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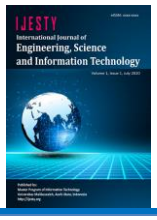

Mobile Learning Application Tahsin Al-Quran Using Dynamic Time Warping Method Based on Adroid

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Abstract

This research aims to design and build an Android-based Quran tahsin learning mobile application using the Dynamic Time Warping (DTW) method. This application offers tajweed learning features and voice exercises to find out the readings of Al-Quran readers. The DTW method is used to analyze the similarity between the user's voice pattern and the reference voice pattern in the application. The research methods used include reference collection, direct observation, and literature study. The application is designed with a user-friendly interface and equipped with an accurate ability evaluation feature, so that users can find out their weaknesses and strengths in learning Qur'an tahsin. Based on the test results, out of 42 voice data tested, 38 data were successfully recognized correctly and 4 data had errors. The average accuracy rate of this application reached 90.47%. This application is designed to overcome some of the main problems in learning Quran tahsin: lack of understanding of basic tahsin techniques, lack of appropriate learning tools, difficulty in evaluating skills, and lack of motivation to learn. With this application, users can learn Quran tahsin more easily and effectively through interactive and varied methods. Evaluation of users' ability to recite Quranic verses can also be done accurately, so that users can know their strengths and weaknesses in tahsin learning. The implementation of this application is expected to make a significant contribution in improving the quality of Quran tahsin learning among the wider community.

Keywords: *Mobile Learning, Dynamic Time Warping, Tahsin Al-Quran*

1. Introduction

Technology is currently developing rapidly. Mobile technology is one of them, which is now not limited to being used only as a means of communication, but also as a means that facilitates users in their daily lives. This can happen because mobile technology has a variety of facilities, including internet access, e-mail, organizers, music, games and various other facilities that can be used anytime, anywhere more easily and quickly [1]. Sound as a way to communicate and express ourselves [2]. Sound is a mechanical energy produced by vibrations with a certain frequency [3]. Along with the times, the need for systems and applications to analyze and identify sounds is getting higher [4].

The Quran as a holy book rahmatan lil-'alamin, a blessing for all the universe which contains various types of science, law, social, technology, and so on. The Quran is studied to find out the message or meaning of the memorization in it [5]. In studying the Al-Quran, it should not be arbitrary, there are sciences that must be studied in the process of studying the Al-Quran, including Tahsin Al-Quran [6]. The science of tajweed means the science that studies how to issue letters based on their location by applying their properties [7].

The use of smartphones for learning is very good, based on research by Rosadi et al. [9] this can simplify and make learning fun. In the research of Iqbal et al. [10] entitled "Offline Implementation of Indonesian Language Sign System Recognition Using the Dynamic Time Warping Method on Android Devices" designed a system to measure the similarity of two temporal sequential data (time series) whose time and speed are different. In this research, the implementation of the DTW algorithm is presented to recognize Indonesian language (Indonesian Language Sign System SIBI) offline. In Dinata et al's research [11] DTW method is used for feature matching, where DTW can find out the difference or distance between two analyzed data. In Syofian & Oktarina's research [12] entitled "Speaker Voice Recognition Using the Dynamic Time Warping Method" develops applications through the use of LPC (Linear Predictive Coding), also supported by the DTW (Dynamic Time Warping) method.

Including Muslims can learn Quran tahsin through smartphones using the dynamic time warping method, so they don't have to bother going far to the recitation park and learning with their Quran recitation teachers. Mobile learning refers to the use of a handheld device, such as a smartphone, PDA (Personal Digital Assistant), and tablet [8].
Dynamic time warping is a method of calculating the similarity between two time series that may differ in time and speed. Dynamic time warping is also referred to as non-linear sequance alighment, so this distance is more realistic to use in measuring the similarity of a pattern. In Muhammad's research with the title "Use of Dynamic Time Warping (DTW) Distance", on Time Series Data Cluster Analysis, the researcher used the dynamic time warping method to find the use of dynamic time warping distance on time series data cluster analysis. So with the use of the dynamic time warping method, the researcher is helped more to group objects based on their characteristics [13].
In line with this, researchers use the dynamic time warping method which is a suitable method for learning Quran tahsin using smartphones independently. This method aims to align two vector sequences until an optimal match is found between the two sequences [14].
The use of the dynamic time warping method can also be used to find the level of similarity of two voices in pronouncing the same sentence. In this study, applying the dynamic time method serves to check the similarity of sound and the level of accuracy of a tajweed law and is assisted by MFCC (Mel Frequency Cepstrum Coefficients) which serves to extract sounds from training data using 30 voice samples in order to check the similarity of the sound of the existing tajweed law.

2. Research Methods

The research was conducted at SMP Swasta IT Al-Munadi, Jalan Marelan VII Lingkungan 1 Number 212, Medan Marelan District, Medan City, North Sumatra Province, as many as 10 students of takhosus tahfidz class VIII at SMP Swasta IT Al-Munadi. The steps in the research include collecting references, observations, and literature studies. The tools used include: a) Hardware in the form of a computer / PC with 4 GB RAM specifications, Intel Core i3 CPU 2.53 GHz, System type 64 bit, Vivo Y12 Smartphone; and b) Software with Microsoft Window 10 Operating System specifications, Microsoft Word 2010, React Native Software, Android SDK, Visual Studio Code, XAMPP.
This research uses the DTW method, which is an algorithm used in aligning two different time series data through calculating the minimum distance between data points [15]. The use of the dynamic time warping method in this application is assisted by sampling and windowing techniques. Sampling is the process of sampling human speech signals in the form of analog signals in a certain period of time. While the windowing method is used to limit the filter length in the time domain [16]. As for the stages, the researcher entered a sampling sound as many as 14 Al-Quran reading laws listed on the Tajweed feature taken from the recording results. Then the program will calculate how much the sound match between the sampling sound and the user. In this case the researcher uses The Distance formula.

3. Result and Discussion

The problem analysis related to the mobile learning application of tahsin Al-Qur'an using the Android-based Dynamic Time Warping (DTW) method can be explained as follows: a) lack of understanding of tahsin al-qur'an; b) lack of appropriate learning tools; c) difficulty in evaluating ability; and d) lack of motivation to learn. The sample training that can be done in the mobile learning application of tahsin Al-Qur'an using the Android-based Dynamic Time Warping (DTW) method, including: a) basic introduction of tahsin al-qur'an; b) pronunciation exercises of hijaiyah letters; c) tajweed exercises; d) tahsin exercises of short letters; e) evaluation of ability.
Detection results that can be generated by the application of mobile learning tahsin Al-Qur'an using the Android-based Dynamic Time Warping (DTW) method: a) detection of pronunciation errors; b) detection of pronunciation speed; c) evaluation of user skills; d) data collection of evaluation results.
Analysis of algorithm performance in the mobile learning application of tahsin Al-Qur'an using the Android-based Dynamic Time Warping (DTW) method can be done by measuring the speed and accuracy of pronunciation error detection and detection of user pronunciation speed. The following is the analysis of algorithm performance in the application: a) pronunciation error detection speed; b) pronunciation error detection accuracy; c) pronunciation speed detection speed; d) pronunciation speed detection accuracy.
In the Dynamic Time Warping test used during the process of taking sound recording test data and matching between the training sound and the test sound, this technique aims to accommodate the time difference in the recording process when testing with those contained in the reference signal template. The basic principle is to provide a range of 'steps' in a time frame in the sample and time frames in the template are then applied to match the path that shows the greatest local match (similarity) between straight time frames, the results of the matching between the training voice and the test voice will be obtained the type of voice of the user.
Before testing the sound, there are several calculations that can be done such as frame blocking search and MFCC process.

a. *Frame blocking* is a mechanism that divides sound samples into several *frames* or slots.

$$Jumlah\ frame = M/Ts \quad \text{.....(1)}$$

Ts = Sound capture duration (s)
M = Frame length
For example Ts = 5, then to calculate the frame blocking is:
Ts = 5 and M = 60 is 60 / 5 = 12 s

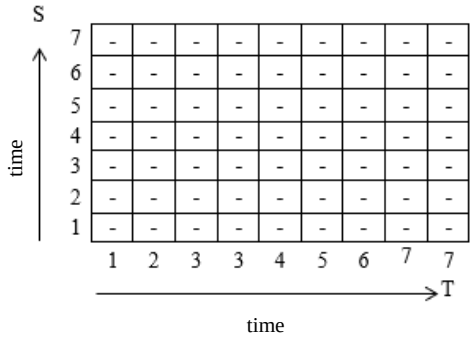
b. The MFCC process aims to calculate the average of the voice sample data and reduce the value of each voice sample with the average value, this aims to discard data that is not needed in the training voice process.

$$y|n| = x|n| - \bar{x} \quad \text{.....(2)}$$

y[n]= Sample Signal result
x[n]= Original sample signal
x = Average value of the sample
1 = (8+6+4+3) - x
x = 21/1 = 21

Based on the timing of the user's voice with the voice in the program, two time series signals t and s can be taken:
t (*testing*) : 1, 2, 3, 3, 4, 5, 6, 7, 7
s (*stored template*) : 1, 2, 3, 4, 5, 6, 7

Table 1. Empty Matrix



Once the optimal trajectory of the sound pattern is obtained, the next step is the *accumulated distance* process. To minimize the time axis distance stretched or compressed, we can arrange two observation sequences on the grid side with the unknown sequence at the bottom and the stored template on the left side. Both sequences start from the bottom left of the grid [17]. Inside each cell, we can place a distance counter that compares the corresponding elements of the two sequences.

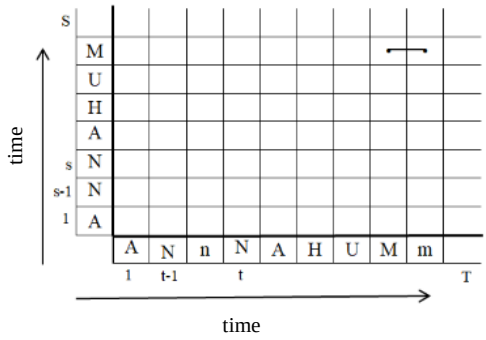
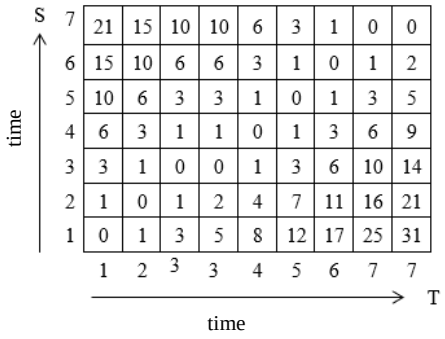


Fig 1. *Accumulated* Distance Process Result

It can be seen that the *accumulated distance* is the distance between one *local distance* and another *local distance*. The existing matrix can be searched for other *local distances* starting from the left and bottom corners with the formula:

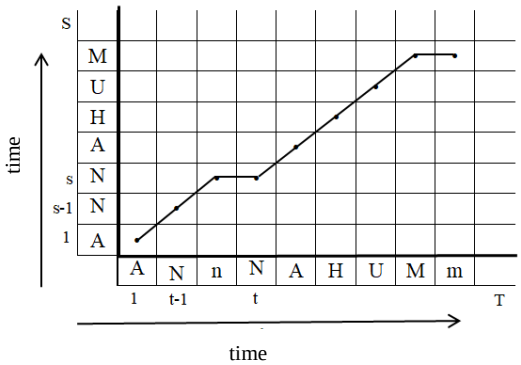
$$d(c) = d(x,y) = |t_x - s_y| + Min\{(t-1,s),(t,s-1),(t-1,s-1)\} \ldots (3)$$

Table 2. Local Distance Filled Matrix



In the *distance* section is the final distance that shows the *warping path*, the distance between the user's voice and *the* reference voice.

Table 3. Warping Path Matrix



In the results of *the distance* process, it can be seen that the number of k (*warping path*) is 9 points. To find the normalized time distance using the formula in the second equation, namely:

$$D\ (X,Y) = \left[\frac{\sum_{t=1}^{K} d(t)}{\sum_{t=1}^{K} k}\right] \quad \text{.....(4)}$$

$$D\ (X,Y) = \frac{0+0+0+0+\ 0+0+0+0+0}{9}$$

$$D\ (X,Y) = 0$$

Based on the calculation above, it can be seen that the distance between the user's voice and the *stored template* (the voice in the program) is 0. Distance 0 in DTW implies that the time series between the user's voice and the voice in the program is very similar.

If we take an example of another user's voice in voice training, such as the example of reading "*Annahum*", we will get two time series signals T (*testing*) and S (*sampling*) as follows.

S : 1, 5, 3, 3, 2, 6, 4, 2
T : 1, 7, 3, 4, 1, 8, 3, 2

Based on the two time series signals, we can know the *warping path* or the path traveled by *warping* in the matrix is as follows.

Table 4. *Path Warping* Time Series

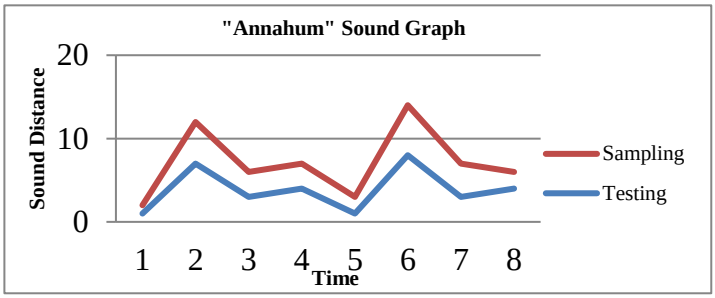


Table 5. Warping Math Time Series

S \ T	1	7	3	4	1	8	3	2
2	18	23	24	26	27	33	34	0
4	17	20	21	0	3	7	8	10
6	14	15	18	20	25	27	30	34
2	9	14	15	17	18	24	25	0
3	8	12	0	1	3	8	0	1
3	6	10	0	1	3	8	0	1
5	4	6	8	9	13	16	18	21
1	0	6	8	11	11	18	20	23

time (S) — time (T)

It can be seen that the number of *warping paths* traveled by the *warping* path is as many as 10 with data.
d = [0, 8, 7, 3, 0, 18, 14, 8, 6, 4, 0].

Then find the normalized time, calculate the *distance* with the formula.

$$D\ (X,Y) = \left[\frac{\sum_{t=1}^{K} d(t)}{\sum_{t=1}^{K} k}\right] \quad \text{..... (4)}$$

$$D\ (X,Y) = \frac{0+8+7+3+0+18+14+8+6+4+0}{11}$$

$$D\ (X,Y) = \frac{68}{11}$$

$$D\ (X,Y) = 6{,}18$$

Based on the above calculations, it can be seen that the distance between the user's voice and the *sotred template* (the voice in the program) is 6.18. This means that the match or suitability between the *user*'s voice and the *sampling* voice is still not appropriate.

From the number of samples that researchers used, namely 10 people, each of them did 4 voice exercises per person and there was 1 person for 7 voice exercises. Of the 42 sound data obtained, there are 4 sounds that have errors, so only 38 sounds are obtained from the checking results. The accuracy level of the use of *dynamic time warping* in tahsin *mobile learning* applications can be known as follows.

$$Accuracy\ Level = \frac{100}{42} \times 38$$

$$Accuracy\ Level = 90{,}47\%$$

4. Conclusion

The design of tahsin mobile learning application on android-based Quran memorization using the Dynamic Time Warping (DTW) method is to design the system. In designing the system there are three things that must be determined, namely vector results, detection results, and algorithm performance analysis. Of the 42 total data there are 4 data that have errors, so only 38 data can be checked. So that the accuracy rate in designing tahsin mobile learning applications using the dynamic time warping method on memorizing the Koran is 90.47%..

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