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Indonesian Sign Language Recognition Based on Shape of Hand Gesture

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Abstract

In this research the proposes a method of recognition of BISINDO letters based on hand-shape features that hint every shape of BISINDO Letters. In outline, this method is divided into two parts: the first is part of formation database shape features of BISINDO letters A-Z and the second is part of BISINDO letters recognition. In the first section consist of hand-shape image acquisition that hint every BISINDO letters, segmentation process, edge detection process, feature extraction process that is probability value of hand-shape chain code occurrence and process of database feature formation. In the second section is consist of hand-shape image acquisition process as BISINDO letters query followed by segmentation process, edge detection process, hand-shape feature extraction and recognition process by using calculation difference in distance between query shape feature to each shape feature in database feature. The image acquisition process in two parts above conducted directly (real time) via Webcam connected to the computer device. The method above has been implemented into prototype of Bisindo letters recognition software interface. The experiment results show the accuracy level of BISINDO letter recognition (26 BISINDO letters A to Z) which is reaching above 95%.

Keywords: BISINDO; Segmentation; Edge Detection; Shape Feature Extraction; Shape and Letter Recognition

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1. Introduction

In Indonesia, the dumb uses sign language in communicating. One of the sign languages used is Indonesian Sign Language or known as BISINDO. Sign language communication is conducted by hand. Known 26 handshapes that represent 26 BISINDO letters (A to Z) [1]. The handshape that represents a letter is an important case in the communicative movement because sign language is highly structured and very suitable as a testbed [2, 3].

The dumb can communicate each other but commonly normal people need translators to be able to understand what the meaning of the shape of the dumb hand gestures. Automatic translation of the handshape into alphabetical characters A - Z can be performed with the help of information technology. The shape of hand gestures was acquisitioned into an image and then analyzed with the help of various theories of digital image processing. This research proposes BISINDO letters recognition method based on feature analysis of handshape which represents the BISINDO letters.

2. Related work

Hand gesture recognition technology is grouped into two parts, namely Sign language recognition based on computer vision and Sign language recognition based on sensor data. In this research, we used gestures recognition based on vision, in which the camera is used as an input. Video is captured in the form of video files before being processed by using image processing [4]. The hand gestures recognition has recently become an important field of research focusing on hand gestures recognition [5].

Some studies on sign language in Indonesia, namely Wijayanti et al. [6], conducting a research on words gestures in sign language of SIBI using Kinect. Combining the Decision Tree algorithm and Back Propagation Neural Network (BPGANN) used as the classification method provides the recognition rate of 96% for static gestures. Nicholaus et al [7], conducting a study on BISINDO sign language using Principal Component Analysis (PCA). The results achieved in this research, the recognition rate is 67.65% by using the white wall background and the recognition rate is 53.23% by using the white shirt as background. Asriani, F and H. Susilawati [8], conducting research on SIBI sign language gestures system using BNN (Back Propagation Neural Network) with static hand gestures recognition rate of 69%. Indra et al. conducting a study on BISINDO sign language using Chain Code Contour and Euclidean Distance with static hand gestures recognition and the recognition rate is 94% [9].

3. Proposed method

The analysis method of BISINDO letters recognition based on shape features is shown in Fig. 1. This method consists of two stages: the first stage is the database formation of shape features of BISINDO letters (training stage on the left side) and the second stage is the BISINDO letters recognition based on similarity of shape features (testing stage on the right side). In the first stage consists of five processes, namely pre-processing, segmentation, edge detection, shape feature extraction and database formation. In the second stage consists of five processes, namely the first four processes are the same as in the first stage and the fifth process is BISINDO letters recognition.

3.1. BISINDO alphabet

Image inputs are BISINDO A-Z. BISINDO letter images can be represented by using one hand and two hands. The BISINDO letters formed by using one hand consists of the letters C, E, I, J, L, O, R, U, V and Z, while BISINDO letters are formed by two hands consist of letters A, B, D, F, G, H, K, M, N, P, Q, S, T, W, X and Y [10]. Some research on the identification of handshape that represents the letters [11, 12, 13]. The images are in Red, Green and Blue (RGB) format and captured from the webcam directly for used as training data and testing data. The images of the training data are stored in a folder inside the computer.

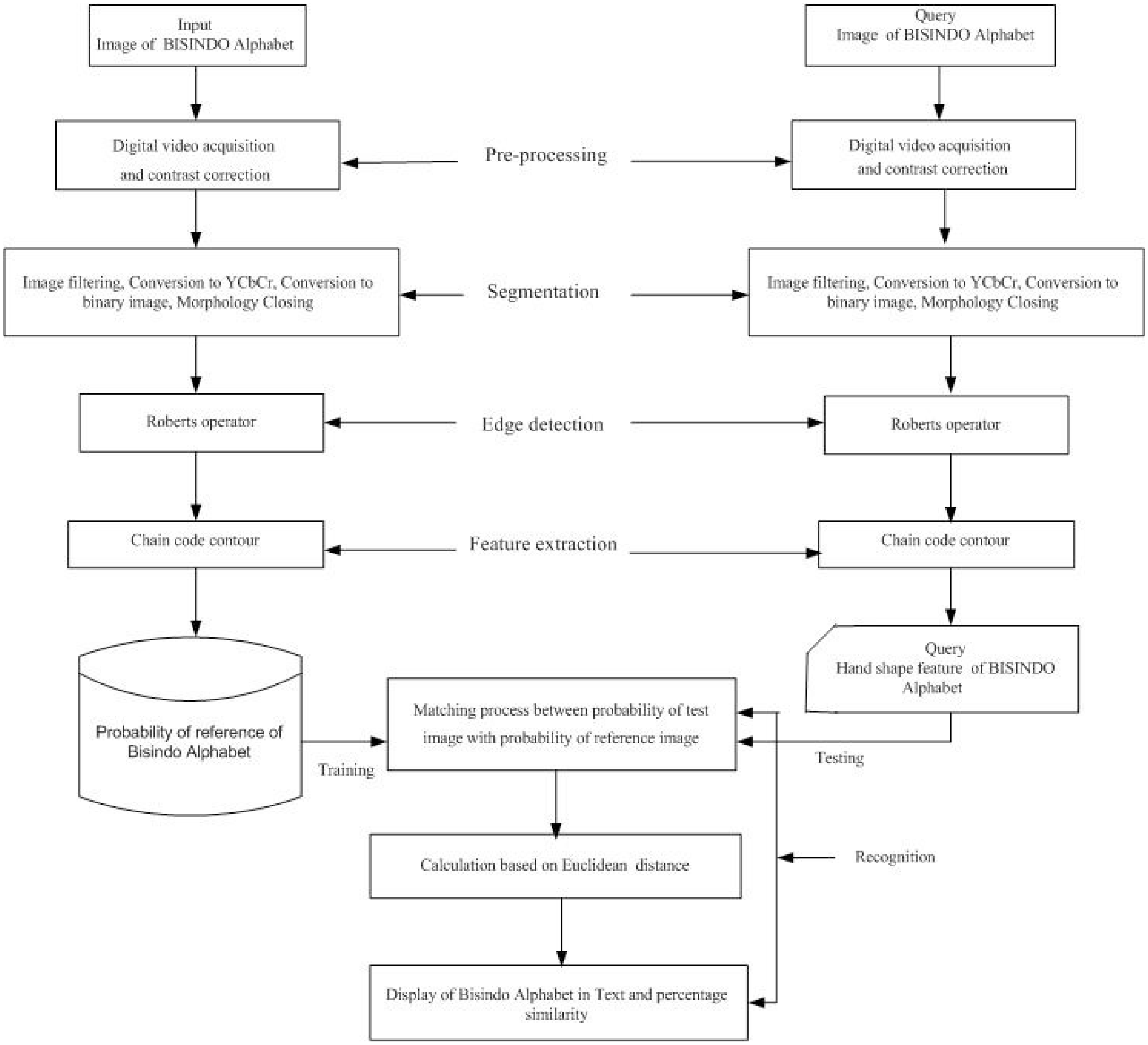

Fig. 1. The proposed system of BISINDO letters recognition.

3.2. Pre-Processing

At this stage, we perform an acquisition of digital video (webcam) and contrast correction. Digital video acquisition uses YCbCr color space format expressed in the format 'YUY2_320x240' producing an image size of 320x240 pixels because this image size already good for generating information about the BISINDO letters image. Furthermore, we set the contrast or color brightness by using gamma correction with value range that is 0 to 1. For the value of γ (gamma) close to 1 will produce darker color image that leads to black, while for the value of γ (gamma) close to 0 then brighter color image that leads to white. Based on the experiment, the value of γ (gamma) in the default setting is 0.5 because this value already good for brightness of image color. This value can be adjusted according to the desired level of precision.

3.3. Segmentation

Color segmentation stage is a process of separation of area in an image based on the color contained in the image. This color segmentation can be used to distinguish human skin color and other object colors including background. This segmentation model uses the YCbCr color space and known as skin detection [14]. Hand skin color detection is the process of separating between skin pixels and non-skin pixels [15]. In this process consist of several processes that is Filtering, Color conversion, Skin area extraction and Morphology closing.

Filtering stage, separation of R (red), G (Green) and B (Blue) components is performed to the image that has been acquisitioned directly by the webcam. The aim is to find the greatest value of each color component. Furthermore, this value is used to perform value scaling of the color components of R, G and B. The output image of this scaling process becomes the input of the filtering process. The filtering process by using the median filter aims to reduce the noise contained in the input image.

Color Conversion stage, conversion of RGB image to YCbCr image which aims to separate the component of luminance Y from chrominance (color components of Cb and Cr) to be easier in skin color analysis.

Skin Area Extraction stage. This process aims to separate the skin and non-skin areas. The color of the skin is marked by two chroma components Cb and Cr at a range of values of $100 \geqslant Cb \leqslant 127$ and $128 \geqslant Cr \leqslant 150$. All pixel values presenting in the range are expressed as part of the skin of the hand and valued as white, while the pixel value beyond the vulnerable will be removed or blackened. The output of this process is a binary image containing the hand-shape object.

Morphology Closing stage. This process is used to perform closure of holes that may exist on the object as a result of the incomplete binary process. The gap width of holes can be closed by setting the structural matrix element that is 5 rows and 5 columns (5x5) with the value of each element is 1.

3.4. Edge detection

The edge detection stage is used to extract the shape of hand edge representing each of BISINDO letters to ease in determining each shape feature. The edge detection process is performed on the image of the morphological process by using Roberts operator.

3.5. Feature extraction

The feature extraction stage is a process to get the shape features of each letter of BISINDO A-Z by using chain code. The chain code used in this research is a neighboring 8-way approach (0-7) based on the Freeman chain code model [16,17]. Furthermore, the probability calculation process is based on the appearance of each chain code because when the image acquisition can be smaller or larger. Changes in the size of the object can cause the chain code length to be different even with the same letter form, so that the chain code becomes independent of changes in the size of the BISINDO letter object, it is necessary to calculate the probability for each chain code shown in Equation 1.

$$Probability\_CC = \frac{Code\_lengt\ \ (i)}{Total\ of\ Code\_length} \tag{1}$$

At this equation 1 where Probability CC is Probability of Chain Code, Code_length(i) is The length of each 8-way chain code and Total of Code_length is Overall length of the 8-way chain code.

3.6. Recognition

The recognition stage is conducted by measuring the similarity level of the shape features between query BISINDO letter and the shape features contained in the database. The similarity of the features measured by using the Euclidean distance [17]. The Smaller value of distance obtained by two letters can be declared as identical or recognizable. Otherwise, the greater value of distance obtained then the two letters are declared different. The Euclidean distance is shown in Equation 2.

$$Euc = \sqrt{\sum (Test\_img - REF\_img)_i^2} \tag{2}$$

At this equation 2 where Euc is Euclidean Distance, Test_img is Test Image and Ref_img is Reference Image.

4. Results and discussion

Fig 2. shows an example of the results of each stage of the proposed method. Fig. 2 (b) is the result of the pre-processing of the original image (Fig. 2 (a)). Fig. 2 (c) is the result of conversion to YCbCr color space of image Fig. 2 (b). Fig. 2 (d) is the result of hand-shape object segmentation representing the BISINDO letter "C". Fig 2 (d) is the result of edge detection by using Roberts operator of the image of segmentation result. These results indicate that the proposed method is able to detect skin color and segmenting the hand-shape based on the color of the skin. Edge of the hand-shape detected clearly visible and connected so the encoding of the shape features will be easier.

(a) (b) (c) (d) (e)

Fig 2. (a) Original Image; (b) Pre-processing result; (c) YcbCr image result; (d); Segmentation result; (e) Edge detection result.

The next stage is the feature extraction process by using the chain code contour method. The result of the shape feature extraction process through tracking and contour following of object is shown in Fig 3. The probability values of each chain code occurrence are used as the shape feature stored in the database.

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1222212121111010100000111000011111121112121222121122112211011010
0010100010111011010110100011010007000700700000707707770777777770
7707665565644444444444454444443443444444454544454544565666656666
6667770700700000000100100000000700707770706654544454544444544454
4544444444444444444544445454544454545454545454444544454544444544444454
55555545445443443434333222222222222222
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Fig. 3. Shape of code chain contour of BISINDO letter "C" in Fig 2 (e).

For instance, the chain code probability features value of letter "C" is shown in Fig. 4. In addition, the number of contours on the object can be used as an additional feature to distinguish the shape of BISINDO letters. In Fig 4, the image at the bottom right side shows the shape of the letter C which has only one contour. The shape of the letter A in Fig. 5 has two contours, i.e one contour is in the larger contour. Furthermore, the letter B in Fig 6. has three contours ie two smaller contours located mutually close and both are in a larger contour. From the experimental results, there are three groups of shape letters based on the number of contours. The groups are given in Table 1.

Table 1. The Contour Number of BISINDO Letters.

BISINDO letters	The contour number
C, E, F, G, H, I, J, K, L, R, S, T, U, V, W, X and Z	1
A, D, N, O, P and Q	2
B and M	3

In order to ease in recognize the BISINDO letters, we have developed a prototype of software interface for BISINDO letters recognition as shown in Fig. 4, Fig. 5, and Fig. 6. This interface is connected directly to the webcam for image acquisition as shown in part of top left side. This image is then processed to find the number of feature contour and the chain code probability of each contour formation of BISINDO letters.

Fig 4. Recognition process results of BISINDO letter "C".

This feature is displayed on the table in the interface. Furthermore, features extracted from the query letters compared to the features of each letter that has been registered in the database. The shape letter "C" in Fig. 4 is recognized with the similarity level of 94.4874 %.

Fig 5. Recognition process results of BISINDO letter "A".

The shape letter "A" in Fig. 5 is recognized with the similarity level of 95.9237 % and the shape letter "B" in Fig. 6 is recognized with the similarity level of 96.835 %.

Fig 6. Recognition process results of BISINDO letter "B".

The testing result for overall recognition of BISINDO letters of A to Z are shown in Table 2. From several experiments, in this table shows the testing results of three different query images for each letter. This experiment results shows that the BISINDO letters recognition system can recognize all the query letters directly (100% recognizable) with an average similarity level of each recognized letters is above 95%.

Table 2. Overall testing of BISINDO letters A to Z.

Letters	1st Testing Similarity rate (%)	2nd Testing Similarity rate (%)	3rd Testing Similarity rate (%)
A	93.9363	97.6455	95.9237
B	94.8868	93.5802	96.8350
C	93.9460	95.3382	94.4874
D	94.0180	96.7040	96.2707
E	95.3493	93.1564	95.8891
F	97.4754	96.7316	95.0863
G	94.2188	95.5366	94.3367
H	95.1153	94.7641	96.4030
I	96.8895	94.2787	93.8514
J	92.6569	96.6478	93.6207
K	93.9637	95.5858	93.6226
L	95.1917	96.2096	93.8598
M	94.9266	94.1713	93.3747
N	98.0860	94.0211	93.4705
O	94.7096	95.3197	95.8775
P	97.9045	96.8709	97.3198
Q	94.9434	95.8844	97.4610
R	97.0361	94.1137	94.5512
S	95.4645	96.3329	95.1820
T	96.8897	96.7703	94.4739
U	96.8965	97.4117	95.3583
V	95.3770	95.7481	95.5378
W	97.2160	96.4569	96.6443
X	97.9551	95.5575	95.4221
Y	96.0608	98.0720	94.3155
Z	95.1328	95.2591	94.5467
Average	95.6249	95.6988	95.1431

5. Conclusion

The proposed method can be segmenting the shape, detecting the contour shape properly, and extracting the shape feature representing the BISINDO letters. The resulting features are the number of contours and the probability value of chain code occurrence. Based on the number of contours, the BISINDO letters are divided into three groups the first, C, E, F, G, H, I, J, K, L, R, S, T, U, V, W, X and Z has one contour, the second, A, D, N, O, P and Q have two contours, and the last B and M have 3 contours. The experimental results show 100% of the query image can be recognized with an average similarity level of above 95%.

References

[1] Shin, Jae-Ho, Jong-Shill Lee, Se-Kee Kil, and Dong-Fan Shen. (2006) "Hand Region Extraction and Gesture Recognition using Entropy Analysis." *IJCSNS International Journal of Computer Science and Network Security* **6** (**2A**): 216 – 222.

[2] Zahoor, Zafrulla, Helene Brashear, and T. Starner. (2011) "American Sign Language Recognition with the Kinect", in *13th International Conference on Multimodal Interfaces*, ACM. pp. 279–286.

[3] Tara, R.Y., P. I. Santosa, and T.B. Adji. (2012) "Sign Language Recognition in Robot Teleoperation Using Centroid Distance Fourier Descriptors." *Int J Comput Appl* **48** (**2**).

[4] Stergiopoulou, E., and N. Papamarkos. (2009) "Hand Gesture Recognition Using A Neural Network Shape Fitting Technique." *Engineering Applications of Artificial Intelligence,* Elsevier, **22** :1141–1158.

[5] Sutarman, M.A., Majid, and J.M. Zain. (2013) "A Review on the Development of Indonesian Sign Language Recognition System." *J Comput Sci* **9** (**11**): 1496–1505.

[6] Wijayanti, N.K., A.S. Yohanes, and S. Nanik. (2017) "Combining Decision Tree and Back Propagation Genetic Algorithm Neural Network for Recognizing Word Gestures In Indonesian Sign Language Using Kinect." *Journal of Theoretical and Applied Information Technology* **95** (**2**): 292-298.

[7] Nicholaus, A.P., W.W. Yustinus, and K. Adhi. (2015) "Sign Language Interpreter Application using Principal Component Analysis Algorithm", in *International Conference on New Media (CONMEDIA)*. pp. 67-72.

[8] Asriani, F, and H Susilawati. (2010) "Static Hand Gesture Recognition of Indonesian Sign Language System Based On Backpropagation Neural Networks." *MAKARA J Technol Series* **14**: 150-154.

[9] Indra, Dolly, S. Madenda, and E.P. Wibowo. (2017) "Recognition of Bisindo Alphabets Based on Chain Code Contour and Similarity of Euclidean Distance." *International Journal on Advanced Science Engineering Information Technology* **7** **(5)**: 1644-1652.

[10] Indra, Dolly, S. Madenda, and E.P. Wibowo. (2017) "Feature Extraction of BISINDO Alphabets Using Chain Code Contour." *International Journal of Engineering and Technology (IJET)* **9** (**4**): 3234-3241.

[11] Zadghorban, Masoud, and Manoochehr Nahvi. (2016) *An Algorithm on Sign Words Extraction and Recognition of Continuous Persian Sign Language Based On Motion and Shape Features of Hands*. London, Springer-Verlag.

[12] Kishore, P.V.V., M.V.D. Prasad, D. Anil Kumar, and A.S.C.S. Sastry. (2016) "Optical Flow Hand Tracking and Active Contour Hand Shape Features for Continuous Sign Language Recognition with Artificial Neural Networks", in *6th International Conference on Advanced Computing*. IEEE. pp. 346-351.

[13] Nagendraswamy, H.S., B.M. Chethana Kumara, and R. Lekha Chinmayi. (2016) "Indian Sign Language Recognition: An Approach Based on Fuzzy-Symbolic Data", in *Intl Conference on Advances in Computing Communications and Informatics (ICACCI)*. IEEE. pp. 1006-1013.

[14] Surampalli, P. Gururaj, J. Dayanand, and M. Dhananjay. (2012) "An Analysis of Skin Pixel Detection using Different Skin Color Extraction Techniques." *International Journal of Computer Applications* **54** (**17**): 1-5.

[15] Shaik, Khamar Basha, P. Ganesan, V. Kalist, B.S. Sathish, and J. Merlin Mary Jenitha. (2015) "Comparative Study of Skin Color Detection and Segmentation in HSV and YCbCr Color Space", in *3rd International Conference on Recent Trends in Computing 2015 (ICRTC-2015) Procedia Computer Science* **57**: 41 – 48.

[16] Mahanty, Mohan, D. Kiranmayi, and P. Chandana. (2015) "Sketch Retrieval using Contour Detection by Chain Codes." *International Journal of Advanced Research in Computer and Communication Engineering* **4** (**10**): 210-213.

[17] Jabr, Zamen Fadhel. (2015) "Hand Palm Recognition using Combination of Freeman Chain Code and Texture Features with Fuzzy Logic Classifier." *IJCSMC* **4** (**3**): 585 – 598.