Using $1 \textit{UNISTROKE}$ Recognizer Algorithm in Gesture Recognition of Hijaiyah Malaysian Hand-Code

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ABSTRACT

How people communicate with each other depends on one’s ability to hear, see, lip-reading skills, body language, sign language or speaking abilities. What if one person is deaf or speech impaired and the other does not understand sign language or body language used by the deaf in communicating. Conventional sign language is not effective and is not applicable when it comes to recitation of al-Quran. To overcome the difficulty in using conventional sign languages to teach Quran for deaf people, a method called FAKIH was introduced in deaf school for Muslim deaf pupil in Malaysia. However, it is difficult to evaluate and to interpret the gestures performed by deaf or speech impaired when they master these signs. This is one of many reasons why a technology like gesture recognition could help. Researchers have conducted numerous researches on gesture recognition within the last 2 decades. Although these techniques have been used in gaming and providing control mechanism for virtual environment for users, there is some variation within the tools and environments used between implementations. Recognition of gesture by a person, especially deaf or speech impaired should be easily perceived without going through complex procedures. However, technology has evolved and advanced devices and techniques have been introduced to simplify recognition of gestures. These techniques and technologies can be used to help people with special needs. A simplified gesture recognition platform specially focused on detecting the methods described in FAKIH is crucial for the speech impaired or deaf community to practice and recite al-Quran. This research involves evaluation of algorithms name $1 \textit{UNISTROKE}$ Recognizer and identify the gestures in accordance to FAKIH method.

Keywords: Deaf, Gesture Recognition, Hand-Code, Quran, Sign Language

INTRODUCTION

The “$1 \textit{Unistroke Recognizer}” is a 2-D single-stroke recognizer designed for rapid prototyping of gesture-based user interfaces [1]. “$1 \textit{recognizer}” is a very light weight recognizer which uses geometric template matching and is considered as simple and accurate gesture recognizer which can be implemented with only 100 lines of code. Figure shows the pseudo code of $1 \textit{unistroke recognizer}$. To increase the accuracy of gesture detection we can load more than 3 templates for each gesture. Even with 1 loaded template the authors claim that it has 97% accuracy and if the recognizer is loaded with more than 3 templates the accuracy is almost 99%. Also in their paper, authors stated that the results were nearly identical to Dynamic Time Warping and superior to Rubine.

HAND-SIGNS HIJAIYAH

When we take all the unique gestures from the signs of FAKIH method [2] by ignoring the hand-signs, there are 22 unique gestures which can be easily tracked using $1 \textit{Unistroke Recognizer}$ if we perform those signs individually. Since $1 \textit{Unistroke Recognizer}$ does not track non-gesture movements, it will be quite difficult to find the beginning of a gesture, if gestures are being performed sequentially. Following figure shows the 22 unique gestures in signing the Arabic letters described in FAKIH. Some of the characters share the same hand movements (see Figure Error! No text of specified style in document.) but it can be distinguished by detecting the hand-signs or state of fingers (opened and closed fingers) using smart glove [4].

The $1 \textit{Unistroke Recognizer}$ requires a starting point and an ending point of a gesture to recognize. Since the gestures are performed continuously this will be an issue for implementing this algorithm. A solution for this
issue is to implement it with a combination of algorithmic search with $1$ Unistroke Recognizer. An algorithmic search could calculate the starting point of a gesture by using X and Y coordinates and then by identifying to which direction the joints are moving. For example all gestures stated in FAKIH method starts from a point where right hand is above spine joint. Eighteen gestures out of 29 characters starts from a point where right hand is above spine joint and left hand is loosely held straight below hip-center joint. We can define the starting point of these gestures using neural networks.

**RECOGNIZE(points, templates)**

1. \( b \leftarrow +\infty \)
2. \( \textbf{foreach} \, \text{template} \, T \text{ in templates do} \)
3. \( d \leftarrow \text{DISTANCE-AT-BEST-ANGLE(points, } T, -\theta, +\theta, \theta_2) \)
4. \( \textbf{if} \, d < b \text{ then} \)
5. \( b \leftarrow d \)
6. \( T' \leftarrow T \)
7. \( \text{score} \leftarrow 1 - b / 0.5 \cdot (\text{size}^2 + \text{size}^2) \)
8. \( \textbf{return} \, (T', \text{score}) \)

**DISTANCE-AT-BEST-ANGLE(points, T, \theta_0, \theta_0, \theta_2)**

1. \( x_1 \leftarrow \theta_0 \theta_0 + (1 - \theta) \theta_0 \)
2. \( f_1 \leftarrow \text{DISTANCE-AT-ANGLE(points, } T, x_1) \)
3. \( x_2 \leftarrow (1 - \theta) \theta_0 + \phi \theta_0 \)
4. \( f_2 \leftarrow \text{DISTANCE-AT-ANGLE(points, } T, x_2) \)
5. \( \textbf{while} \, |\theta_0 - \theta_1| > \theta_0 \text{ do} \)
6. \( \textbf{if} \, f_1 < f_2 \text{ then} \)
7. \( \theta_0 \leftarrow x_2 \)
8. \( x_2 \leftarrow x_1 \)
9. \( f_2 \leftarrow f_1 \)
10. \( x_1 \leftarrow \theta_1 \theta_0 + (1 - \theta) \theta_0 \)
11. \( f_1 \leftarrow \text{DISTANCE-AT-ANGLE(points, } T, x_1) \)
12. \( \textbf{else} \)
13. \( \theta_1 \leftarrow x_1 \)
14. \( x_1 \leftarrow x_2 \)
15. \( f_1 \leftarrow f_2 \)
16. \( x_2 \leftarrow (1 - \theta) \theta_0 + \phi \theta_0 \)
17. \( f_2 \leftarrow \text{DISTANCE-AT-ANGLE(points, } T, x_2) \)
18. \( \textbf{return} \, \text{Min}(f_1, f_2) \)

**DISTANCE-AT-ANGLE(points, T, \theta)**

1. \( \text{newPoints} \leftarrow \text{ROTATE-BY(points, } \theta) \)
2. \( d \leftarrow \text{PATH-DISTANCE(newPoints, } T_{\text{points}}) \)
3. \( \textbf{return} \, d \)

**PATH-DISTANCE(A, B)**

1. \( d \leftarrow 0 \)
2. \( \textbf{for} \, i \text{ from } 0 \text{ to } |A| \text{ step } 1 \, \text{do} \)
3. \( d \leftarrow d + \text{DISTANCE}(A_i, B_i) \)
4. \( \textbf{return} \, d / |A| \)

Figure 1: $1$ Unistroke Recognizer's pseudo code [3]
Figure 3: Detecting starting point of character gesture using neural network

The Figure illustrates how we can detect a starting point of a character gesture using neural network. Similar method could be used to detect the end-point of the gesture and then pass the detected gesture to $1$ Unistroke Recognizer for recognition.

ANALYSIS OF $1$ UNISTROKE RECOGNIZER ALGORITHM

To evaluate the algorithm of 1 Unistroke Recognizer, only 1 coordinate (coordinate of palm) is used from the collected data because $1$ Unistroke Recognizer is a single-stroke gesture recognition algorithm. This algorithm rate the similarity of gestures based on its angle and distance among the points. The score value determines the most similar gesture based on the templates provided. Figure Error! No text of specified style in document. demonstrates the points after removing the unwanted data of wrists and elbows which were used in Dynamic Time Warping algorithm.
ACCURACY ANALYSIS

The same data from the 3 students which have been collected earlier was used after removing the unwanted points to evaluate $1$ Unistroke Recognizer. Student A’s data was used as a sample template and Student B and C’s data was passed to the algorithm to rate the similarity. Figure 5 shows the results of the comparison.

Student B’s gesture’s angle variance (blue color) is low compare to Student C’s angle variance but the distance (red) calculation for both gestures are quite close. Total score (green) which determines the similarity of the gesture is high for Student B which is the expected results as we have seen the actual gesture movement from Figure Error! No text of specified style in document.. However, the distance value in both gestures is quite close compare to the visual representation of gestures. This may lead to an inaccurate result when we compare with a larger data set. The same data were also used to compare with random gestures which were collected from students. Since $1$ Unistroke Recognizer is an angle invariance recognizer it detects gestures which are similar in appearance if angle of gesture is ignored. Figure 6 shows some of the gestures which were inaccurately recognized using $1$ Unistroke Recognizer.
PERFORMANCE ANALYSIS

To evaluate the performance of the $1 Unistroke algorithm gesture templates having multiple samples were loaded and random gesture data was passed to the algorithm. Figure 7 shows impressive performance results of this algorithm when gesture templates with different amount of gestures are loaded.

CONCLUSION

From the results of performance tests, it is very clear that $1 Unistroke Recognizer could be use in gesture recognition for hand code hijayah with a total number of 45 gestures loaded as templates. However $1 Unistroke recognizer can only work on a single point.

REFERENCES