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A Real time Alphabets Sign Language Recognition System using Hands Tracking

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***Abstract*—Majority people can communicate through verbal language, but there are some people with limited abilities must use sign language with hand and finger movements to communicate even though not everyone is able to understand its meaning. The rapid development of information technology can assist in understanding and translating the gestures. This research aims to design and build a system gesture recognition of alphabet sign language that have the characteristic that fingers open by utilizing the Kinect camera. Recognition system built through two stages, i.e., the tracking process and the recognition process. Implementing the hands tracking method did the tracking process. The recognition process consists of two phases, i.e., the first process is to get input that will be used as reference data and data testers which is done by calculating the vectors and vector angle and, the second process is the gestures recognition process was done by calculating the Euclid distance. The system is able to recognize gestures alphabets of 69.79% of the average level of accuracy that is different in each case.**

***Keywords*—Hand tracking; sign language recognition; alphabet sign language; kinect technology**

I. INTRODUCTION

Communication is one of the most important things in human life. The majority of people communicate through verbal language, but there are some people with limited abilities must use sign language with hand and finger movements to communicate even though not everyone is able to understand its meaning. Sign language has not been standardized in universal standard so it is possible that the standardized sign language in a country different with sign language standardized by other countries. Standardized alphabets sign language in Indonesia follows the American Sign Language (ASL) and words sign language follow the Indonesian Broadcasting System (SIBI) [3]. Therefore, we need to develop a system that can translate sign language, so that the system can be used as a medium of communication or for learning sign language [4].

Camera technology can be used to detect objects, especially about human motion detection in whole or specific of body parts such as the face, facial expression, hand or leg on digital video that are kept by the camera or in a real time captured by camera [1]. Kinect is one technology that allows the camera to recognize the main joints, face and human voice because Kinect is equipped with motion sensor and voice detection [2]. The Kinect technology capabilities are certainly able to assist in understanding and interpreting gestures to more quickly and accurately, and thus it can be used to tracking hands, detecting gestures and recognizing the sign languages.

Some results regarding sign language recognition that apply sign languages has been developed, however, the most of them are not considered the shape of a hand when making gestures since the application using simple optimization algorithm [3]. This research performed by utilizing the Kinect camera and developed using Candescent NUI as tools to perform hand or fingers' tracking using the depth data and Sequential Pattern Tree (SP-Tree) algorithm to recognize seven alphabet sign languages and 20 words sign languages [3]. Some others research about hand gesture recognition using Kinect technology also applying K-Means Clustering algorithm and modified Moore Neighbour Tracing algorithms to process tracking and using the Contour Tracking methods and 3-Point Alignment algorithm for the identification process of naming each finger, and Vector Matching method for gesture recognition process. Their results were able to recognize two alphabets and seven words sign languages [5]. Another research also using Kinect technology for hands detection, but the results of this study is limited to the tracking process that is able to inform the position coordinates and depth within the center of the palms and fingertips are detected along with the number of detected fingertips. The study also generates a hand tracking process in 3-dimensional form [6].

This research presents gesture recognition system based on ASL alphabet in real time using Kinect by implementing hand tracking method that have been proposed in [6]. The data will be used for gestures recognition process, and it is obtained through the establishment of vectors and vector angles of the

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points and the gesture recognition process is using Euclid distance measurement.

II. Fundamental Concepts

There are two important processes in the detection of gestures. The first is the process of hand tracking by Kinect depth sensor and then the process of recognition to recognize the movements are performed. To recognize a gesture required information, which can provide special features of each gesture. On alphabet sign language recognition, information needed is a component which finger is used and it can be obtained in the process of hand tracking. This section describes the methods that used to hand tracking, vector and Euclid distance measurement.

A. Hand Tracking

The hand tracking method used in this paper is based on the method developed in [6]. Generally, the main step in tracking method are generate a matrix of pixels nearby that can be done with relative depth method or absolute depth method, reduce noise, classifying pixels into contours or inside pixels, distinguish hand and calculate contours, allocate an interior point, find the center of palm hand, determine the fingertips and allocate points into 3-dimensional space (3D).

The final results of this tracking method are coordinates of the palms center and fingertips in 2D or 3D. Recognition system constructed utilizing only in 2D coordinates of the points.

B. Vector

Vector is a quantity that has value and direction. Vector in two-dimensional space can be calculated as follows.

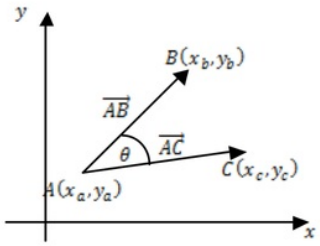

Fig. 1. Angle *theta* (θ) between vectors $\overrightarrow{AB}$ and $\overrightarrow{AC}$

The angle θ can be calculated as follows [5].

$$\theta = \arccos \frac{x_1x_2+y_1y_2}{\sqrt{x_1{}^2+y_1{}^2}\sqrt{x_2{}^2+y_2{}^2}} \qquad (1)$$

C. Euclid Distance

Euclid distance is the shortest distance calculations that can be obtained from the two points are taken into account. Euclid distance can be calculated as follows [7].

$$d_{euc}(x,y) = \sqrt{\sum_{i=1}^{j}(x_i - y_i)^2} \qquad (2)$$

III. Results

Gesture recognition method performed by utilizing the values obtained in the process of hand tracking. Those values are the coordinates of the position of fingertips and palms center in 2D. The alphabet sign language that can be recognized are based on alphabet ASL with characteristics open fingers are: C, D, F, G, H, I, K, L, V, W, X and Y.

Recognition methods generally consist of two stages. The first is the process to get input that will be used as reference data and data testing, which is done by calculating the vectors and vector angle. The second is gesture recognition process made by calculating the Euclid distance.

The process to get input (angle) is done as follows.

1. Made a point of pilot based on the center point of the palms, as shown by the following figure:

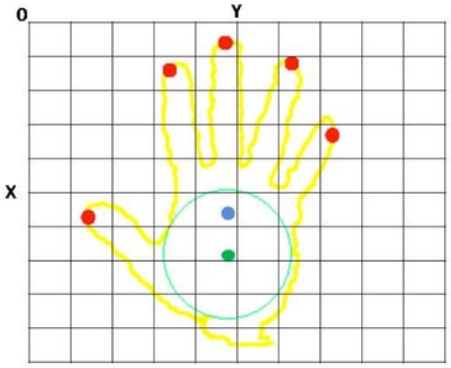

Fig. 2. The formed pilot point's position.

2. Create a vector palm-pilot and vector palm-fingertips. After that, calculate the angle between the vectors palm-pilot and vector palms-fingertip by equation (1).

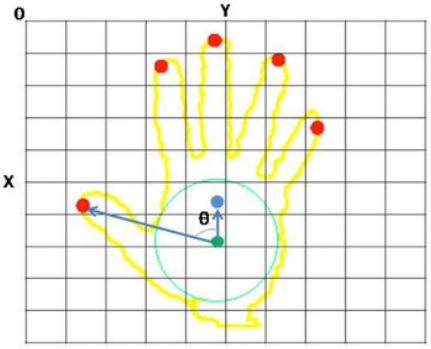

Fig. 3. The overview of vector and angle.

3. The last, the angle obtained is stored in the form of an array. At this stage the reference data obtained by displaying the value of the existing angles when performing alphabet gestures. If represented in flowchart form, then the recognition algorithm is as follows.

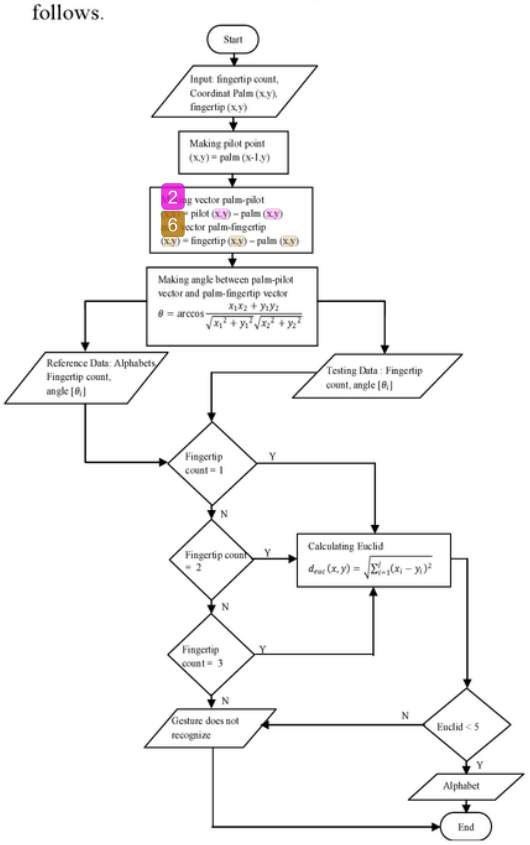

Fig.4 Recognition Algorithm

Reference data for each alphabet with hand's characteristics expends is, respectively, given in the Tables 1, 2 and 3.

TABLE 1. REFERENCE DATA FOR ALPHABETS WITH CHARACTERISTIC EXPEND 1 FINGER

Alphabet	Angle (°)
D	8.130102354156
G	57.8042660652867
H	79.0459373566017
I	19.5366549381824
X	32.2756443145776

TABLE 2. REFERENCE DATA FOR ALPHABETS WITH CHARACTERISTIC EXPEND 2 FINGER

Alphabet	Angle 1(°)	Angle 2(°)
C	36.1581854398083	108.434948822922
K	16.6992442339936	10.6196552761551
L	12.9074086712658	66.5713071912546
V	10.6196552761551	27.6459753637387
Y	36.5288553669852	51.8427734126309

TABLE 3. REFERENCE DATA FOR ALPHABETS WITH CHARACTERISTIC EXPEND 3 FINGER

Alphabet	Angle 1(°)	Angle 2(°)	Angle 3(°)
F	14.7435628364	3.57633437499	36.4692343900
W	2.00955381302	23.8387401831	22.2034785320

The second Stages in recognition process is measuring the closeness of angle data between the center of the palms and fingertips on the reference data and testing data. Distance measurement method uses Euclid distance as found in equation (2).

Tests performed gesture recognition at a certain distance is 52 cm - 77.5 cm with depth relative tracking method. Testing is done by repeating the movement of alphabets in front of the camera as much as 400 times the experiment by the same user with the user making reference data.

TABLE 4. RESULT IN TESTING OF SYSTEM ACCURACY IN RECOGNIZING MOVEMENT IN A SINGLE USER

Alphabet	Accuracy by user
C	35%
D	87.5%
F	85%
G	82.5%
H	45%
I	87.5%
K	65%
L	92.5%
V	65%
W	57.5%
X	75%
Y	70%
Accuracy Average	69.79%

Average the system capability to recognize gestures is 69.79%. Lowest accuracy rate by the alphabet C then H, this is due to a few finger gestures must be tightened so that the

tracking process is difficult to detect the exact fingertips. The highest accuracy by the alphabet L, because the movement is different from other alphabets, its gestures are easy in practice and the process is able to detect fingertip tracking well.

The reading of alphabet is sometimes recognize other alphabets in the testing process since the gesture of the alphabet is almost similar with each other such as the letter D and I. The tracking process influences the gesture recognition process if it is capable detecting a fingertip point as well, and thus the system increases the potential for letter recognition. Change hand positions also affects the tracking process that will have an impact on the process of gesture recognition, due to changes in the position of the hand can cause a change point of the fingertips and palms were recognized. These third thing is what can affect the accuracy of the movement of each letter.

IV. Conclusions

The system can recognize gestures with characteristics expend the fingers, as many as 12 alphabets, namely: C, D, F, G, H, I, K, L, V, W, X and Y. The system is able to recognize alphabet sign language with accuracy 69.79% with a level of accuracy that is different in each case. Lowest accuracy rate is the alphabet C of 35%, and the highest accuracy is the alphabet L of 92.5%.

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