Hand Contour Recognition In Language Signs Codes Using Shape Based Hand Gestures Methods

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Abstract— **The deaf and speech impaired are loosing of hearing ability followed by disability of developing talking skill in everyday communication. Disability of making normal communication makes the deaf and speech impaired being difficult to be accepted by major normal community. Communication used is gesture language, by using hand gesture communication. The weakness of this communication is that misunderstanding and limitation, it's due to hand gesture is only understood by minor group. To make effective communication in real time, it's needed two ways communication that can change the code of hand gesture pattern to the texts and sounds that can be understood by other people. In this research, it's focused on hand gesture recognition using shaped based hand algorithm where this method classifies image based on hand contour using hausdorff and Euclidian distance to determine the similarity between two hands based on the shortest range. The result of this research is recognizing 26 letters gesture, the accuracy of this Gesture is 85%, from different human hands, taken from different session with different lighting condition and different range of camera from image. It also can recognize 70% different hand contour. The different of this research from other researches is the more the objects are, the less the classification of hands size is. Using this method, hands size can be minimized.**

Keywords— **Hand contour, Gestures, Shape-based hand gesture methods, Hausdorff distance, Euclidean distance.**

I. INTRODUCTION

To communicate with deaf people, it is mostly used sign language or often called Indonesian Gestures Language Systems, i.e. the sign language that uses hand and finger movements. Along with advances in technology, it has developed some methods of learning (self-learning) for speech impaired and deaf people who want to learn to speak.

One of them is a method developed in English by the ABC organization, whereas in Indonesian this method has not been developed. Therefore, the researchers design a learning system for the speech impaired and deaf patients through a software with expectations the patients can perform the learning through computer media [1]. Indonesian with the hand gestures pattern was developed [2] by using an artificial network, with only 69% accuracy rate values. For the encoding, it must use a PC (Personal Computer) in order to overcome the problem on resolution, besides that gestures recognition was limited only 15 words, as well as pattern recognition (hand gesture recognition) used is still static, whereas for hand gesture recognition, it is needed dynamic hand gesture recognition due to the shift patterns of the hand gesture (movement sequences).

Several studies have been developed previously, as done by Rakhman et al. (2010) using the method of tracking haar classifier and classifying image data set to train with K Nearest neighbors algorithms, the system is only able to recognize 19 letters of 26 gestures, the letters that are not be able to be recognized are; M, N, S, T, A and Z. This is due to the level of similarity between the letters signs is high and it is also due to the limitation of using only the same hand image. The purposes are to design a system of sign languages encoded by hand movements in real time for speech impaired and deaf people, by using the technique of hand gesture recognition.

The systems will be useful for speech impaired and deaf people as their two-ways communication. This study was developed using method 1: Feature consists of a hand contour data. Classifier based on the modified Hausdorff distance. Method 2: Feature consists of independent components of the hand silhouette. Classifier is the Euclidean distance. By using this method, the advantage of it, if compared with other studies, is that the more the number of objects (hand contours) are used, the less hand size classification is. Thus, using this method, although there are a lot of subjects to be used, the size of the hands can be minimized.

II HAND SEGMENTATION

Image segmentation is the process of grouping the image into several regions based on certain criteria. In this study the hand segmentation aims to extract the hand region from the background. Segmentation divides two objects, which consist of the hand and the background, but in reality, the accuracy of the segmentation will be reduced because of the presence of rings, cuffs overlap, or rope/chain watches or folds around the boundary due to the slow or strong pressure. Moreover, the depiction of the hand contour must be accurate. It is caused of the difference between the hands of different individuals. Erdem Yoruk and friends had compared two different segmentation methods, namely clustering segmentation method, which is followed by morphological operations, and segmentation based on watershed transformation. Normalization hand image involves registration of a hand image (registering), i.e. the global rotation and translation, as well as the re-orientation of the fingers along the direction of each individual standard, without any distortion of the shapes [4]. In fact, this is the most critical operation for biometry applications based on hand shapes when global features are used. There are also schemes that use only local features for example contour separates the fingers. The need for re-orientation is shown in the figure below [5][6][7].
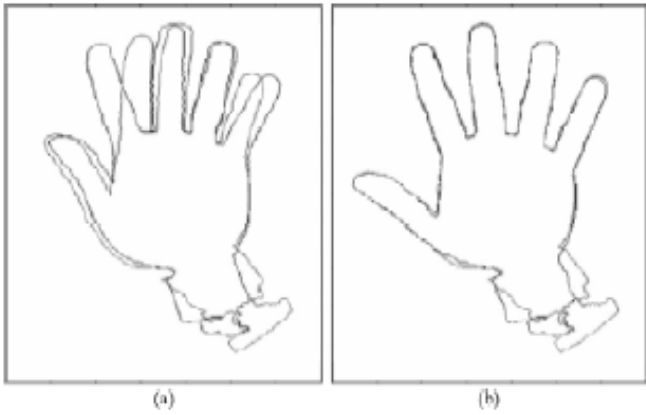
Fig 1 Superposition contour of same individuals hands
(a)   Registration of global hand
(b)   The alignment of fingers after fingers registration

A. *Localizing Extremity Hand*

The figure shows the same hand image, taken at 2 different sessions. The left image is the hand contour after global registration (but no registration finger), while the right image is the result after the registration of a finger. The registration process consists of two stages:

1. Translation of the center of the hand (centroid) such that it coincides with the center/center image.
2. Rotation toward the direction of the larger eigenvector, i.e. the eigenvector corresponds to the magnitude of the eigenvalue of the inertia matrix. Inertia matrix is a simple 2 x 2 matrix of second order central moments of the binary hand center pixel spacing of the center (centroid).

Detecting and localizing extremity hand, the fingertips and valleys between the fingers, is the first step to the hand normalization. Due to the two extremities characterized by high curvature, we first experimented with curve gram contour, i.e. the curvature of the contour plots at various scales along the length path parameter. Nine maxima in curve gram, which is consistent at all scales, is the part that will be searched after hand extremity done. However, this technique is sensitive to contour irregularities, such as the alias and convoluted cavity (kinks), especially around the wrist area that is difficult to translate.
A more powerful alternative technique is given by the plot of the radial distance to the reference point in the area around the wrist. This reference point is taken as the first point of intersection of the major axis (eigen vector of the larger inertia matrix) with the wrist line. Sequence resulting from the minimum and maximum radial distance will correspond to the extreme point is searched. Extreme outcome is really stable because the definition of 5 maxima (fingers) and the minimal 4 are not affected by contour irregularities. The function of the radial distance and typical hand with the extremity contour marked on it are given in the figure below [8][9][10] .
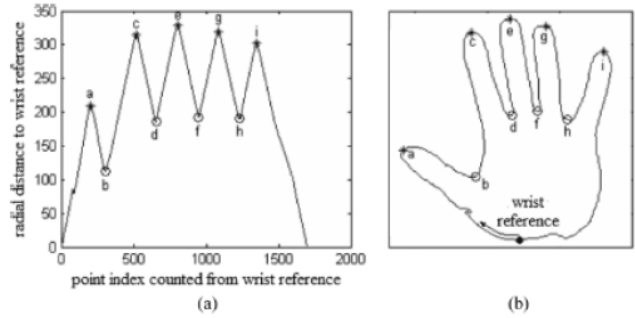

Fig 2 (a) Function of radial distance for fingers extraction and (b) Hand contour with marked extremity

B. *Feature Extraction and Recognition*

There are several options for selecting the features used in order to distinguish between hand-in biometric applications. Erdem Yoruk, Ender Konukoˇglu, Bülent Sankur, 2006 introduced two schemes relative hand recognition that are very different in nature. The first method is based on a measure of distance between the contour that represents the hand, and therefore a shape-based. The second scheme considers the introduction of the whole scene image that contains of normalization hand and background, also apply the subspace method. Thus, the second method can be considered as a method of appearance-based, although the scene is composed of binary hand silhouette normalization. However, this approach can be applied to gray-level image of the hand, which will include hand texture and pattern of palm prints.

In order to compare the different hand geometry, Hausdorff distance is an effective method. According to M.P.Dubuisson, this metric has been used in the binary image and comparison forms and computer vision for a long time. The advantage of Hausdorff distance, when compared with the binary correlation, is the fact that this distance measures the proximity, not the exact superposition, making it more tolerant of disturbance at the location points [8][9][10].

If $F = \left\{ f_1, f_2, \ldots, f_{N_f} \right\}$ and
$G = \left\{ g_1, g_2, \ldots, g_{N_f} \right\},$

whereas $\{f_i\}$ and $\{g_i\}$ shows the two hands contour pixels for
$$i = 1, \ldots, N_f \text{ and } j = 1, \ldots, N_g$$
Hausdorff distance will be determined as:

$$H(F, G) = \max\big(h(F, G), h(G, F)\big),$$

whereas

$$h(F, G) = \max_{f \in F} \min_{g \in G} \| f - g \| \tag{1}$$

In this equation, $\| f - g \|$ is a rule for two sets elements and of course for contour pixels (f, g) that runs for index set
$$i = 1, \ldots, N_f \text{ and } j = 1, \ldots, N_g$$

III. TEMPLATE MATCHING

Template matching is a technique in digital image processing that has function to match each part of an image with the template image (reference). Template matching is a process where a pixel in the image has been made into a grouping of objects and relationships between different objects has been specified, this is the last step in the system recognition of an image object. Adjustments will do a comparison of each object image with a model that has been stored, thus it will be determined the most appropriate similarity between them.

Template matching, a basic pattern recognition, has been used both in the context of the introduction of posture and movement (gesture recognition). In the context of the image, template matching is done by comparison of pixel-by-pixel image of the prototype and the candidate. The similarity of the candidate with the prototype is comparable to the total score on the selected similarity measure. For hand posture recognition, detected hand image forms image candidate that is directly compared with the prototype of hand posture image. The best matching prototype (if any) is considered as a posture matching. Obviously, because of the comparison image uses a pixel-by-pixel, the template matching is not invariant to be scaled and rotated.

Template matching is one of the first methods used to detect hands on images. To overcome the variability due to scale and rotation, some authors have proposed a method of normalization scale and rotation, while others complete the set of prototype with the image of multiple angles. In H.Birk study, hand images for rotation normalized based on the detection of hands and the main axis, then, is scaled based on the dimensions of the hand in the image. Therefore, in this method, it is limited to the hands that move on a planar surface that is front to parallel of the camera. To overcome the computational cost when compared to some of the same prototype angles, the angles are described by the orientation parameter [H.Fillbrandt]. Searching of matching prototype will be accelerated, by searching only the relevant posture with respect to the prototype that was detected in the previous frame. A template that consists of the direction of the edge is used in [W.Freeman and Roth]. Edge image detection performed on isolated hand and edge orientation is calculated. Histogram of orientation is used as a feature vector. Evaluation of this approach shows that the end of the orientation histogram is not very discriminatory, because some of semantically different motion histograms show the same movement [8][9][10].

IV. IMPLEMENTATION

In the study, the software was designed to encode hand sign language. Sign language code of recognition system (hand gesture recognition) used an input from a camera. In this study the object used was a hand (palm and fingers), which is used as the encoding to deliver sign language. Hand sampling conducted in SLBB Palembang, with 10 deaf and speech impaired people.

System testing was conducted to determine the level of accuracy in identifying each image and the hand gesture letters. Tests carried out on 10 images with contours of different hands in the same distance. Table I shows that by

using this system, it is able to recognize hand images with different contours by 70%. From the 10 samples of the hand contours used, 3 hands cannot be recognized, while the rest can be recognized.
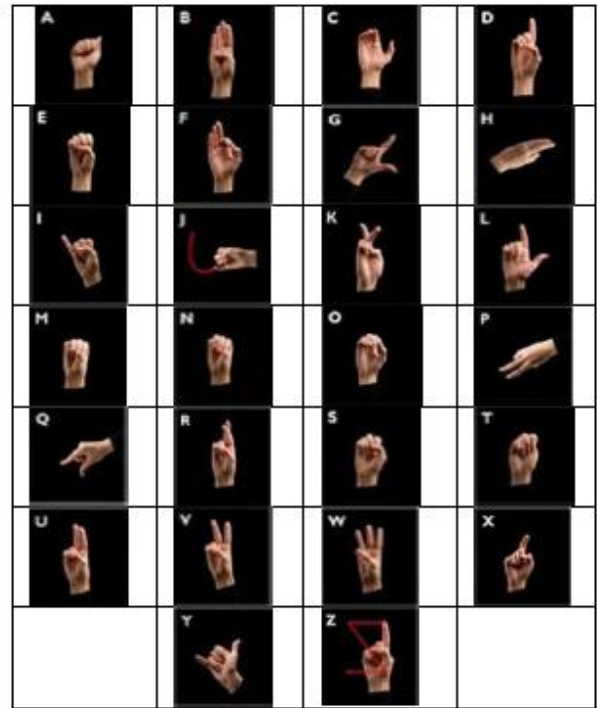

Fig 3 Sample Sign Language Code

TABLE 1
SIGN LANGUAGE CODE RECOGNITION WITH 10 DIFFERENT HAND CONTOUR

Kontur Tangan	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	5	5	5	5	2	5	5	5	5	1	5	5	1	0	5	5	5	5	1	2	5	5	5	5	5	2
2	4	5	4	5	3	5	5	5	5	1	5	5	0	0	5	5	4	5	0	0	5	5	5	5	5	3
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	4	5	5	3	5	5	4	5	0	5	5	1	1	4	5	4	5	1	1	5	5	4	5	5	2
5	4	5	5	5	2	5	5	5	5	1	5	5	2	2	5	5	5	5	2	1	5	5	5	5	5	3
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	5	5	5	5	3	5	5	5	5	1	5	5	2	1	5	5	5	5	1	1	5	5	5	5	4	4
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	5	5	5	5	3	5	5	5	5	2	5	5	2	1	5	5	5	5	2	1	5	5	5	5	5	2
10	4	4	5	5	1	5	5	5	5	0	5	5	2	1	5	5	5	5	2	0	4	5	5	5	5	3

The introduction of code in each sign language can be recognized even if there is not recognized correctly, with a success rate of sign language recognition system correctly is 85%. Where the sign language code J, M, N, S, T and Z are in the small level recognition, this is because the code is rolled down form that makes it be difficult to perform the separation fingers in determining their owned boundaries. The tests of detecting the distance of the hand is done by using a distance of 10 cm to 70cm.

TABLE II
THE TESTS OF DETECTING THE DISTANCE OF THE HAND

Kontur Tangan	JARAK (cm)						
	10	20	30	40	50	60	70
1	x	v	v	v	v	x	x
2	x	v	v	v	v	x	x
3	x	v	v	v	v	x	x
4	x	v	v	v	x	x	x
5	x	v	v	v	x	x	x
6	x	x	v	x	v	x	x
7	x	v	v	v	v	x	x
8	x	x	v	x	v	x	x
9	x	v	v	v	v	x	x
10	x	v	v	v	v	x	x

Various distance measurements will affect the accuracy of recognition, the minimum distance of the objects that cannot be able to be recognized is at 20 cm, while the maximum distance is at 60 cm, it is due to the reduction and enlargement of the region of interest (ROI) that form imperfect image.

V. CONCLUSION

a. The results of the tests performed system can recognize 26 letters gestures language, the accuracy of hand gesture recognition code language of the different contour hands is 70%.

b. The introduction of code in each sign language can be recognized even if it is still not recognized correctly, the correctly sign language recognition system success rate is 85%. The sign language code J, M, N, S, T and Z are in the small level recognition, it is because of the code is rolled down form that makes it be difficult to perform the separation fingers in determining their owned boundaries.

c. Various distance measurements will affect the accuracy of recognition, the minimum distance of the objects that cannot be able to be recognized is at 20 cm, while the maximum distance is at 60 cm, it is due to the reduction and enlargement of the region of interest (ROI) that form imperfect image.

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