Quran Recitation Recognition & Interactive Learning of Quran Recitation

Name:	Rahma Hassan
ID number:	201501344
University:	Zewail City for Science and Technology

1. Introduction and Motivation

Muslims either Arabs or non-Arabs, need to know how to read the Quran in the correct way. The Holy Quran is a divine book from Allah to Muslims and it represents a great value for them. The Quran needs to be written and spoken properly. Therefore, there is a need to teach people the right recitation in an easy, effective, and efficient process. Unawareness of Tajweed rules is a great mistake because different readings of verses of the Quran change the meaning of some words [1]. Many software applications are made for this purpose using automatic speech recognition like 'E-Hafiz' app and 'Tarteel' app, etc.

The purpose behind such programs is to replace the traditional method which needs making sessions with Quran reading experts by technological techniques based on speech recognition. This saves time and facilitates learning the Quran anywhere anytime by just using proposed applications on our smartphones [1]. It is important to mention that developing such ASR tools for teaching Quran recitation solves the problem of unavailability of 'expert Quran teachers' and the limitation of session time with them.

The Quran set of rules is called 'Tajweed' which determines for example where to stop in speech and for how long. It also tells us how to pronounce letters and how to merge two words, etc [2]. It is important to know that Automatic speech recognition systems (ASR) is a process in which a computer takes voice and transforms it to words for specific purposes. General approach for the (ASR) consists of collecting data, preprocessing them, feature extraction and finally, classification using different models to identify the recitation rule and to determine correctness of user recitation.

Different feature extraction techniques are used in literature like MFCC. Also, one of most common methods used in automatic speech recognition is Carnegie Mellon University (CMU) Sphinx which is a statistical speaker-independent set of tools using the Hidden Markov Models (HMM). CMU Sphinx tool is used to train and evaluate a language model on Quran recitations [7].

In this report, literature review about various speech recognition models is presented. Different approaches from different papers are mentioned here in the literature review section to illustrate related work in this topic. In addition, the results of each model are presented.

2. Literature Review

We find in [2], published 2020 that a system for recognizing different ‘Tajweed’ rules in audio files was built and it was implemented in ‘IMAM’ app too. They proposed a tool for recognizing 4 recitation rules of Tajweed (Edgham Meem, Ekhfaa Meem, tafkheem Lam, Tarqeeq Lam). First, Data was collected from paid specialists and volunteers with right and wrong recitations. then collecting 657 recordings for the 4 different rules was done, also, the files were processed by different techniques like limiting and unifying audio files lengths. After that, Feature classification was done by cutting the signal into frames (each one is 25ms), applying a hamming window to decrease noise and applying FFT to get the spectrum of audio files. Finally, 4 classification models for the 4 different rules were implemented by SVM with adjusting hyperparameter C (regularization parameter equal to 1 and gamma equal to 0.1 to get best results. System was able to recognize accurately when the rule started and ended besides recognizing the rule itself. Validation accuracy is 99% for each model of the 4 models which is tested against 30% of the data. The whole system is tested against full verses too.

In paper [3], the authors implemented the ‘E-Hafiz’ app in which comparison between users ‘recitations and Hafiz ‘Quran reading expert person’ is done. Therefore, any mismatch between user recordings and expert recitation recordings stored in the database is pointed out to users to notify them about the error. System can detect mistakes on the ‘word’ level. The whole system was taking input from user, make data preparation to extract words from audio, make feature extraction using MFCC, make VQ which is a data compression technique to reduce the features, generate codebook of these recorded words, make the same thing by recorded audios by experts to generate the codebooks of them too, Calculating the distance between both recitations and last thing is to determine the mismatch by comparing the resultant distance by specific Threshold. Accuracy rate is 92% for Men reciters, 90% for Women reciters and 86% for children reciters. The Future work of this paper is to make the recognition on the level of letters.

The authors of [4] said that their paper is special because the paper addresses the problem of identifying the Quran recitation with Tajweed on ‘entire’ Quran, focusing on ‘eight different recitation rules’. In this paper, they tried different combinations of traditional and non-traditional techniques for feature extractions. The difference in this paper was using Convolutional Deep Belief Network (CDBN) in feature extraction. Authors used in classification Nonlinear ML algorithms like KNN, SVM, ANN. In addition, they used different Ensemble ML algorithms too. Best results obtained by combining traditional methods (MFCC, WPD, HMM-SPL) with non-traditional methods (CDBN) for feature extraction with SVM for classification. The obtained accuracy is 96.4 % which SVM can classify 506 out of 525 instances correctly.

In paper [5], there was a development of a speaker dependent Quranic recitation recognition system. The authors used (CMU) Sphinx-4 open-source tool based on HMM. The data used in the model is from Quran recitation experts and users too. Because CMU sphinx is usually used with the English language, a transliteration mechanism is needed to be able to use it with Arabic language for Quran recitation recognition application. In [4], we find that the system is tested in 4 different ways. These ways are Arabic words with Arabic alphabets, transliteration word with syllable, transliteration compound word with syllable, transliteration syllable with syllable. Accuracy results are 67% for Arabic words with Arabic alphabets, 96% transliteration word with syllable and 94% transliteration compound word with syllable.

The system presented in [6] is an engine to help people to recite the Quran with its rules well which the developed engine is tested on primary Malaysian students. The input data to the system is speech signal and phonetic transcription of the speech. The data used is (Surat Al-Fatihah). The engine used MFCC in features extraction, Hidden Markov Model (HMM) in classification. It is illustrated in this paper that the recognition task is divided into 2 parts, Identification part, which words are recognized based on (Maximum Likelihood) concept and verification task, which features extracted from user input are compared to stored database and threshold is used to verify if recitation is correct or wrong. The data of the system is 5 different reciters 52 Ayates,82 probable samples of phonemes for all Quranic collected samples. ***Word based Model*** and ***Phoneme based Model*** are the 2 different models constructed for training the data. In the testing stage, there are Word(ayates) like-Template and Phonemes like-Template too. Recognition rate is 91.95% for *Ayates* and 86.41% for *Phonemes*. The results are better in (*Ayates*) than (*Phonemes*).

In paper [7], published 2016, Carnegie Mellon University (CMU) Sphinx was used to train the model on The Quran recitations. They focus on using a simplified set of Arabic phonemes instead of the Romanized set of phonemes. The data used was recordings of verses from Quran chapters (1,112,113,114) because they contain few sets of recitation rules. The audio files were converted to 16 kHz,16 bit. Cutting the beginning and ending of files is done as a part of the preprocessing step. The applied ASR system shows good results in recognition with WER lower than 2%. The intention is to include more chapters and more recitation recording to increase the dataset and enhance the model in the future.

The system in [8] is used for Qalalqah checking ‘Tajweed rule’. The purpose is to help students read Quran properly. The Feature Extraction and Classification Technique is ‘hybrid MFCC-VQ architecture’. Overall real-time factor using hybrid MFFC-VQ was faster than traditional method using MFCC. This because MFCC needs much time. Comparing between user’s recitation and expert recitation is done in the system. The data was on ‘sourate *Al-Ikhlas’* from 45 speakers ,20 males, 20 females and 5 children. This paper addresses ‘real time factor’. The system can be used in recognition of Qalqalah Sughrah and Kubrah. Real time factor was 86.928% for males, 94.495% for females and 64.683% for children. Accuracy achieved was 83.9%, 82.1%, and 95.0%. (For males, females, children).

3. References

[1] Khan, Rehanullah & Hadwan, Mohammed & Qamar, Ali. (2019). Quranic Reciter Recognition: A Machine Learning Approach. Advances in Science, Technology and Engineering Systems Journal. 4. 10.25046/aj040621.

[2] Eljazzar, Maged & Alargrami, Ali. (2020). SMARTAJWEED Automatic Recognition of Arabic Quranic Recitation Rules. 10.5121/csit.2020.101812.

[3] Muhammad, Aslam & Qayyum, Zia & Muhammad, Waqar & Tanveer, Saad & Martinez-Enriquez, Ana & Syed, Afraz. (2012). E-Hafiz: Intelligent System to Help Muslims in Recitation and Memorization of Quran. Life Science Journal. 9. 534-541.

[4] Al-Ayyoub, Mahmoud & Damer, Nour Alhuda & Hmeidi, Ismail. (2018). Using Deep Learning for Automatically Determining Correct Application of Basic Quranic Recitation Rules. International Arab Journal of Information Technology. 15.

[5] Hafeez, Aurish & Mohiuddin, Khawaja & Ahmed, Sohaib. (2014). Speaker-dependent live quranic verses recitation recognition system using Sphinx-4 framework. 333-337. 10.1109/INMIC.2014.7097361.

[6] Ibrahim, Noor Jamaliah & Idris, Mohd & Razak, Zaidi & Rahman, Noor. (2013). Automated Tajweed Checking Rules Engine for Quranic Learning. Multicultural Education & Technology Journal. 7. 275-287. 10.1108/metj-03-2013-0012.

[7] El Amrani, Mohamed Yassine & Rahman, M. M. & Shah, Asadullah. (2016). Towards Using CMU Sphinx Tools for the Holy Quran Recitation Verification. International Journal on Islamic Applications in Computer Science And Technology. 4.

[8] Ismail, Ahsiah & Idris, Mohd & N.M, Noor & Razak, Zaidi & Yusoff, Zulkifli. (2014). MFCC-VQ approach for Qalqalah Tajweed rule checking. Malaysian Journal of Computer Science. 27. 275-293.