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Hand Gesture Recognition using Leap Motion Controller for Recognition of Javanese Script

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Abstract: Javanese Script is The cultural heritage of ancient Javanese people used to write in the manufacture of books, manuscripts, song Java, inscriptions, or correspondence. It is important to maintain and preserve this heritage, so that the Indonesian people can understand the cultural values and art writing. The development of technology is currently increasing rapid, making some researchers use Leap Motion as a translator device. In this study, a hand gesture recognition system using a leap motion controller is proposed for the recognition of Javanese Script. By using a leap motion controller, every bone coordinate point on the hand will be detected, so that these coordinate points can be used as input features. The use of the feature of the distance between the palm position and distal phalanges measured using the Euclidean distance. These features will then be classified using the k-nearest neighbor classification method. System testing was carried out using 20 Javanese characters consisting of /ha/, /na/, /ca/, /ra/, /ka/, /da/, /ta/, /sa/, /wa/, /la/ , /pa/, /dha/, /ja/, /ya/, /nya/, /ma/, /ga/, /ba/, /tha/, /nga/. This research was successful with an average accuracy rate of 95% in Javanese script.

Keywords: Javanese Script, Leap Motion, Gesture, Classification

1. Introduction

Javanese script itself is one of the priceless cultural heritages. The form of the letters and the art of making them become a relic that deserves to be preserved. This script is evidence of ancient times before the existence of the Indonesian country. The government is pursuing efforts to preserve the Javanese script. One of the efforts is to include it in the education curriculum.

The Javanese/hanacaraka script has 20 basic letters. The Javanese script when translated into Latin letters consists of /ha/, /na/, /ca/, /ra/, /ka/, /da/, /ta/, /sa/, /wa/, /la/, / pa/, /dha/, /ja/, /ya/, /nya/, /ma/, /ga/, /ba/, /tha/, /nga/. Javanese script is a syllable in Latin letters. The character of a Javanese script is written according to the sound of writing the Latin letters of a syllable or based on the sound of its pronunciation [1].

The Leap Motion Controller is a compact device that can be connected to a PC using a USB. It uses InfraRed (IR) imaging to define the position of predefined objects in a limited space in real time. It can then sense hand and finger movements in the air above it, and these movements are recognized and translated into actions by the approach to be developed. The sensor software analyzes the objects detected in the device's field of view. It recognizes hands, fingers, and tools, to permit reporting discrete positions, gestures, and motion [2].

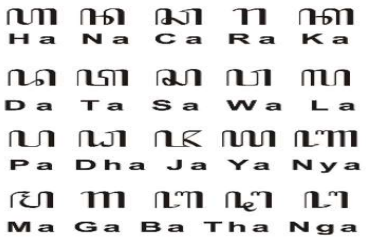

Figure 1: Javanese script.

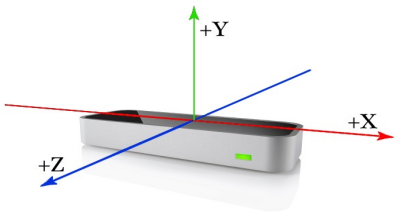

Figure 2: Leap motion controller

Current technological developments are increasingly rapid, making some researchers use Leap Motion as a translator device. Several studies have used Leap Motion as a translator, one of which is research on Recognition of American Sign Language using Leap Motion Controller [3]. The features used for machine learning are pinch strength, grab strength, average distance, average spread, average tri-spread, extended distance, dip-tip projection, orderX, and angle. Pinch and grab strength obtained from the API while the other features derived from the API using specific calculation. They record gesture dataset of 26 ASL alphabet from two people, one of them is deaf. They apply two classification method, those are kNearest Neighbor (k-NN) and Support Vector Machine (SVM). By using four-fold cross validation, they obtained 72.78% classification accuracy in k-NN method and 79.83% in SVM method [4].

Another research is Real Time SIBI Sign Language Recognition based on K-Nearest Neighbor. The technology of the leap motion controller will generate the existence of coordinate points on each bone in hand. As an input, we used the value of the distance between the coordinates of each bone distal to the position of the palm, which was measured using Euclidean Distance. This feature of distance will be used for training and testing data on the K-Nearest Neighbor method. The experiment result shows that the best accuracy is 0,78 and error 0,22 with proposed parameter of K = 5 [5].

In this study, we proposed hand gesture recognition using Leap Motion Controller for Recognition of Javanese Script. By using the Leap Motion Controller, every coordinate point bone in the hand will be detected, so that the coordinate points can be used as input feature. The use of distance feature between palm position with type distal measured by Euclidean distance. These features will be used for training and testing data for the k-nearest neighbor classification method. Training data used are 10 samples for each letter, the number of 20 letters of the Javanese Script, so that the total amount of training data 200 for one person.

2. Methods

In this study, several stages of the proposed system will be explained, pre-processing explanations, data retrieval of the coordinates of the distal phalanges on each finger and palm position, measuring the distance between each distal phalanges on each finger and the palm position, from the process will produce output in the form of data testing and training data. The two outputs will be classified using K-Nearest Neighbor and produce an object in the form of a class.

2.1 Data Collection

The sample data recorded using the researcher's right and left hands were 10 samples for each Javanese script. For manual trials, the training data used is the sample data itself, while the testing data used for real-time practices are data recorded directly from the hands of the researcher.

2.2 Design System

System design consists of two main parts, namely the application of data training or builder and application of data testing.

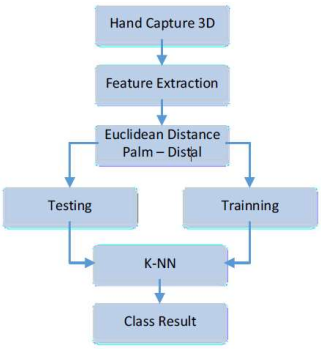

Figure 3: Design system.

2. 3 Hand Gesture

Gestures (hand gestures) are the non-verbal language used to communicate. There are at least three kinds of gestures, namely: body gestures, hand gestures, and facial gestures. The stage as in Figure 3, is a process to

obtain a collection of input data obtained from the LMC detection of the hand, which shows the results of the coordinate points and the hand gesture. The coordinate points generated by the leap motion controller are palm position, distal phalanges, intermediate phalanges, proximal phalanges, and metacarpals. In this study, only the coordinates of the palm position and distal phalanges of each finger were used.

2. 4 Feature Extraction

The input of this stage is the result of data collection of coordinate points from the previous preprocessing step. The features used in this study are static features. Static features are some static features that are obtained from the hand coordinates of the LMC. The static feature used in this study is the average.

2. 5 Euclidean Distance

Euclidean Distance is the classifier that is most often used to calculate the similarity of 2 vectors. Euclidean distance measures the distance from the palm of the hand to the distal phalanges of each finger, namely the thumb, index finger, middle finger, ring finger, and little finger. The Euclidean distance measurement can be seen in the following equation.

$$d(xyz)\sqrt{(x_2 - x_1)^2 + (y_2 - xy_1)^2 + (z_2 - z_1)^2} \quad (1)$$

2. 6 Training Data

At the training step, it is necessary to sort the data which will be used as training data. The input features for each hand gesture will be used as training data, and the Javanese script classes for each hand gesture will be determined. This training data will be compared with testing data.

2. 7 Testing Data

The trial or testing process is a step to get a class on the test data. This step compares the test distance data with each training distance data. If it fails, compare it with the training distance for the next character, and so on, so that testing data is found with the appropriate training data. The trial process was carried out using the KNN method.

2. 8 Classification

This classification step aims to classify the trial data that is inputted in real-time from the LMC to the training data given to the class. Each trial data entered will be organized against the existing training data to get a class on the trial data. For the classification process, the KNN classification method will be used. The output generated from the classification process is text display and Javanese script speech sounds.

3. Result and Discussion

In this chapter, we will discuss the implementation of the proposed system, and the system was tested with hand gesture. In this trial of Javanese script hand poses, a pose test with Javanese script output will be carried out using a Leap Motion Controller as a generator. The Javanese Script if translated into Latin letters consists of /ha/, /na/, /ca/, /ra/, /ka/, /da/, /ta/, /sa/, /wa/, /la/, / pa/, /dha/, /ja/, /ya/, /nya/, /ma/, /ga/, /ba/, /tha/, /nga/. The recorded data will immediately display the output in the form of Javanese Script along with the audio.

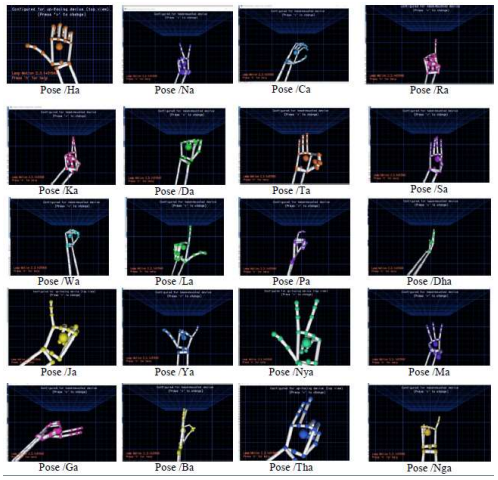

Figure 4: Javanese script hand gesture.

From the experiment of 20 Javanese Script above, it can be drawn the graph shown in Figure 5 below.

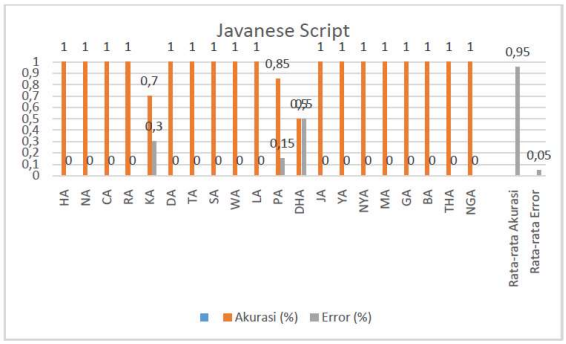

Figure 5: Java script basic testing graph gesture.

To measure the success of the proposed system, a trial was carried out by measuring accuracy. The problem was carried out using the hands of the researcher. Each Javanese script was tested ten times. Accuracy is calculated using the following equation.

$$\boldsymbol{Accuracy} = \frac{\boldsymbol{Number\ of\ correct\ predictions}}{\boldsymbol{Total\ number\ of\ predictions}} \qquad (2)$$

The test results for 20 Javanese scripts obtained an accuracy table which can be seen in table 1, with an average accuracy of 95%.

Javanese Script	Accuracy (%)	Javanese Script	Accuracy (%)
HA	1.00	PA	0.85
NA	1.00	DHA	0,50
CA	1.00	JA	1.00.
RA	1.00	YA	1.00.
KA	0.70	NYA	1.00
DA	1.00	MA	1.00

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Table 1. Accuracy results

TA	1.00	GA	1.00
SA	1.00	BA	1.00
WA	1.00	THA	1.00
LA	1.00	NGA	1.00
	Average Rate	0.95 %	
	Average Error rate	0.05 %	

From the results of the graph above, it can be seen that there are several Javanese Scripts whose accuracy is below 100%, and the average that can be taken from the overall accuracy is 95%. The accuracy results above can change at any time due to the different gesture movements captured by the Leap Motion Controller, and the stored sample data adjust the distance results.

4. Conclusions

In this study, we propose hand gesture recognition using Leap Motion Controller for recognition of Javanese Script . From the results of the research that has been done, it can be concluded that Leap Motion Controller is the latest infrared sensor technology that can detect coordinate points on the hand so that it can facilitate developers in recognizing hand movements. The hand gesture recognition using Leap Motion Controller for Recognition of Javanese Script as a whole can realise hand gestures with an average accuracy of 95% in Javanese script, shown by the previous graph.

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