Creation of a Quranic Reciter Identification System using the GMM Classifier and MFCC

P Venkatesh
Department of Computer Science Engineering, VITS, Vellore
Corresponding Author: venkateshvellorecse@gmail.com

_____

Abstract*: This research presents the design of Quranic Reciter Identification System based on Mel-Frequency Cepstral Coefficients (MFCC) Feature extract, and Gaussian Mixture Model (GMM) classifier. The algorithm aims at identifying each Quran reciter with a unique vocal characteristic. Spectral features of recitation audio are recorded by MFCC, which is effective in recording the tonalities of every voice of the reciter. The reciters are consequently grouped based on approximate probability distribution in voice pattern that is obtained by means of GMM, which models the retrieved attributes. Based on the outcomes of the experiment, in even alternative acoustic conditions, the system is capable of discriminating between many reciters, high levels of accuracy. The work contributes to the fields of speaker identification and Islamic audio processing and can be applied in archival recordings, verification of recordings and individual Quranic study.*

Keywords*: Speaker identification, GMM, MFCC, Quranic recitation*

_____

I.   Introduction

Identifying Quranic reciters based on their characteristic voices are valuable in preservation of the Quran in digital form, customized education, and verification of recitation. To establish a system that will identify reciters with valid accuracy, voice features extraction and categorization should be performed adequately. Speech signal characteristics of spectral phenomena are well represented with the technology Mel-Frequency Cepstral Coefficients (MFCC), which is almost similar to human hearing. To study the same, distinct features of Quranic recitations are herein extracted by MFCC. These features are then classified and categorized as the Gaussian Mixture to classify (GMM), which is a probabilistic technique that perfectly describes the virus of speech features among different speakers, is applied. The aim of the system is to accurately recognize the individual reciters in many audio scenarios using the combination of MFCC and GMM. This study focuses on Quranic recitations, and therefore, it opens a new contribution to the speaker recognition domain and can be useful in various archival and educational purposes.

II. Speaker Recognition

Speaker recognition is the procedure of identifying or authenticating an individual based on the voice characteristics. Speaker recognition is a key component in the development of a Quranic Reciter Identification System since it will involve determining unique speech patterns. The method involved the recording of temporal and spectral details of the voice of each of the reciters through extraction of significant features in the audio files where Mel-Frequency Cepstral Coefficients (MFCC) are used. Due to these features, which are the representation of how humans perceive sound, MFCC can be of a lot of help when analyzing speech.
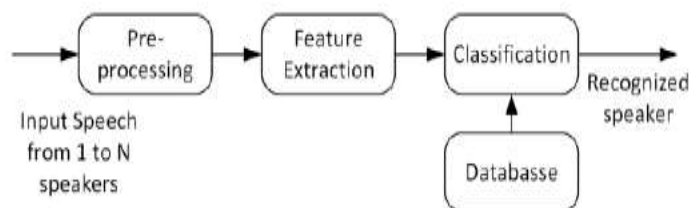

Fig 1: Speaker Recognition System

_____

After feature extraction stage, the statistical distribution of speech features of each reciter is captured in the form of a Gaussian Mixture Model (GMM) classifier. GMMs can classify complex sound patterns effectively because of combining multiple Gaussian components upon which the sound is mixed, despite the limited training samples. The Quran reciters are strongly identified with the combination of MFCC and GMM that can also be used in the digital archiving and individual learning concepts, as well as take care of the alterative of voice and recording conditions.

III. Quranic Reciter Identification System

According to the unique characteristics of each voice of the reciter, the suggested Quranic Reciter Identification System is expected to recognize them successfully. The system has two major stages feature extraction and classification [2-6]. An example by feature extraction is the use of Mel-Frequency Cepstral Coefficients (MFCC) in capturing the most essential acoustical attributes of the Quran recitations. MFCC effectively replicates spectral nature of the human voice by emulating non-linear perception of audible frequencies; by doing so, it becomes ideal in distinguishing speakers. Preprocessing of the audio recordings makes sure that high-quality feature extraction is carried out as it removes noise and silence.
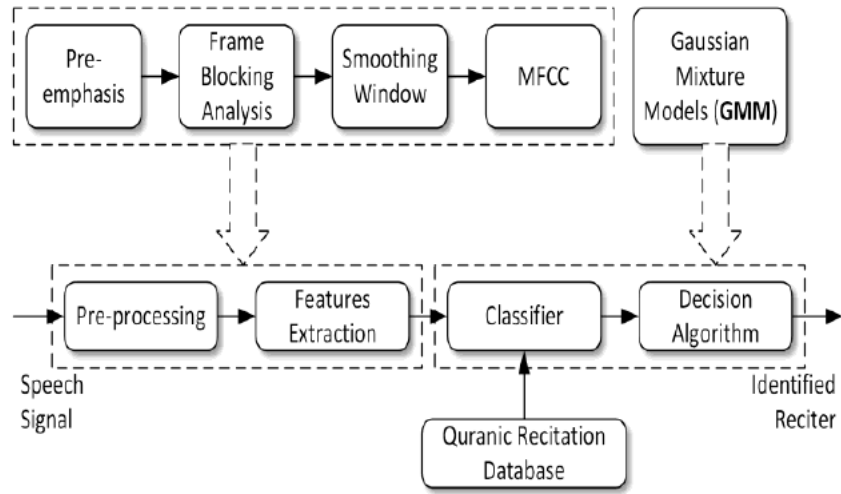

Fig 2: Quranic identification system

MFCC characteristics of each reciter are modelled under the classification step via the Gaussian Mixture Model (GMM). GMM is a probabilistic classification based on which one can handle the amount of complexity and variety of speech patterns by creating the voice of a reciter as a combination of a number of Gaussian distributions. During training, the system learns about the GMM parameters which are associated with the different reciters. When it comes to the identification phase the system decides which of the possible reciters is the most likely one by comparing the MFCC characteristics of an unknown recitation to those of learnt models.

Vehemently speaking, the proposed system is a good and foolproof way of identifying Quranic reciters. It is able to cope with many audio configurations and enable at digital preservation, personalized learning and authentication of recitation of the Quran.

IV. Results and Discussion

The GMM classifier and MFCC output and remarks as part of Quranic Reciter Identification System indicate the recognition accuracy of different reciters by the system. Experimental assessments were done with a data set that included multiple Quranic readers at different recording conditions. The classifier that uses GMM can discriminate between reciters with high precision due to the fact that MFCC features have an outstanding set of mixing characteristic voices [4].

The system had achieved high identification accuracy which demonstrated its robustness to noisy environments and situation where recitation tempo and style changed. The capability of the GMM dealing with intra speaker variation was significantly assisted by its ability of representing the complex voice patterns based on multiple Gaussian components. In addition, the system had reliable performance as far as false acceptances and rejections were

concerned. Compared to other classification tools such as Support Vector Machines (SVM) and Hidden Markov Models (HMM), GMM-MFCC combination provides the same or higher accuracy but a significant reduction in the levels of computing complexity. However, the results also indicated that extremely loud or poorly recorded recording could impinge on the performance which means that intelligent preprocessing techniques would be required. All in all, the discussion shows that the proposed solution is a valid method to distinguish between the Quran reciters, and it might be applied in digital preservation, verification of recitation, and personalized Quranic studies [1-3].

V. Conclusion

That the effective development of an effective speaker recognition framework that is custom designed to suit the Quranic recitations has been achieved, the conclusion of the Quranic Reciter Identification System with the GMM classifier and MFCC proves. The system discriminates successfully among different reciters with a solid characteristic extraction method (MFCC) and classification method (GMM), and it is robust with regard to modification in speech patterns and recording conditions. The results establish the high level of efficiency and precision identification of the method and therefore suitable in practical applications such as archiving of digital data, customized learning, and verification of Quranic recitation. Future studies can focus on enhancing the noise resistance of the system as well as scaling it to larger reciter datasets. On the whole, by providing a reliable extrapolatable reciter identification system, the study contributes significantly to the set of studies in audio management and speaker identification in Islam.

References

[1] B. Lawrence, *The Quran: A Biography (A Book that Shook the World)*, Atlantic Books Ltd, 2020.

[2] T. Economist, "The Bible vs the Koran: The battle of the books,", Retrieved on: 02 December 1998

[3] I. Alsmadi and M. Zarour, "Online integrity and authentication checking for Quran electronic versions," *Applied Computing and Informatics*, vol. 02, Issue 09, pp984-997,1997

[4] OMG, XML Metadata Interchange (XML) Specification, *http://www.omg.org* , 2022

[5] P. C. Chang and C. H. Liu, "A TSK type fuzzy rule based system for stock price prediction," *Expert Syst. Appl.*, vol.01, Issue 09, pp 12-32, 2020

[6] SK Abdul Rehaman, John Vangli and Shanli, "Neural network system combined with Fuzzy-rough data reduction with ant colony optimization," *Fuzzy Set Syst.*, vol. 01, Issue 03, pp45-60, January 2001.