially for extracting information from uterus area in order to support accurate diagnostic.

Supriyanti [10] comparing some edge detections methods for localizing uterus area. Continued by Supriyanti [11] discuss about using template matching for noisy digital images produced by low-resolution ultrasonography device especially for localizing uterus region. In this research, we will do a comparative analysis study for ultrasonography image especially focus on uterus area by comparing moment values produced by central moment, spatial moment and invariant moment. Extraction analysis will be implemented to geometric operation such as rotation, translation and scale. It is expected to know the initial process of pattern recognition for uterus area produced by ultrasonography image and to know the characteristics of this image for further analysis.

II. Methodology

A. Data Acquisition

In this research we use image data produced by low resolution ultrasonography. We use 2- D ultrasonography because the main goal of this research is to improve performance of image produced by low resolution ultrasonography. The main research is that kind of equipment available in most area in Indonesia including for rural area. It is expected by implementing this method we can reduce the maternal mortality in Indonesia because diagnostic supporting by accurate information from low resolution ultrasonography images.

B. Flow Chart

Basically, our steps during experiment are divided into nine steps as described in Fig. 2.

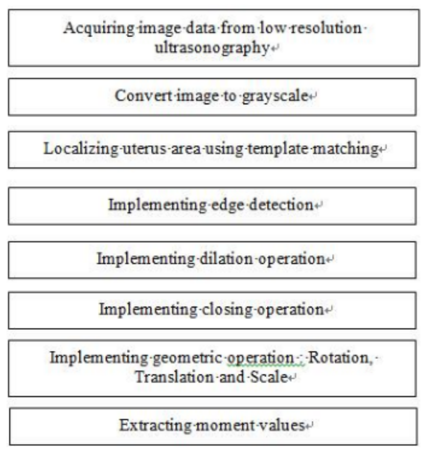


Figure 2. Steps of experiment

C. Spatial Moment and Central Moment

Based on explanation by Kadir [12] spatial moment order (m,n) is defined by Equation 1.

$$M_{ij} = \sum_{x=1}^{M}\sum_{y=1}^{N} x^i y^j I(x,y) \qquad (1)$$

In which:

i, j = 0, 1, 2..., in which i j stated order moment
M stated the number of column
N stated the number of row
X stated the pixel ordinat
Y stated the pixel axis
I(x,y) staed pixel intensity at (x,y) position

The central moment is calculated spatial moment relative to the center of mass. If the center of mass is $(\bar{x}, \bar{y})$ central moments are written as described in Equation 2:

$$\mu_{ij} = \sum_{x=1}^{M}\sum_{y=1}^{N} (x-\bar{x})^i (y-\bar{y})^j I(x,y) \qquad (2)$$

D. Invariant Moment

Invariant moment usually is used as a feature in image processing, remote sensing, pattern recognition and classification. Moment could provide object characteristics that uniquely represent its shape. Invariant shape recognition is done by classification within the multi-dimensional invariant moment features [12]. Traditionally, invariant moments are calculated based on information provided by the boundary shape and the interior regions. Moment invariant moments are used to form a well-defined continuous but for practical implementation, discrete moments computed. Given a function f (x, y), is defined by the moment as Equation 3.

$$M_{pq} = \iint x^p y^q \, f(x,y)\, dx dy \qquad (3)$$

M_{pq} is a two-dimensional moment of the function f (x, y). Order moment is (p + q) where p and q are natural numbers. For implementation in digital form, then this equation becomes described as Equation 4.

$$M_{pq} = \sum_x \sum_y x^p y^q \, f(x,y) \qquad (4)$$

To normalize the translational invariant in the image plane, the image centroid is used determines the central moment. Coordinates of the center of gravity of the image is calculated using the above equation and is given by Equation 5:

$$\bar{X} = \frac{M_{10}}{M_{00}} \bar{Y} = \frac{M_{01}}{M_{00}} \qquad (5)$$

Furthermore, the central moment can be determined discrete as Equation 6.

$$\mu_{pq} = \sum_x \sum_y (x - \bar{x})^p (y - \bar{y})^q \qquad (6)$$

And then, Moment normalized for the effect of changes in scale by using Equation 7.

$$\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}{}^{\gamma}} \qquad (7)$$

where the normalization factor $\gamma = \left(\frac{p+q}{2}\right) + 1$, based on normalization of centre moment, 7 values could be calculated by Equation 8 to Equation 14.

$$\phi_1 = \eta_{20} + \eta_{02} \qquad (8)$$

$$\phi_2 = (\eta_{20} - \eta_{02})^2 + 4\eta^2{}_{11} \qquad (9)$$

$$\phi_3 = (\eta_{30} - 3\eta_{12})^2 + (\eta_{03} - 3\eta_{21})^2 \qquad (10)$$

$$\phi_4 = (\eta_{30} + \eta_{12})^2 - (\eta_{03} + \eta_{21})^2 \qquad (11)$$

$$\phi_5 = (3\eta_{30} - 3\eta_{12})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (\eta_{21} - \eta_{03})(\eta_{21} + \eta_{03})x[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] \qquad (12)$$

$$\phi_6 = (\eta_{20} - \eta_{02})[(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] + 4\eta_{11}(\eta_{30} - \eta_{12})(\eta_{21} + \eta_{03}) \qquad (13)$$

$$\phi_7 = (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{12} - \eta_{30})(\eta_{21} + \eta_{03})x[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{30})^2] \qquad (14)$$

E. Geometric Operations

Based on explanation from Kadir [12], a geometric operation is performed in an image geometrically such as rotation, transition and scaling. There is geometric mapping which are states the mapping relationship between pixels in the input image and pixels in the output image. Basically there are two ways that can be used, first is forward mapping and second is backward mapping as described in Fig. 3.

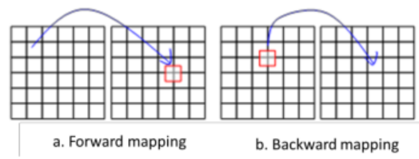


Figure 3. Geometric operations (source: Kadir, 2012)

Translation is an operation for moving each pixel in the input image (x1,y1) to a new position in the output image (x2,y2) accordance to the translation value (p,q) [12]. Fig. 4 described an example of Translation in our experiment.

Original image Result of translation

Figure 4. Translation operation

Rotation is transformation geometry to move the pixel values from the initial position (x1, y1) to the end position (x2, y2) and determined by angle θ to center coordinate (m,n) [12]. Fig. 5 described an example of rotation operation in our experiment.

Original image Rotation with θ = 30°

Figure 5. Rotation operation

Scaling is a geometric operation to enlarge or reduce size of input image accordance to the ratio scale. Fig. 6 described an example of scaling with ratio 0.5.

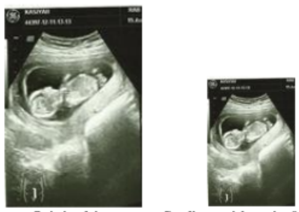


Figure 6. Scaling operation

F. Image Segmentation

Image segmentation is the process to get the objects contained in the image or split the image into several regions with each object or area that have similar attributes. In the image contains only one object, the object is distinguished from the background [12]. Referring to our previous work [10], in this research we implement Sobel edge detection method to localize uterus area. This ultrasonography image has a characteristic shape and area which has a difference of pixels, lines and contours are very significant. Uterus area itself has a different value of contrasts information with the background area. Therefore, changes in the contrast between uterus area and the background area could be detected by Sobel operator to calculate the gradient of the image.

Quantity used in this phase is a fudge factor which is has value = 3. Fudge factor is a quantity that is added or subtracted in order to improve the accuracy of scientific measurements [12]. The reason for using fudge factor = 3 because this value generate edge detection according to what researchers expected. Fig. 7 describes an example of segmentation process result.

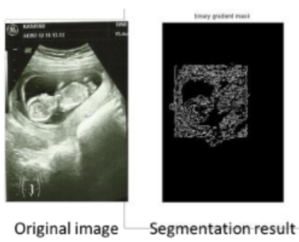


Figure 7. An example of segmentation process

G. Image Morphology

Morphology is an image processing technique that is based on processing in the form of a segment or region of the image. Morphological operations apply a structuring element to insert an image, forming an output image with the same size as the image inserted. In morphological operations, the value of each pixel in the output image is based on a comparison of the pixels around it. By determining the size and shape of the neighborhood, we can construct a morphological operation that is sensitive to a specific form of the input image [12]. An example of morphological operations is dilation operation. Dilation is an operation adding pixels to the boundaries of an object in an image so that the image results are larger in size than the original image. Dilation operation was used to get the effect of widening the pixels value 1.

Another morphological operation is closing. Closing is a combination of morphological operations where an image subjected to a dilation operation followed by erosion operation. Fig. 8 describes an example of morphological operation in our experiment.

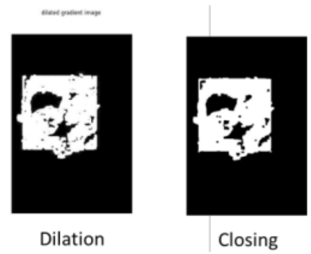


Figure 8. An example of morphological operation in our experiment

III. Results and Discussions

A. Spatial Moment Feature Extraction

The first step in our analysis is extracting spatial moment features in a normal condition, and the some results are described in Fig. 9.

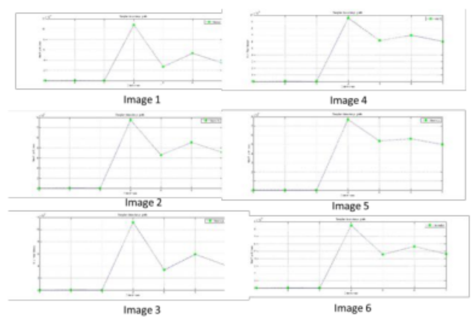


Figure 9. Spatial moment extraction in a normal condition

According to Fig. 9, it can be seen that each image has different spatial moment values and order. Each image has a unique characteristic that can be used to distinguish one image to other. This experiment aims to investigate spatial moment characteristic of ultrasonography image when extracting to geometric operation such as rotation, translation and scaling. Therefore, after extracting spatial moment in a normal condition then we extract spatial moment after we did a geometric operation. Firstly we perform geometric operation as described in Fig.10.

According to fig. 10, in the rotation operation we did two kinds rotation, the first is using θ=45 and second using θ=90 in order to investigate whether the difference spatial moment value at different angle. In the scaling operation we reduce the size of image by ration 0.5 to the original size. While for translation operation, we shift 25 pixels both horizontal and vertical. In order to investigate the difference condition of spatial moment feature between normal and geometric operation treatment, we use a graph to present result as described in Fig. 11.

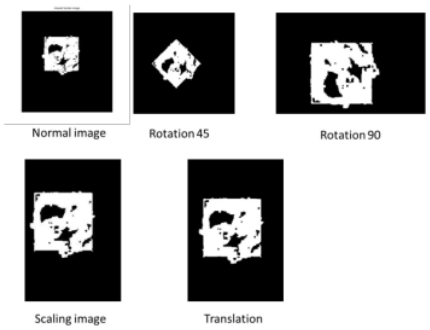


Figure 10. Geometric operations in our experiments

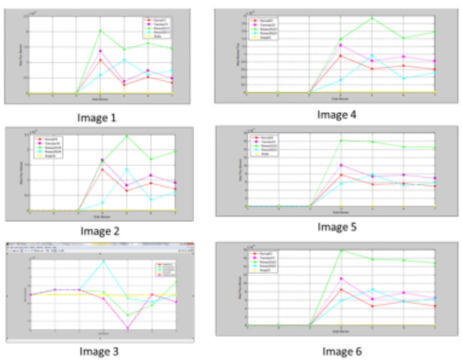


Figure 11. Spatial moment extraction after geometric treatment

By using graphic presentation on each treatment we can investigate whether geometric operation will be influenced or no to the feature extraction. According to the results as described in Fig. 11, it can be seen that spatial moment values a highly affected by rotation, translation and scaling. It can be proved by values changing in each order.

According to the results in this experiments as described in Fig. 11, we conclude that by extracting spatial moment feature of ultrasonography images have been processed to order η1, η2 and η3 show the same characteristics in the treatment rotation 90 degrees, scaling and translation. However in the rotation 45 degrees, we obtained different value of spatial moment.

Based on the results both in Fig. 9 and Fig. 11, we obtained that spatial moment values is changing after geometric operation treatment. Therefore we conclude that we could not use spatial moment features in the field of pattern recognition or shape recognition of ultrasonography images.

B. Centre Moment Features Extraction

Central moment is a spatial moment computed relative to the center of mass, or can also be interpreted central moment is the moment corresponding to the central area. As we did in the extraction of spatial moment, first we extract center moment features in a normal condition and the results are described in Fig. 12.

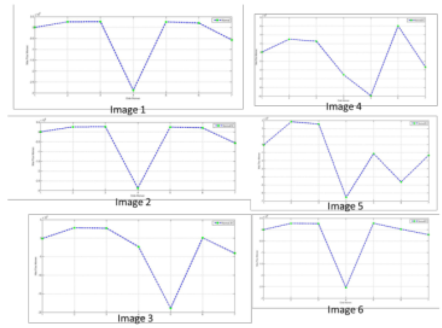


Figure 12. Centre moment extraction in normal condition

According to Fig. 12, each image has different center moment values and also in the different order also has different value. Each image has unique information that could be distinguish with other image. As we did in the previous experiment about spatial moment, we also extract center moment features after we did geometric operation and the results are described in Fig. 13.

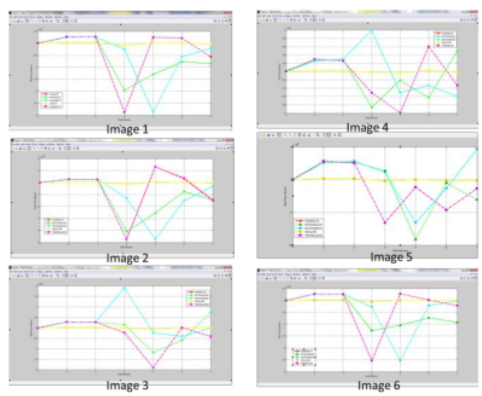


Figure 13. Centre moment extraction after geometric operations

According to Fig. 13, center moment values is affected by geometric operation especially for rotation and scaling, however center moment values is not affected by translation operation. Based on the value of the central moments features are obtained in the image processing translation or shift that the treatment is done does not affect the value of the central moments can be seen from the graph characteristic of the normal condition and translation operation. Regarding to the scaling operation, the results show that there are different graph characteristic between normal condition and after rotation operation. It can be seen by the striking graph between both conditions. In the treatment of rotation operation 45 degrees there are different characteristic between normal condition and geometric operation. However, in the rotation 90 degrees, the results show that there is striking different between normal condition and geometric operation, but when we did a deeply investigation, the result shows that graph characteristic of rotation 90 degrees is the reverse values of the center moment values in the normal condition.

C. Invarian Moment Features Extraction

Invariant shape recognition is done by classification within the multi-dimensional invariant moments features. Several techniques have been developed about the decline of the moment invariant features for object representation and object recognition. In this experiment, we did the same steps with previous experiments about spatial moment and center moment. Firstly we extract invariant moment features in the normal condition and the results are described in Fig. 14.

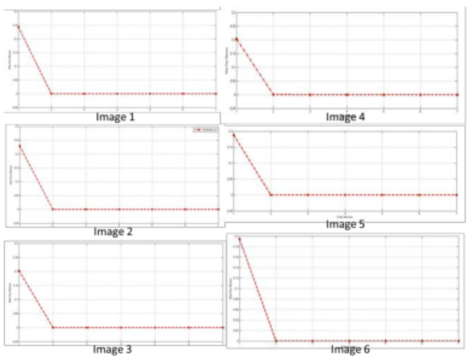


Figure 14. Invariant moment extraction in normal condition

According to Fig. 14, each image has a unique characteristic that can be used to distinguish with other image. Each image has different graph characteristic, but all graphs tend to be processed in the below zero value. Furthermore, we did invariant moment features extraction to images which is implemented geometric operation as the previous experiments about spatial moment and center moment. The results are described in Fig. 15.

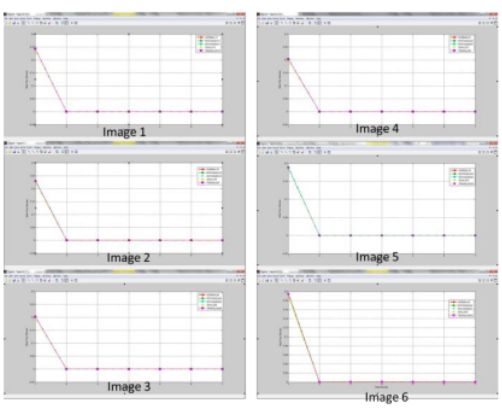


Figure 15. Invariant moment extraction after geometric operation

According to Fig. 15, graph characteristics between normal condition and after geometric conditions have the same type. In general, graph characteristics of all treatments both normal condition and geometric operations have the same characteristics and unaffected by geometric operation treatment. The graph shows that, invariant moment feature values of each image have the characteristics of each, with the values representing the moment's features of the seventh-order moments of its invariant. From the above results, by comparing the value of the invariant moment's features on each of the seven treatment-order moments it will have a value of its own characteristics. In the treatment of translation or shift of 25 pixels to the normal conditions showed that the resulting value of moment features are exactly same. This shows that the operation of the translational invariant moments make the operation not valid or does not affect the value of the extraction results held on the seventh image. While in the scaling operation, graph has the same characteristic in second order to seventh order. However, when compared in the value of the results obtained there are relatively small differences in the value of the seventh-order moments on each image. Comparison between invariant moment features in the normal condition and rotation 45 degrees there is a relatively small difference in the value of the seventh-order moments are extracted. While in rotation 90 degrees, both conditions have similar characteristics although in the third order and seventh order have different value moment features. Based on this analysis, we could conclude that invariant moment is not affected by geometric operations.

IV. CONCLUSIONS

Based on the discussion above, we could make conclusions as follows: (1) In order to obtain the values of the features contained in an image, we have to do a segmentation process for separating objects that are focused with the background. (2) Ultrasonography images have different moment values each other in order to distinguish each of them. (3) Spatial moment features is affected by geometric operation because moment values between normal condition and after geometric operation rotation 45 degrees, 90 degrees, scaling and translation have a large different value. (4) Centre moment features in some conditions are affected by geometric operation especially for rotation 45 degrees, rotation 90 degrees and scaling. However, it is unaffected for translation operation. (5) Invariant moment features is unaffected by all geometric operation therefore invariant moment features is the best choice for extracting information of ultrasonography images in order to make a feature for object recognition.

ACKNOWLEDGMENT

We would like to thank you so much to Radiology Department of Banyumas General Hospital for their permission and willingness to take several data for our experiments. Also this work is supported by Directorate General of Higher Education through Hibah Strategis Nasional (STRANAS) with contract number 2407/UN23.10/PN/2014

REFERENCES

[1] V. Chan and A. Perlas, "Atlas of ultrasound-guided procedures in interventional pain management," *Springer Science and Business Media*, 2011, pp. 13-19.

[2] J. C. Mose, U. Sabarudin, J. S. Efendi, and A. Pribadi, "Ultrasonography dasar obstetri dan ginekologi," Obgin FK Unpad, 2009

[3] R. Larsen, M. B. Stegmann, S. Darkner, S. Forchhammer, T. F. Cootes, and B. K. Ersbøll, "Texture enhanced appearance models, computer vision and image understanding," Elsevier, vol. 106, 2007, pp. 20-30.

[4] M. S. Thayf, "Evaluasi kinerja momen invarian untuk pengenalan objek," Thesis, Gadjah Mada University, 2008

[5] Z. Bahri, "Perbandingan metode moment invariant hu dan metode deskriptor fourier dalam pengenalan pola karakter," Thesis, Riau University, 2012

[6] P. T. Yap and R. Paramesran, "Image analysis by krawtchouk moments," *IEEE Transactions on Image Processing*, vol. 12, no. 11, November 2003

[7] F. Jan, "Moment invariants in image analysis," in *Proc. World Academy of Science, Engineering and Technology*, vol. 11, February 2006.

[8] S. X. Liao, 'Image analysis by moments," Thesis, University of Manitoba, 1993.

[9] H. Z. Shu, L. M. Luo, and J. L. Coatrieux, "Moment-based approaches in image," *IEEE Engineering in Medicine and Biology Magazine*, 2007

[10] R. Supriyanti, D. A. Putri, E. Murdyantoro, and H. B. Widodo, "Comparing edge detection methods to localize uterus area on ultrasound image," in *Proc. International Conference on Instrumentation, Communication, Information Technology and Biomedical Engineering*, Bandung, November 2013.

[11] R. Supriyanti, I. A. Pradana, E. Murdyantoro, and H. B. Widodo, "Localizing uterus region from low-resolution ultrasonography device using template matching method," in *Proc. 3rd International Conference on Bioinformatics and Biomedical Science*, Copenhagen, June 2014

[12] Kadir, Abdul dan Susanto, Adhi, "Pengolahan citra teori dan aplikasi," Penerbit ANDI, 2012.

Retno Supriyanti is an academic staff at Electrical Engineering Department, Jenderal Soedirman University, Indonesia. She received her PhD in March 2010 from Nara Institute of Science and Technology Japan. Also, she received her M.S degree and Bachelor degree in 2001 and 1998, respectively, from Electrical Engineering Department, GadjahMada University Indonesia. Her research interests include image processing, computer vision, pattern recognition, biomedical application, e-health, tele-health and telemedicine

Ades Wahyu Dwi Susilo received his Bachelor degree from Electrical Engineering Department, Jenderal Soedirman University Indonesia. His research interest is Image Processing

Yogi Ramadhani is an academic staff at Electrical Engineering Department, Jenderal Soedirman University, Indonesia. He received his MS Gadjah Mada Universirt Indonesia, and his Bachelor degree from Jenderal Soedirman University Indonesia. His research interest including Computer Network, Decision Support Syetem, Telemedicine and Medical imaging.

Haris Budi Widodo is an academic staff at Public Health Department, Jenderal Soedirman University, Indonesia. He received his Ph.D fromAirlangga University Indonesia. Also He received his M.S degree and bachelor degree from Gadjah Mada University Indonesia. His research interest including public health, e-health and telemedicine

Arwita Mulyawati is an academic staff at Public Health Department, Jenderal Soedirman University, Indonesia. She received her Bacehelor Degree from University Indonesia and her Master Degree from Diponegoro University. Her research interest including public health and e-health.

25._Extraction_of_Ultrasonography_Images.pdf

ORIGINALITY REPORT

15%	9%	10%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Brawijaya Student Paper	3%
2	publications.waset.org Internet Source	1%
3	Ahmed Kamel, Zenat El-Sabbagh, Ali Ali. "ROLE OF ULTRASONOGRAPHY AND COLOR DOPPLER IMAGING IN IDENTIFICATION OF THYROID NODULES SUSPICIOUS OF MALIGNANCY FOR FINE NEEDLE ASPIRATION", Ain Shams Medical Journal, 2021 Publication	1%
4	Tao Tang, Xiao Wang, J. Carbonara, Zhixin Shi. "Feature shape and elevation based road classification and extraction on high spatial resolution remote sensing imageries", 2009 17th International Conference on Geoinformatics, 2009 Publication	1%
5	Jiasong Wu, Shijie Qiu, Youyong Kong, Yang Chen, Lotfi Senhadji, Huazhong Shu.	1%

"MomentsNet: A simple learning-free method for binary image recognition", 2017 IEEE International Conference on Image Processing (ICIP), 2017
Publication

6	Frank Y. Shih. "Image Processing and Pattern Recognition", Wiley, 2010 Publication	1 %
7	journal.uad.ac.id Internet Source	1 %
8	icbfe.org Internet Source	1 %
9	Lecture Notes in Computer Science, 2012. Publication	1 %
10	Submitted to University of Newcastle upon Tyne Student Paper	1 %
11	Submitted to Manipal University Student Paper	1 %
12	www.ijcaonline.org Internet Source	1 %
13	S.X. Liao, M. Pawlak. "On image analysis by moments", IEEE Transactions on Pattern Analysis and Machine Intelligence, 1996 Publication	<1 %

14 Rangkuti. "CONTENT BASED BATIK IMAGE RETRIEVAL", Journal of Computer Science, 2014 <1%

Publication

---

15 "Advances in Multimedia Modeling", Springer Science and Business Media LLC, 2010 <1%

Publication

---

16 Submitted to University of Central England in Birmingham <1%

Student Paper

---

17 Hongwei Lu, Wei Xia. "A Robust Binary Image Watermarking Based on Wavelet Domain and Krawtchouk Moments", 2009 International Conference on Research Challenges in Computer Science, 2009 <1%

Publication

---

18 Retno Supriyanti. "Technology supporting health services for rural areas based on image processing", Journal of Physics: Conference Series, 2019 <1%

Publication

---

19 A.J. Noraini, P. Raveendran, N. Selvanathan. "A Comparative Analysis of Feature Extraction Methods for Face Recognition System", 2005 Asian Conference on Sensors and the International Conference on New Techniques <1%

in Pharmaceutical and Biomedical Research, 2005
Publication

20	www.ijmlc.org Internet Source	<1 %
21	"Protein Conformational Dynamics", Springer Science and Business Media LLC, 2014 Publication	<1 %
22	Lecture Notes in Computer Science, 2005. Publication	<1 %
23	Submitted to Universiti Malaysia Sabah Student Paper	<1 %
24	core.ac.uk Internet Source	<1 %
25	vbook.pub Internet Source	<1 %
26	N Aini, B Sustriawan, V Prihananto, T Heryanti. "Characteristics of cheese analogue from corn extract added by papain and pineapple extract", IOP Conference Series: Earth and Environmental Science, 2019 Publication	<1 %
27	www.sersc.org Internet Source	<1 %