VOICE SEARCH FOR QURANIC VERSES RECITATION

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Abstract - **This paper describes challenges and solutions for building a successful voice search system as applied to Quranic verses. The paper describes the techniques used to deal with an finite vocabulary how modelling completely in the voice domain for language model and dictionary can avoid some system complexity, and how we built dictionaries, language and acoustic models in the framework. The Holy Quran is written in Arabic language, and the Arabic is one of the oldest languages in the world that presents its own features and challenges while searching for Arabic-based content. The most search systems for the Holy Quran is organized around text words (contained in the target verses) but no system organized around voice while there is need to search in quranic recitation. The speech recognition approaches are applied to build the dictionary and test the system, while the MFCC and stemming techniques will be will be applied to find the stem of the word. The development of voice search for Quranic recitation led to a significant simplification of the original process to build a system to retrieving audio information related to the Qur'an, it also helps to build a system to serve people with special needs such as blind,paralyzed, and others who can not use the keyboard.**

Keywords- **voice search; Quranic recitation; Quranic acuistic; Speech recognition**

I. INTRODUCTION

voice search the ability to perform web searches simply by speaking, first appeared around 2008 on iPhone and Android phone in US English, Soon after a several of researchers focusing on developing voice search systems for other languages.[1]
Arabic language is not similar to US English, it is a semantic language with a composite morphology. Arabic words are categorized as particles, nouns, or verbs. Unlike most western languages, Arabic script writing orientation is from right to left. There are 28 characters in Arabic. The characters are connected and do not start with capital letter as in English. Most of the characters differ in shape based in their position in the sentence and adjunct letters.[2, 3]

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The Quran is the holy book of Islam,originally written in Classical Arabic language, consists of 6236 verses divided into 114 chapters called suras. Each surah also differs from one another in terms of the number of verses (ayat) [3, 4].

Orthographic variations and the use of diacritics and glyphs in the representation of the language of Classical Arabic increase the difficulty of stemming[5]. Many verses are similar and even identical.
Searching for similar words (e.g verses) could return thousands of verses, that when displayed completely or partly as list would make analysis and understanding difficult and confusing. Moreover it would be visually impossible to instantly figure out the overall distribution of the Identified or retrieved verses in the Quran. [4]

II. LITERATURE REVIEW

Using our voice to access information has been a part of science fiction ever. Today, with powerful smartphones, cloud-based computing, and speech recognition techniques science fiction is becoming reality.
One of the important voice applications is is a speech recognition technology that allows users to search by saying terms aloud rather than typing them into a search field. The information normally exists in a large database, and the query has to be compared with a field in the database to obtain the relevant information[6, 7].
The proliferation of smart phones and other small, Web-enabled mobile devices has spurred interest in voice search.

The voice applications are available in the markets which recites the holy Quran. One of the most popular and commonly used is Quran Auto Reciter (QAR) [8], and some of applications depend on speech recogniton techniques like Hafas[9] and Ehafiz[10, 11].
This study proposes the system the ability to search in recitation by voice, And the expected benefit of Quranic voice search system is using in retrieving audio information related to the Holy Quran, as well as a systems to serve people with special needs who can not use the keyboard.

A. RELATED STUDIES

In 2008, a new version of GOOG-411 has been deployed which allowed (and encouraged) the user to state their need in a single utterance rather than in sequential utterances that split apart the location and the business. This was motivated by our desire to

accommodate faster interactions as well as allow the user greater flexibility in how they describe their needs[6].

With regard to Quranic search systems, most of researchers have interested on the development of search techniques for the Quranic text, but the principle can be applied in the development of voice search systems, for example,
Kadri et al. [3] proposed a new stemming method that tries to determine the core of a word according to inguistic rules. The new method shows the best retrieval effectiveness. The linguistic-based method can better determine the semantic core of a word.
Naglaa Thabet [5] proposed a new light stemming approach that gives better results, when applied to a rich vocalized text as the Quran. The stemmer is basically a light stemmer to remove prefixes and suffixes and is applied to a version of the Quran transliterated into western script.
Riyad Alshalabi [3] provided a technique for extracting the trilateral Arabic root for an unvocalized Arabic corpus. It provides an efficient way to remove suffixes and prefixes from the inflected words. Then it matches the resulting word with the available patterns to find the suitable one and then extracts the three letters of the root by removing all infixes in that pattern.

Regarding researches in the development of speech recognition techniques to use in Quran recitation applications, there are several research in the field of Quranic voice recognition, of the most famous of such research is an automated delimiter introduced by Hassan Tabbal et al.[8] Which extracts verses from an audio file and coverts Quran verses in audio file, using speech recognition technique. The Sphinx IV framework is used to develop this system.

The core recognition process is provided automatically by the sphinx engine using the appropriate language and acoustic models. The sphinx framework must be configured using an xml based configuration file.
The recognition ratio in the case of Tarteel is slightly better than in the case of TAJWEED. One possible reason for this could be that the majority of the Tarteel recitations available now follows the same monotony and the duration (in time) of each phoneme differs slightly from one reciter to another. There is also the extra noise that is caused by the compression of the audio files and the low quality of the recordings.

Although we had anticipated this by using noisy audio files during the training, but the differences in compression ratios between the files add a lot of variation of the added noise and thus causing extra errors. When unskilled persons tested the system (we even tested it on children), it behaved astonishingly well even when the reciter was a woman, a case that cannot be encountered in real life because it's not usual to have a woman reciting the Holy Quran. There is also an interesting observation drawn from these tests: It is always recommended [12]to train the system with more than 500 different voices in order to reach speaker independence. But we didn't train our system with this relatively large number and still we were able to have remarkable speaker independence results.

The system introduced by Hassan Tabbal[8] an automated delimiter, which extracts verses from the audio files, using MFCC feature extraction. This system is useful for people who are well versed with Tajweed rules. However, users who are not Arabic speakers don't benefit from this system. In addition, it may also not help reciters to improve recitation abilities. The system is useful to those people who already know the correct recitation of the holy Quran and the subsequent rules and not suitable for none Arabic speakers. A system that will be able to help users to know recitation rules (TAJWEED), pointing out mistakes made during recitation is a necessity and a task achieved by the E - Hafiz system.

The other system introduced by Bushra Abro [13] Arabic language which included isolated words and sentences. The dataset comprised of few Arabic sentences and words. The system was built on Al-Alaoui algorithm that trains Neural Networks (NN) and has been able to achieve 88% accuracy on sentence recognition. But the drawback of this technique is that the system was trained on distinct sentences.
Similarities in sentences separate NNs and therefore are needed to be trained which is computationally very expensive, for the purpose of Qur'an memorization, MFCC was used to extract features. The dataset consists of few small Quranic verses and pattern matching was done by Vector Quantization. The system gained good recognition rate but the approach is statistical and therefore difficult to scale up for larger system to be built on complete Qur'an. It is also known to take much time and space complexity which is a shortfall of a real time system.

Zaidi Razzak [14] presents different recognition techniques used for the recitation of the Quran verses in Arabic verse pointing out the advantages and the drawbacks. The most useful method for the project "Quranic verse Recitation Recognition for support j-QAF learning" is explained therein. J-QAF is a pilot program, that aims to encourage learners to learn Quran reading skills, understanding Tajweed and Islamic obligations. The method of teaching j-QAF (teacher and student) is still handled manually. One basic goal of this paper is to automate the learning process.

B. Hidden Markov models

Markov chain is a series of cases and final set of random functions in times of intermittent and continuous[15]. Where assume some conditions, and notices that are generated randomly as initial values for the model. And is moving from case to case again by the probability matrix. Can see the output of the random function and its relationship with the case, but can't figure out stages of the transition from one state to another, nor knowledge of the sequence of observations and time, so called hidden Markov models. Hidden Markov models are classified on the basis of time into two classes: Notes in intermittent times and in times of continuing notes.

C. STEMMING TECHNIQUES

Stemming is a pre-processing step in most of search system. It is the process of removing all affixes (prefixes, suffixes and affixes) from a word to extract its root.
Stemming has been widely used in several fields of natural language processing such as data mining, information retrieval, and multivariate analysis. It is a method for improving the performance of information retrieval systems.
The two approaches of stemming are light stemming and heavy stemming. The former is "the process of stripping off prefixes and suffixes to produce stem of the word"; and heavy stemming is "the process of striping off prefixes, suffixes and affixes to produce the root of the word"[3].

III. METHODOLOGY

There are four major stages in this research. The phases are sequential as described in Figure 1. The stages are as follows;

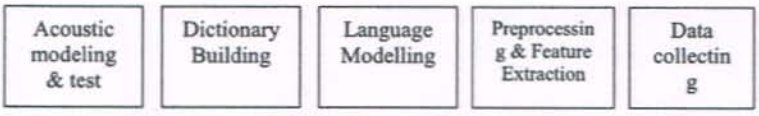

Figure 1 Research stages

A. DATA COLLECTION:

This stage, Acoustic data is necessary to build initial acoustic models and test sets to measure performance.
The Holy Quran contain 77439 words and the roots of quranic words is 1739 roots[16].
Root letters are letters that form the main part of a word. Most of the Arabic words are constructed from root letters.
These root letters provide the basic lexical meaning of the word. They are joined along with some other letters to form different words which have related meanings. Just as the root determines the type of plant, the genes determine the characteristics of a person; similarly roots determine the meaning of the word.

Example: the root – "رحم" joins together to form the original word "رحيم" (Rahim): womb. Mercy is derived from the womb. If we understand the mercy of a mother, then we can understand the concept of mercy that is related to this root. Thus, the root gives the characteristic of mercy.
Most Arabic words have three letter roots and rarely four or five letter roots, and they always maintain their order specific arrangement. Example: "علم" = knowledge and " ع ل م " =action (changing the order gives a completely different meaning!) . This roots come From one set of root letters, come multiple stem words " مصدر" and from them many words emerge out, like from the roots of a plant; the stem and many branches emerge.
For example, the root "ع ل م" gives the stem words:"عِلم" (ilm) and "عَلم" (alam). Furthermore, from the stem word :"عِلم" (ilm) comes the branching words :"يعلم" (ya'lamu), "عليم" (aleem)," عالم " (aalim) etc; and from "عَلم" (alam) comes the branching words "عالمين "(aalameen) etc.
In this stage, also remove of noise from digital audio signals in order to extract the distinctive features of the voice clearly. Also the time and frequency must be consolidated, that can be applied in several ways such as (MA Analysis) In order to be a specific time and frequency(EX. 10s, 22.050hz) [10]. This study will focus on the roots of Quranic words (representing its keywords in database file).

B. PREPROCESSING & FEATURE EXTRACTION

This stage, to remove of noise from digital audio signals in order to extract the distinctive features of the voice clearly. Also the time and frequency must be consolidated, that can be applied in several ways such as (MA Analysis) In order to be a specific time and frequency(EX. 10s, 22.050hz),
Also the process of finding the roots will be done at this stage, Stemming is a pre-processing step in any Information Retrieval (IR) system. It is the process of removing all affixes (prefixes, suffixes and affixes) from a word to extract its root.
Stemming has been widely used in several fields of natural language processing such as data mining, information retrieval, and multivariate analysis. It is a method for improving the performance of information retrieval systems.
The two approaches of stemming are light stemming and heavy stemming. The former is "the process of stripping off prefixes and suffixes to produce stem of the word"; and heavy stemming is "the process of striping off prefixes, suffixes and affixes to produce the root of the word".
As well in this stage the audio signal is processed until we get a clear parameters which enables us to recognize the Speech to analyze its characteristics before recognition process.
Features extraction using MFCC method consists of seven steps [14]. Pre-emphasize is the first step in the process followed by framing, windowing, filtering, transforming using Fast Fourier Transform, log calculations and inverting the Discrete Fourier Transform.
The goal of feature extraction is to find a set of properties of an utterance that have acoustic correlations in the speech signal i.e. parameters that can somewhat be estimated through processing of the signal waveform. Such parameters are termed as features.

Several different feature extraction algorithms exist, namely Linear Predictive Cepstral Coefficients (LPCC): computes Spectral envelop before converting it into Cepstral coefficient.

Perceptual Linear Prediction (PLP) Cepstra: it is based on the Nonlinear Bark scale. The PLP is designed for speech recognition with removing of speaker dependent characteristics.

Mel-Frequency Cepstral Coefficients (MFCC) are extensively in ASR.MFCC is based on signal decomposition with the help

of a filter bank, which uses the Mel scale. The MFCC results on Discrete Cosine Transform (DCT) of a real logarithm of a short-time energy expressed in the Mel frequency scale.

MFFC is the most widely used techniques in the Arab speech recognition because it is effective in noisy, vocal tract, and provide higher result of low bandwidth. The MFCC Processes are; frame blocking, windowing, DFT, Mel Scale Filter, Inverse Discrete Fourier Transform (IDFT) block. In the frame, blocking the speech waveform is cropped to remove silence or acoustical interference that may be present at the beginning or end of the sound file. As an outcome of this process Fourier transformation process is enabled[17].

Windowing: In order to minimize and eliminate discontinuity from the start and end of each frame of the signal, Hamming window process is applied. It is the most commonly used in MFCC to minimize the discontinuities of the signal by tapering the beginning and end of each frame to zero.

Discrete Fourier Transform (DFT): Due to the speech signal form is a set of N discrete number of samples (windowed signal Y1 [k]... Y1 [m]), each frame sample is converted from time domain into the frequency domain (a complex number Y2 [k]). DFT is normally computed through Fast Fourier Transformation (FFT) algorithm.

Mel Filter-bank: Low frequency component in speech contains useful information as compared to high frequency. It represents the relationship between the frequency in Hz and Mel scale frequency. In order to perform Mel-scaling, a number of triangular filter-bank is used and therefore, a bank of triangular filters is created during MFCC calculation, collecting energy from each frequency band[17].

Inverse Discrete Fourier Transformation (IDFT): The final step of MFCC feature extraction is to take inverse of DFT. As an output of this step we get features of speech in vector format called feature vectors. The feature vector is obtained. This feature vector is used as input of the next phase. MFCC feature is considered for speaker–independent speech recognition and for the speaker recognition tasks as well.

C. Language Modelling

As it is known that the Quran is written in the original classical Arabic. And Arabic is one of the languages that are often described as morphologically complex and the problem of language modeling for Quranic recitation are multipart by the methods and speed of recitation.It is also there are many difficulties begin when dealing with the specialties of the Arabic language in Al-Quran, due to the differences between written and recite Al-Quran [8, 18, 19]. The Quranic Arabic alphabets consist of 28 letters, known as hijaiyah letters (from alif (ا)...until ya (ي)) [12, 19, 20]. Those letters includes 25 letters, which represent consonants and 3 letters for vowels (/i: /, /a: /, /u :/) and the corresponding semivowels (/y/ and /w/), if applicable. A letter can have two to four different shapes: Isolated, beginning of a (sub) word, middle of a (sub) word and end of a (sub) word. Letters are mostly connected and there is no capitalization. The letter is represented as below at table, in their various forms.

Table 1 . The various forms of Arabic letter

Character	Name	Isolated	Initial	Middle	Final
Alif	ألف	ا	ا	ـا	ـا
Ba'	باء	ب	بـ	ـبـ	ـب
Ta'	تاء	ت	تـ	ـتـ	ـت
Tha'	ثاء	ث	ثـ	ـثـ	ـث
Jeem	جيم	ج	جـ	ـجـ	ـج
H'a'	حاء	ح	حـ	ـحـ	ـح
Kha'	خاء	خ	خـ	ـخـ	ـخ
Dal	دال	د	د	ـد	ـد
Thal	ذال	ذ	ذ	ـذ	ـذ
Rai	راي	ر	ر	ـر	ـر
Zai	زاي	ز	ز	ـز	ـز
Seen	سين	س	سـ	ـسـ	ـس
Sheen	شين	ش	شـ	ـشـ	ـش
Sad	صاد	ص	صـ	ـصـ	ـص
Dhad	ضاد	ض	ضـ	ـضـ	ـض
Tta'	طاء	ط	طـ	ـطـ	ـط
Dha'	ظاء	ظ	ظـ	ـظـ	ـظ
A'in	عين	ع	عـ	ـعـ	ـع
Ghain	غين	غ	غـ	ـغـ	ـغ
Fa'	فاء	ف	فـ	ـفـ	ـف
Qaf	قاف	ق	قـ	ـقـ	ـق
Kaf	كاف	ك	كـ	ـكـ	ـك
Lam	لام	ل	لـ	ـلـ	ـل
Meem	ميم	م	مـ	ـمـ	ـم
Noon	نون	ن	نـ	ـنـ	ـن
Ha'	هاء	ه	هـ	ـهـ	ـه
Waw	واو	و	و	ـو	ـو
Ya'	ياء	ي	يـ	ـيـ	ـي

D. Dictionary Building

After feature extraction process executed, to build the Quranic recitation dictionary, the recognition process will compare the

extracted features with its reference model. This reference model is developed, after the enrolment or training phase had been successfully implemented. In this case, the reference model (stored model in database) used consist of 2 types of models, which are Word based Model and Phoneme based Model.

The reference model for phoneme[12, 21] based model is totally differs from word based model, where speech features that have been extracted are directly compared to the word templates.

The Quranic recitation has 60[22] phoneme that led more difficulties to the dictionary building. Here, each of word templates in direct matching model will store as a vector of features parameters. Word based model will be used as a first model, while phoneme based model been the second model used as template matching at testing/recognition part.

E. ACOUSTIC MODELING & TEST

The acoustic modelling will be done by HMMs, Nevertheless there are three methods for: Hidden Markov Models HMM, Vector Quantization (VQ), Artificial Neural Network (ANN)[12] and Hybird Model[23].

HMM or VQ can be apply for training and testing. HMM is used when Arabic language recognition has to perform and VQ for English language[24] HMM had introduced the Viterbi algorithm for decoding HMMs, and the Baum-Welch or Forward-Backward algorithm for training HMMs. All the algorithm of HMM play a crucial role in ASR. It involved with states, transitions, and observations map into the speech recognition task.

The extensions to the Baum-Welch algorithms needed to deal with spoken language. These methods had been implemented by D. Jurafsky and J. H. Martin (2007) in their research. Here, speech recognition systems train each phone HMM embedded in an entire sentence. Hence, the segmentation and phone alignment are performed automatically as parts of the training procedure[14]. It consists of two interrelated stochastic processes common to describe the statistical characteristics of the signal. One of which is hidden (unobserved) finite-state Markov chain, and the other is the observation vector associated with each state of the Markov chain stochastic process (observable)[17].

Artificial Neural Network (ANN) is a computational model or mathematical model based on biological neural networks. The procedure depends on the way a person applies intelligence in visualizing, analyzing and characterized the speech based on a set of measured acoustic features[14], but the basic neural networks are not well equipped to address these problems as compared to HMM's.

Vector Quantization (VQ) Quantization is the process of approximating continuous amplitude signals by discrete symbols. It can be quantized on a single signal value or parameter known as scalar quantization, vector quantization or others. VQ is divided into 2 parts, known as features training and matching features. Features training is mainly concerned with randomly selecting feature vectors and perform training for the codebook using vector quantization (VQ) algorithm[14].

IV. EXPECTED RESULT

The results can be summarized as expected:

1. Create a new system that able to search in Holy Quran by vioce.
2. Help the special needs people in the Quran search and access to the selected Sura easly .
3. Assist in the development of audio information retrieval systems regarding the Quran .

V. CONCLUSION

This paper has covered many aspects of speech recognition system and Quranic recognition,and focusing on The voice search in Holy Quran. And this research funding will be highly beneficial with special needs and who can not use the keyboard, as it will be useful in information retrieval researches in the Holy Quran..

By the end of this study it is expected that the existing models will be enhanced and improved for more suitable for specificity the Holy Quran.

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