

A Knowledge-based System for Extracting Combined and Individual Quranic Recitations

Moulay Ibrahim El-Khalil Ghembaza

Department of Computer Science and IT Research Center for the Holy Quran and Its Sciences (NOOR),
College of Computer Science and Engineering (CCSE),
Taibah University,
P.O. Box. 344, Medina, Kingdom of Saudi Arabia

Abstract

The aim of this research is to create a web platform to facilitate the teaching and training of various Quranic recitations called "*Qira'at*" using the methods of combined Quranic recitations and individual Quranic recitations via speech/audio and writing text. To do so, this study propose an approach that extracts the ten minor combined-recitations according to Al-Shatibiyyah and Al-Durrah approaches, extracts the seven combined-recitations from Al-Shatibiyyah, and extracts the three combined-recitations from Al-Durrah. Moreover, this approach extracts the group of imams, the individual imams, the individual narrations, the variant methods and their modes of recitation from the ten major combined-recitations according to Al-Tayyibah approach; and is applied on the fourth verse of Chapter "*Al-An'am*", which contains one sub-verse. This study also mentions the statement and explanation of the principles and steady rules of each recitation and the unsteady rules by evidence shown from Al-Shatibiyyah, Al-Durrah and Al-Tayyibah approaches. This study is achieved using concepts from expert systems through the establishment of knowledge bases emanating from expert scholars in Quranic Qira'at, and an inference engine to extract the steps of the combined Quranic recitations and the steps of the individual Quranic recitations in text and audio media formats. A prototype of the proposed expert system is presented based on the collected knowledge base and the database. This research is precedent in demonstrating how far expert systems can be applied to the science of Quranic recitations.

Keywords: *Expert Systems, Knowledge Base, Al-Tayyibah, Al-Shatibiyyah, Combined and Individual Quranic Recitations.*

1. Introduction and Motivation

The science of Quranic recitations, "*Qira'at*", literally means the Quranic readings, which terminologically refers to the multiple various modes of reciting the Holy Quran. Qira'at involves the identification and understanding of the modes by which each of the imams of Qira'at and their narrators recited Quranic words and verses.

Each recitation is attributed to one imam; i.e. each imam has his associated recitation, and this attribution does not imply invention nor creation by the imam, however, it is an inherent and inseparable attribution of proficiency,

expertise and knowledge of that imam. Imams receive their recitations from the Prophet Muhammad (peace be upon him). The famous recognized uninterrupted Quranic recitations have reached us today in frequent, continual, truthful, precise, and authentically form and relate to the recitations that contains the ten schools of famous imams and their twenty famous narrators; i.e. two narrators for each imam. A narrator has his methods and chain of narration, in which he selects a particular mode of recitation that is spread from him; the narrator possesses steady rules that apply to every part of the recitation principles that is frequent and has a uniform rule unless otherwise excluded. These rules are considered fundamental principles of any imam or narrator. Quranic "*Farsh words*" are words that are not frequent and have no uniform rules. They are sometimes referred to as unsteady rules with respect to steady rules. They are words which are considered to have a variance script writing or pronunciation. Fig. 1 illustrates the hierarchy of the above terminologies associated with recitations with five levels showing the ten imams and their twenty narrators and their primary and secondary chains either as a direct chain between the imam and his narrator, method and chain of narration, or an indirect chain through one or more sheikh. *Al-Shatibiyyah* [1], *Al-Durrah* [2], and *Al-Tayyibah* [3] are the famous poems of the Qira'at, and became references approaches for learning Qira'at. The famous recognized uninterrupted Quranic recitations are the recitations stated by Ibn Al-Jazari in his poems "*Al-Tayyibah*" and "*Al-Durrah*" and the poem by Al-Shatibi called "*Al-Shatibiyyah*". Those Quranic recitations are currently adopted in the learning Qira'at. When the texts of Al-Shatibiyyah and Al-Durrah are combined, they are known as the ten "*minor*" recitations; meaning that each narrator has only one method of Quranic recitation. In contrast, the ten major recitations are only contained in the poem of Al-Tayyibah. The term "*major*" means that they contain a thousand chains of narrations in contrary to the ten minor recitations in which each narrator has a single chain of narration.

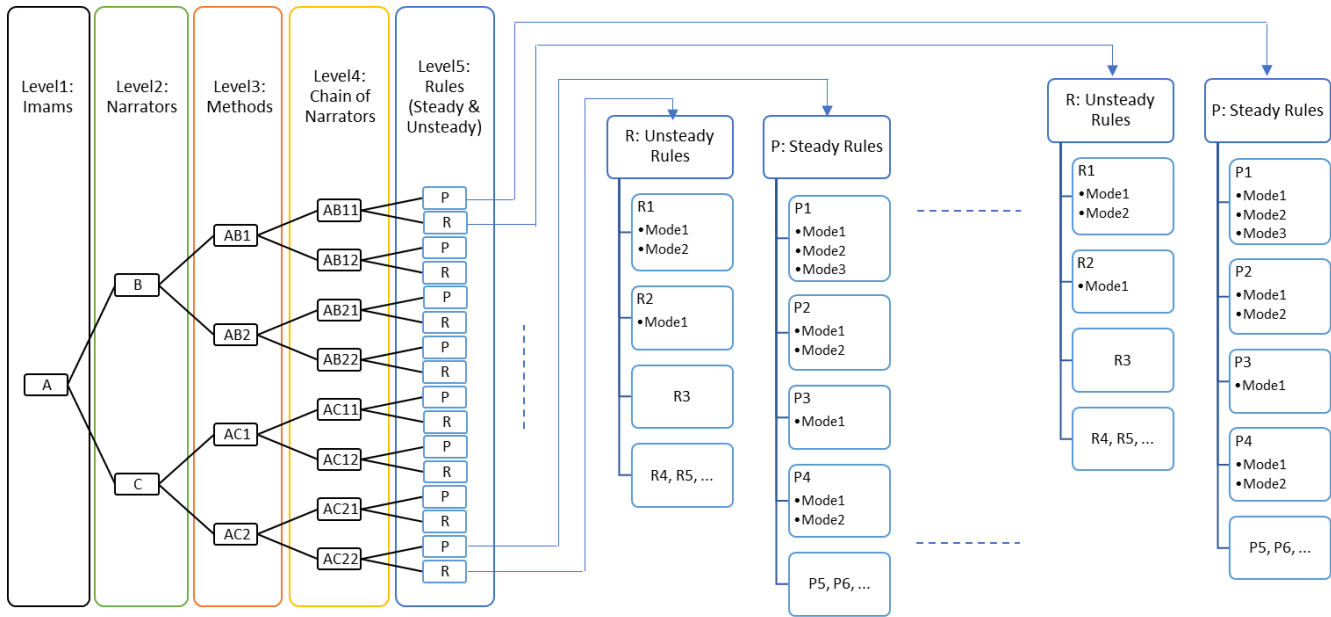


Fig. 1 Hierarchical Qira'at terminologies.

The recitation approaches refer to either the individual- or combined-methods. The method used in the combined-recitation is called the "Waqf" in which the reciter starts the recitation with the narration of Qalun, then follows with the narrator who is closer to the end of the verse unless it has been included with Qalun because the similarities modes. And so, until reciting all the methods of all the imams with their principles and stating their Quranic Farsh words. This recitation approach is not allowed for novice reciters unless he has full knowledge of the individual-recitations.

In order to glorify the practice of the individual-recitations of narrators and for fear of the disappearance and extinction of the science of individual full complete recitations, the topic of this paper was required to cover a review of this science and extract it from the combined-recitations.

Computerized support that is required to deal with the Holy Quran typically involves the development of extensive databases for all that relates to the Quran and its sciences in order to meet the needs of researchers, and scholars in terms of knowledge about the Quran, which should be classified using a comprehensive and authenticated manner. The important databases of Quran and its sciences include those that deal with the science of Qira'at, which contains the details of imams, their narrators and the multiple methods and modes of their recitation.

Due of the importance of the Qira'at science and in order to contribute to its propagation, and facilitate learning of such

sciences using computational techniques, the idea of this research was henceforth established. The motivation here is to build a Quranic information system to recite the Holy Quran using the combined- and individual-recitation methods. This system presents the Quran with various recitations, individually extracted from the variant combinations, each with its different modes, and according to their order retrieved from the Text of the Qira'at poems. This study uses an explanation of the principles and rules of each recitation and the Quranic Farsh words via evidences retrieved from the Text of the Qira'at poems. All such explanations are presented using written and voice formats. The approach presented in this study uses the concepts and characteristics of expert systems to try to simulate the learning of Qira'at for combined- and individual-recitation methods in the process of integrated information retrieval for the user.

Most of the websites or applications that offer the subject of Qira'at are mostly concerned with recitations only, without offering any assistance for learning. Furthermore, most of those existing applications are only concerned with the combined Quranic recitations, without referring to the individual Quranic recitations. Hence, it was necessary to construct a system, concerned with teaching and reciting Qira'at using the individual-recitation method through its extraction from the combined-recitations method of the ten authentically recognized schools of Qira'at. The proposed system provides the rules for the combined-recitations and the extraction rules for the individual-recitations, in order

to distinguish each imam and narrator of each other as to when they agree or differ in recitations, in case of individual- or combined-recitation methods. The proposed system is based on the symbolic coding found in the Qira'at poems. The proposed system also provides a means for reciting the Holy Quran after selecting the narrator and its mode of recitation, and presenting it sequentially, or choosing some verses to be displayed. It also allows displaying the fundamental principles and associated Quranic Farsh words of each verse in the narration and the mode chosen. Additional features include, choosing the desired Chapter for learning the individual-recitation method, using a choice of consecutive verses, or one verse of a Chapter, or choosing an imam, a narrator and the learning mode, or a choice of groups of imams. The system can be used to hear the vocal sounds of an individual-recitation of the verse with its explanatory text written on the screen during the recitation, with the evidence from Text of the Qira'at poems.

After describing the important related terminologies of Quranic recitations, the motivation and objectives in this section, the background related to science of Qira'at and the problem description are stated in the second section. Namely explaining the ways for learning Qira'at, together with the most important poems composed and authored in the science of Qira'at. In particular, it is worth mentioning the poem of Al-Tayyibah in detail for its importance in this study and the fact that it contains the symbolic coding of the ten major recitations that contains the conditions of using the symbolic coding of the imams, the narrators, the methods and the modes in order to extract the individual-recitations or groups of recitations. In addition, this study compares the symbolic coding of the imams and narrators in both Al-Shatibiyyah and Al-Tayyibah approaches. The third section reviews and discusses some of the related works and previous studies, including some of those applications and websites related to the science of Quranic Qira'at. The fourth section deals with the architecture and modeling of the proposed expert system, including a demonstration of a prototype using a set of knowledge bases for the proposed expert system and its data modeling. Moreover, this study explains the methodology and the main phases involved, including; how to gather the rules of the system, and the collection of data which it relies on. The designed system prototype is based on a knowledge base and a database. This prototype will be presented in the fifth section, with an explanation of the method of extracting the individual imams, groups of imams, narrators and methods that are related to the ten major recitations (combined- and individual-recitations), which is applied on the fourth verse of Chapter "Al-An'am" ("The Cattle"). Finally, the conclusions and future work are presented in the sixth section.

2. Background and Problem Description

Only those who perfectly memorizes the Holy Quran should recite with the combination of multiple various recitations. The combined-method is faster for the learners, though there is disparity in the levels from one person to another, some are medium while others only perfect one recitation from one narrator and find it difficult to recite using the other narrations. In view of this, it is appropriate for such learners who only memorized with one or two narrations to find a means to train using that narration which they perfect so that the various recitations will not confuse them. Hence, the necessity of extracting a single narration for such people in order to recite through one narration or a certain uninterrupted and famous chain for a particular narration recitation. In other words, it is the extraction of a single narration or a group of narrations or a method of narration which the teacher also requires to assist the students who want to learn recitation with one, two or more narrations.

The fundamental method adopted by the foremost generation of scholars is for the learner to do a complete recitation of the Holy Quran in-front of his teacher using one narration only without the combination of other narrations; such as the narration of Qalun, Warsh, or Hafs¹ etc. This is known as "*Ifrad*" i.e. individual Quranic recitation, which is the fundamental approach of learning recitation, and was the practice of the early generation until after the first ten centuries, when combined-recitations emerged due to the length of time it takes to finish the Quran with all the ten Quranic recitations through individual-recitation of each method separately. Another reason for this was the speed to complete the Quranic recitation learning. No teacher had allowed it before, except for learners who perfectly complete each recitation, one after another and perfect the methods of narrations, and have completed a full independent individual-recitation for each narrator. None of them allowed any learner to recite for any of the seven or ten imams in one full complete recitation "*Khatmah*" of the Holy Quran except during the recent times.

2.1 Modern Learning Methods of Qira'at

Hence, combined-method allows a reciter to recite each verse or sub-verse of the Holy Quran with all its various modes of recitation before moving onto another verse. By this approach, he learns the Qira'at of the Holy Quran in one full complete recitation, based on the famous rules and regulations which are the consideration of perfect stopping and starting, and avoidance of composition of different

¹ The famous recitations in Islamic world.

modes in one single recitation. There are various methods as follows:

1. Combination for one verse: It is for a reciter to select one particular verse in which he completes all the different modes of recitations of one narration and its chains and then moves onto another narration. He begins each verse with the recitation of Qalun followed by those who agree with him and so on;
2. Professional combination for a verse: It is same as for the combination by one verse, however, differs in the sense that when the reciter finishes with the recitations of a narrator in the first verse, he starts with him in the second verse;
3. Combination using the *Waqf* approach: It is for a reciter to determine the position of a sub-verse on which it is right place to stop; the learner completes all the different modes of recitations of one narration and its chains before moving onto another sub-verse.
4. Professional combination using the *Waqf* approach: It is same as above in terms of reciting a sub-verse, however, differs in the sense that when the reciter finishes with the recitation of one narrator in the first sub-verse he begins with the same narrator in the following sub-verse;
5. Combination using the *Harf* approach: It is for a reciter to recite a verse, and whenever he comes across a Quranic Farsh word in which there is a difference of recitation, he would repeat the word according to the various modes in it and completes the recitation for one single narration, and so on.

The approach proposed in this study can be applied for all the learning methods of Qira'at mentioned above, except for the fifth approach.

2.2 Poem Texts in Qira'at

As part of the methods used for supporting the teaching of this science, numerous Texts have been written. For instance, some Qira'at Texts are written in poetry form, composed for the seven authentically recognized recitations of which the adopted text by scholars of Qira'at is Al-Shatibiyyah. Such text is made up of 1173 poem-verses written by Abu Muhammad Al-Shatibi Al-Andalusi [1]. Another text is Al-Durrah, composed by Ibn Al-Jazari [1, 2]. This text is made up of 240 poem-verses in the same pattern as Al-Shatibiyyah. It is composed for the three complementary recitations of the ten minor recitations which are the recitations of Abu Jaafar, Yaqoub, and Khalaf the tenth. In his poem, he only stated the areas in which those imams differ in their fundamental principles as stated in the text of Al-Shatibiyyah.

2.3 Poem Text of Al-Tayyibah

The text of Al-Tayyibah contains the ten major recitations contained in the book "*Al-Nashr*", which was compiled from thirty-seven other Qira'at books, a thousand chains and was stated along with them selected recitations that were not documented before in spite of the soundness of their chains and fulfilment of the requirements of recitation. The poem is made up of 1015 poem-verses and contains the requirements of sound recitation. He also mentioned the ten imams along with the twenty narrators and the symbolic codes of each of them. As well as the symbolic codes referring to a state of combination and agreement of the imams, stating the places of permissible stopping and starting of the recitation, followed this with the fundamental principles and the Quranic Farsh words which are infrequent words that have no uniform rules. In this poem [3], Ibn Al-Jazari used the symbolic codes and terminologies of Al-Shatibi except for those imams that are not in Al-Shatibiyyah. Since Al-Tayyibah contains about a thousand chains of narration, there is a need to evaluate those modes so that no reciter may commit composition of different modes in a single one.

2.4 Comparison of Symbolic Codes in Al-Shatibiyyah and Al-Tayyibah

Ibn Al-Jazari followed Al-Shatibi by using the alphabets as symbolic codes for the imams and their narrators. In his poem, while he used single letter codes to indicate the names of each imam and each narrator individually, he used some word codes for some groups of imams when they agree on a certain recitation or more. Those word codes are twenty in number, as mentioned in [4] as well as a collection of the ten imams, their twenty narrators, and their primary and secondary chains.

Ibn Al-Jazari derived this system from the order of symbolic codes in Al-Shatibiyyah without going against it because the scholars of this science are used as well as the order of Al-Shatibi, such that anyone that has memorized them may be able to recall what is in Al-Shatibiyyah. Similarly, anyone that memorizes Al-Shatibiyyah will be capable of extracting what is in Al-Tayyibah. Furthermore, the Arabic letter (*wāw* "و") is considered the pivot of the symbolic codes in Al-Tayyibah as it is in Al-Shatibiyyah, because it is used to provide a separation between one recitation and the one next to it.

The terminologies and rules of Al-Shatibi stated in his Qira'at poem [1] in which he was emulated by Ibn Al-Jazari in his Qira'at poem [3] are very important issues that a learner must perfect, since without them he cannot understand the two poems with the steady and unsteady rules they contain.

The chains of narration of Al-Shatibiyyah and Al-Durrah are twenty-one, since each narrator has one method except the chain of *Idris* via *Khalaf* in his selection in which he has two methods in Al-Durrah. That is why its evaluations were simple. As for the chains of narration of Al-Tayyibah, they are as said before about a thousand chains, since for each of the twenty narrators, there are two methods, and for each of the two methods, there is two chains of narration. That is why its evaluations were hard and long. Hence, evaluators made their efforts to take inventory of the Quranic verses and outlined the allowed and disallowed modes of recitations through these chains in their writings.

3. Related Work

There are many websites, forums, web-applications, smart-phone applications, and desktop applications that deal with Quranic Qira'at; but most provide simple classical services such as listening to a specific recitation or a specific narration; browsing or downloading a reference or a textbook related to Qira'at science, listening to one of the Qira'at poems, etc. This section presents some of those applications and websites that provide such services, whilst taking advantage of those ideas.

In [5], a project was completed from Chapter Al-Fatihah until the end of Chapter Al-Mayidah for the seven Qira'at according to the Shatibiyyah approach. Additionally, in [4], the ten Qira'at with combined-recitations was developed according to the Tayyibah approach through the construction of a database system to display the verses of the Quran for the ten combined Qira'at, with clarifications of the principles, rules and evidences from Al-Tayyibah. The explanations were provided in audio and text format; and was implemented on the first eight verses of Chapter Al-An'am [4].

In this study, the individual-recitations will be addressed, which are derived from the combined-recitations of the ten major recitations. A Quranic information system based on a tabular approach for the development of extracted individual-recitations has been proposed in [6] for all narrators through the combined-recitations of the seven Qira'at [5] according to the Shatibiyyah approach system. This system presents the Quran with the seven different Quranic recitations [6], derived from the combined Quranic recitations, for the fourteen narrators, each with its different methods and modes, and according to their order in the poem text of Al-Shatibiyyah, with the clarification of the principle rules and unsteady rules of Qira'at, with the explanations of evidences from Al-Shatibiyyah being presented using audio and textual format.

Numerous websites provide contributions propagating the science of Qira'at, such as audios, videos, lessons, books and Quranic poems using voice and written explanations. For instance, khayma.com [7], includes: seminars of the certified persons in Qira'at, and interviews with famous reciters, the biography of some contemporary reciters and other recorded TV programs. This website has also included most of the Quranic poems related to Qira'at and their explanations to assist the learner. The contribution in [7] included recitations of most of the Quranic Chapters with all ten Qira'at, as well as a library of desktop applications to teach *Tajweed*¹. The website albodoor.com [8] provides some contribution, such as details of the history of the ten imams, the ten Qira'at methods according to Al-Shatibiyyah and Al-Durrah approaches, the Quranic Farsh words of the Qira'at, and the science of directing the Qira'at from Al-Shatibiyyah and Al-Durrah with a full complete recitation of the Holy Quran of all the ten minor Qira'at and their "*Mus'haf*"², in addition to Qira'at reference books. The website islamweb.net [9] provides audios and videos for all the ten minor Qira'at, as well as the full text version of all the twenty narrators. This website assists students in recitation practice and reading about each narrator individually.

The nquran.com [10] is a web-application for Qira'at science and counting-verses science³. It contains the following: the ten minor Qira'at with the *Uthmanic*⁴ script writing and displayed according to the narrators by selecting them from a list that uses colors to show the differences versus the narration of Hafs; Qira'at memorizing tools such as the audio narration of the recited verses. The comparison of verses for each narration, and its differences with the Hafs narration is shown in red; differences between the narrations of each imam. The *Fatawa*⁵ section of the Holy Quran contains fatwas, rulings, interpretations and related issues in the sciences of the Quran. The Quranic poems include the Tajweed and the Qira'at poems and poems for others Quranic sciences offered in video and audio format. This web-application also shows the different methods for counting the verses with comparison of the places of agreement and disagreement. Moreover, Quranic recordings of famous reciters, lectures and lessons; a special section of manuscripts (containing 127 manuscripts of the Quran and its sciences) are provided. As well as other services such as news about programs, reciters, competitions and others regarding the Qira'at. The mosshaf.com [11] is a

¹Tajweed refers to the rules governing learning how to pronounce Quranic words during the recitation of the Holy Quran.

²Mus'haf means literally a collection of pages, which terminologically means the compiled and written copy of the Holy Quran.

³The ending of the verses.

⁴Uthmanic script is the script that was used to write the text of the Holy Quran in Arabic language.

⁵A legal opinion, ruling or decree issued by an Islamic lawyer.

comprehensive electronic encyclopedia of the Holy Quran and its sciences and it is considered as a huge project to serve the Quran. The Encyclopedia consists of twenty sections, each of which is a stand-alone web-application, and includes: the text of the ten Qira'at in the margin of the Holy Quran with the Hafs narration; and with the notice of Quranic Farsh words, and the rulings for all the ten Qira'at. Additionally, information is provided on a number of topics, including: the interpretation section, the interpretation of judgement verses, the prophetic interpretations, and the audible interpretations of some interpretation books related to Quranic science, rhetorical miracles, Quran Tajweed, similarities of verses, translations of the meanings of the Quran, the reasons of revelation, the dictionary of verses, the index of the beginnings of verses, uncommon Quranic words, Quranic broadcasts, Quranic recitations for famous reciters. Other features provided include the possibility of searching in similar or identical words in the Holy Quran, and browsing the Quran with Uthmanic script, without needing the font on the user's device.

The project for spreading the ten minor Qira'at [12] through the development of a web-application and a mobile-application for smart-devices (both Android and iOS) were provided in two editions: one for *Al-Shamrili Mus'haf*¹ and the other for *Al-Madinah Mus'haf*². There were also marks showing the variants of Quranic Farsh words in color. In addition, there are evidences from Al-Shatibiyyah and Al-Durrah on the margins of the pages of the Quran. Also, the science of directing the ten minor Qira'at using the first full complete audio Quran combined-recitation for all the ten minor Qira'at methods, divided into verses and containing more than 100 hours with the voice of *Sheikh Taha Al-Fahd*, and other voices with more than 1000 minutes of sound, containing 186 explanations of the verses in terms of Quranic Farsh words arranged by their positions. Furthermore, other features had included an explanation of the origins of each narrator, and colorful graphical tables to compare some of the principles and combinations modes of some verses with differences relating to the Quranic Farsh words; with the possibility to show the interpretation or the text of the verse or evidences during the time of recitation.

4. Architecture and Modeling of the Proposed Expert System

Expert systems can give programming a new dimension by introducing intuitive rules and intuitive knowledge. Expert systems employ a high level of expertise that enables the

¹ A famous printing version of the Holy Quran found in Egypt and other countries.

² A famous printing version of the Holy Quran in Saudi Arabia.

user to gain experience in knowledge of the expert system. This study uses the concepts and characteristics of expert systems to simulate the process of learning the various Quranic recitations that include the combined- and individual-methods, and the process of retrieving relevant information for the user. Moreover, the system provides various levels of expertise that relate to steps that accomplish the extraction approach.

4.1 Expert System for Quranic Recitations

Expert computer systems have emerged as a branch of artificial intelligence, with expert systems being designed to perform tasks related to human experience [13]. Here, the expert system attempts to carry out processes that are usually human-centered and involves support or decision-making in a particular situation, based on a prior description of this situation. Expert systems are commonly based on knowledge bases that contain an enormous number of fact-based rules containing knowledge. Knowledge is represented as a set of instructions to solve the problem, by means of structured and conditional rules: "IF (condition/premise) – THEN (action/conclusion)". In such systems, it is easier to separate knowledge from control or to add new knowledge either during the development of the system or in the light of the experience gained by the development of the system.

The subject matter of this study, which requires an expert system to solve it, can be classified as a kind of "planning" approach: meaning that handling a series of successive events that achieve a set of objectives with specific initial conditions and operating time constraints. The basic components of a rule-based expert system are shown in Fig. 2:

- Knowledge Base: includes *knowledge* related to the field of expertise.
- Database: includes facts and data related to the field of expertise.
- Inference Engine: a system for processing knowledge and deducing the inference method.
- User interface: allowing the user to access the knowledge of the expert system.

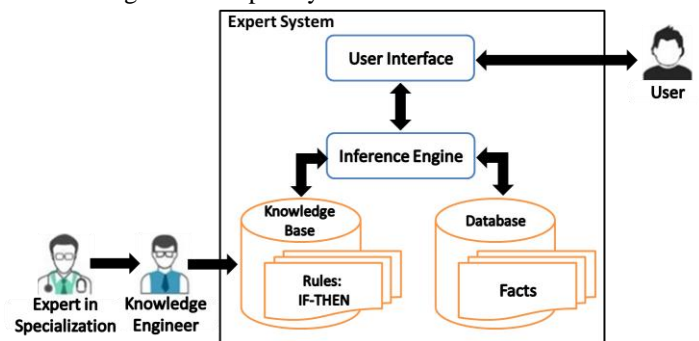


Fig. 2 Architecture of the proposed rule-based system.

4.2 Knowledge Base Construction

A knowledge base refers to a human knowledge model that is a part of the expert system, based on facts consisting of a set of definitions, hypotheses, criteria, instructions, and probabilities describing the problem area. A knowledge base is based on the techniques of representing knowledge that consists of a set of logical and mathematical rules and assumptions that describe how facts fit together in a logical state/situation. The knowledge of the expert is collected and derived from techniques used by the knowledge engineer. Knowledge in expert systems can be represented in different ways, with the most common method being case-based [14] and production-based (also called rule-based) [15], or a combination of both [16]. Knowledge is represented in the form of rules (base of rules) linking between the case/situation (base of events) and the specific reaction required for such a case/situation. A number of other methods present suitable approaches for designing intelligent systems, however, such approaches are not suitable to represent knowledge for real applications [17]. The two common types of representing knowledge can therefore be defined as follows:

- Rule-based systems: such systems run a series of rules to arrive at a specific conclusion on solving the problem according to the data provided to the system;

- Case-based systems: are those systems that derive their conclusions by comparing a particular situation to a case or example stored in the system's knowledge base.

Compiling rules of the knowledge base is an important stage in the process of building an expert system. Here knowledge refers to the facts, information, principles, basics, and steady/unsteady rules acquired in the science of Qira'at. Knowledge is obtained through an expert in the science of Qira'at. Scholars are experts who possess a vast amount of specialized knowledge in the fields of Qira'at science, through which the rules of knowledge can be built by rephrasing the way in which they write the steps/modes of a combined-recitation (to recite a sub-verse or a verse from a specific Chapter) as logical rules in order to be computerized. Table 1 shows a sample set of knowledge rules for the proposed expert system.

4.3 Database Construction

The science of Qira'at is a very important Quranic science that includes many terminologies, rules and information that must be analyzed. The system requirements were identified, the user needs of the system were examined, and the rules of the system were understood. The relevant facts were collected, and the data on which the system relied on was analyzed. This section discusses the system data model and the facts on which it depends.

Table 1: A sample of a set of knowledge rules for the proposed expert system

Legends:		Rules					
NA	Not Applicable						
–	Does not matter if the condition is Yes or No						
✓	The action is applied.						
Conditions	Imam (X) mentioned in the steps of the ten major combined-recitations	Yes	No	No	No	Yes	Yes
	Narrator (Y) mentioned in the steps of the ten major combined-recitations	–	Yes	No	No	Yes	Yes
	Method (Z) mentioned in the steps of the ten major combined-recitations	–	–	Yes	No	Yes	Yes
	Asbahani method mentioned in the steps of the ten major combined-recitations	NA	NA	NA	NA	NA	Yes
	The steps of the ten minor combined-recitations	NA	NA	NA	Yes	Yes	Yes
Actions	Write in the steps of extracting individual-recitation for the desired imam with respect of narrator precedence	✓					
	Write in the steps of extracting individual-recitation for the desired narrator with respect of method precedence	✓	✓				
	Write in the steps of extracting individual-recitation for the desired method	✓	✓	✓			
	Write in the steps of extracting group of imams if required with respect of imam precedence	✓				✓	✓
	Write in the steps of extracting the seven recitations with drop of the three last imams				✓		
	Write in the steps of extracting the three recitations with drop of the seven imams and Abu-Jaafar with higher precedence				✓		
	Write the second number for voice in the steps of extracting the ten minor recitations with respect of precedence					✓	
	Write the second number for voice in the steps of extracting the ten minor recitations and drop <i>Asbahani</i> method with respect of precedence						✓

The description of the proposed model of the system database can be summarized as follows:

According to the text body of Al-Tayyibah, there are ten imams and each imam has two narrators, each narrator has two methods, and each method has two chain of narrations with some exceptions (as mentioned in section 2.4). Hence, since each of the twenty narrators have four chain of narrations, the total number of methods is frequently eighty; those are the original methods, from which 980 consequent branches emerge. Each imam has recitation rules for which the narrators or their methods are committed, and has one, or a multiple modes of recitation aspects that the student must identify and recognize. Some imams followed the same recitation, which resulted in an agreement, whilst others differed in recitation, which resulted in individual-recitations. Accordingly, the recitations were collected in groups of the agreement, and the recitations were separated according to the mode, the method, the narrator or the imam. Additionally, the indexing of all Quranic Chapters was done according to their numbering in the Mus'haf, whilst the verses of each Chapter were assembled and then partitioned virtually into sub-verses according to the length of the verse and the stopping point in each verse.

After modeling this description using an entity-relationship model, it was then transformed into a relational schema by following the known mapping rules [18] to create a computer database of the Holy Quran and the ten major recitations according to Al-Tayyibah approach; and the ten minor recitations according to Al-Shatibiyyah and Al-Durrah approaches. The database contains several tables and fields linked to each other to facilitate the handling of the Quranic text and deal with the recorded audio files of the combined-recitations. The database includes the following tables:

- A Table of Quranic Chapters, that contains 114 Chapters;
- A Table of Quranic Verses, that contains 6236 verses according to the Kufi counting method;
- A Table of Quarters, in which the audio files of the combined Qira'at are deposited;
- A Table of Sub-Verses;
- A Table of the ten Imams; another for the twenty Narrators; and another for the Methods for each narrator; and one for the Chain of Narrations;
- A Table of the Principles for imams, narrators, methods and modes;
- A Table of Quranic Farsh Words for all verses of the Quran;
- A Table for the minor combined-recitations, including the steps/modes for the combination with explanation;
- A Table for the major combined-recitations, including the steps/modes of the combination with explanation;

- A Table for the individual-recitations for each group, imam, narrator, method and mode;
- A Table for each of Al-Shatibiyyah; Al-Durrah; and Al-Tayyibah text poems.

4.4 Inference Engine

The inference engine relates to searching for contents within a knowledge base in a precise context and using a careful sequence. It blends and collates the facts for a particular problem, compares those facts and links them with the knowledge base to generate a solution for the problem in order to select the appropriate step of recitations. The inference engine is a binding machine in which the problem is solved with associated knowledge bases and databases. The inference engine is provided with a program called the inference machine, which is a knowledge processor that compares available information with knowledge from the knowledge base; and derives useful conclusions.

The inference engine determines which rule or rules are involved in resolving the problem. Furthermore, the inference engine decides when and how to apply rules; and determines whether the problem has reached an acceptable solution. That is, it manages the expert system. The specific knowledge rule or rules resolving the problem will identify the associated procedure for resolving the problem and will retrieval the necessary data from the database.

The inference engine is characterized by its non-dependence on the type of application or the field in which the expert system operates; contrary to the knowledge base component. In addition, the inference engine is separated from the knowledge base, so that it may be used successfully with more than one expert system no matter what the system's services are. Hence, the main purpose of the inference engine is to control the execution of rules and facts in the knowledge base and the rule of events in a particular way to reach a certain result for all the events and rules, by controlling the order of their execution. Therefore, the inference engine sorts, arranges, and selects the appropriate rules and events stored in the knowledge base to solve the problem; using information and data on the problem presented to the expert system, requiring additional rules to be derived or inquiring about events from the user, and develop reasons from rules and events that solve the problem.

The inference engine works according to the "*identify, then execute algorithm*" as follows:

- (1). Matching: Look for rules in a knowledge base that meets the needs of the system;
- (2). Resolve the conflict: Select one rule from the selected rules by applying one of the conflict resolution strategies; if no rule is available in the knowledge base, then stop;

- (3). Implementation: Adapt to the situation according to the selected rules;
 - (4). Go to the number (1): Repeat the three-phase cycle: "Matching- Resolving the conflict-implementation".
- Notice that the matching search is based on data retrieved from the database.

4.5 Interactive User Interface

An interactive interface was developed (Fig. 3) that facilitates user interaction with the expert system. The user can choose the desired query, and the system retrieves the appropriate directions and recitation steps/modes for the user's query. The interface is the part of the system through which the user of the expert system enters the data events for a specific action, and thereafter displays the results of the work obtained from the system before using the results as explained in section 5.2

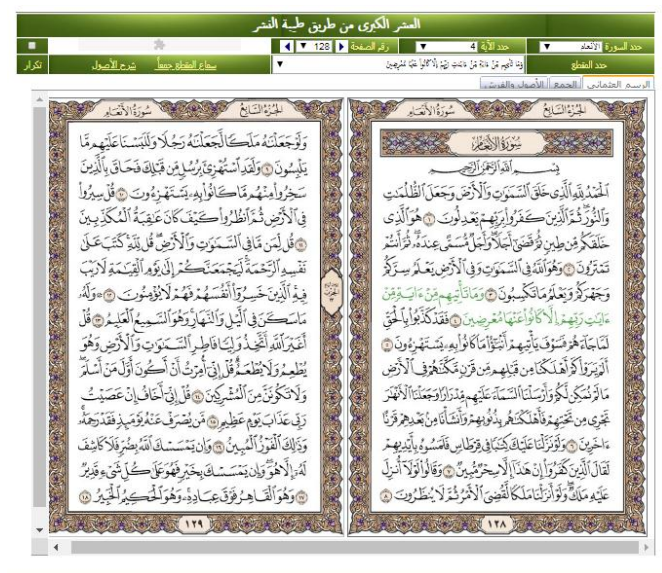


Fig. 3 Interactive Graphical User-Interface.

5. Methodology and Model for Extracting Recitations

A preliminary model is presented in this section to illustrate the methodology used for extracting both combined- and individual-recitations. This study discusses a prototype of the proposed expert system in order to demonstrate the concepts of the expert system in the field of Qira'at. The methodology used in the extraction was applied to the fourth verse of The Chapter 6 Al-An'am, which contains only one sub-verse:

"And no sign comes to them from the signs of their Lord except that they turn away therefrom" [Chapter 6, Verse 4]¹. (The original Arabic verse is showed in Fig.3).

In Fig. 4, the first column in grey represents the selected verse, the second column represents the selected sub-verse. The third column represents the steps/modes of the combined-recitations for the ten major recitations according to Al-Tayyibah; those steps were written by a Quranic Qira'at expert. The fourth column relates to the audio file partitioned virtually in labels, which have the same number as the number of recorded recitation modes. The remaining grey columns are the result of using the extraction methodology through the proposed system. The combined-recitations have different methods as mentioned in section 2.1. The Ibn Al-Jazari method is chosen, which relates to the combined-recitations using the Waqf approach.

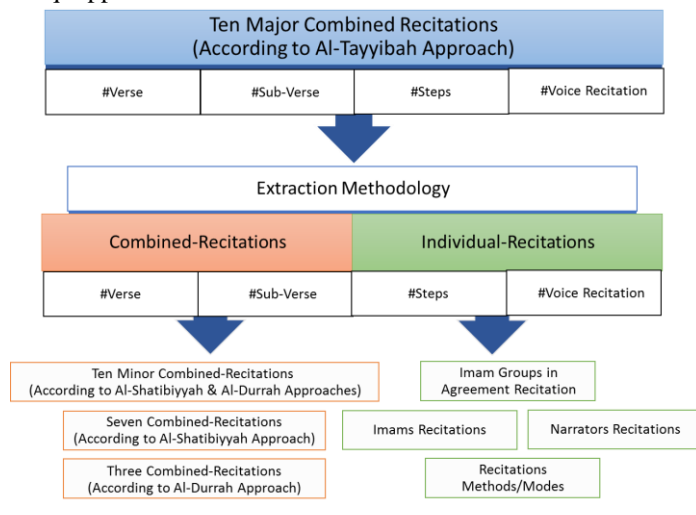


Fig.4 Workflow for extracting the different cases of individual- and combined-recitations.

The combined-recitation methods for the ten minor combined-recitations, the seven combined-recitations, the three combined-recitations, the imam groups, the imam recitations are the same as used when compiling the ten major recitations. Each time the steps of each recitation-case are extracted (Fig. 4) an additional number of label numbers is added in association with the recitation voice-clips of the ten major recitations. The label numbers are related to the steps for each extraction and are colorized. The relation between steps ad label-numbers are repeated for all recitation cases. By following the same approach and adding other knowledge rules in Table 1; the extraction methodology can be applied to individual-recitations and combined-recitations for the rest of the Quranic verses in all Chapters of the Holy Quran.

¹ Sahih International Translation.

5.1 Process of Extraction and Associated Phases

In order to build the prototype of the proposed system, it was necessary to write the steps/modes of the combined-recitations and its explanation (the principles and the Quranic Farsh words) in such a way that individual-recitations can be extracted to each narrator and imam without the interference of the other imams and narrators when there are similarities of recitation modes. This also necessitated writing the different recitation steps/modes of the verses according to rules laid down through the extraction of the individual-recitations from the combined-recitation according to the Al-Tayyibah approach.

The methodology of extracting individual- and combined-recitations was achieved using the rules of knowledge derived from the Qira'at experts (Table 1) through which the steps of recitation text and sounds are extracted for all imams, narrators, group of imams and methods for the ten combined- and individual-recitations as shown in Fig. 5.

In Fig. 5, the first phase involves writing the steps and modes of the combined-recitations and explanations of those steps/modes from Al-Tayyibah. The second phase involves two manual operations: audio recordings of the Quranic verses for the combined-recitations according to Al-Tayyibah, and the audio recordings of the poem-verses for the Al-Tayyibah and Al-Shatibiyah poems. The third phase involves recording the explanations attached to the principles and Quranic Farsh words, before finally, reviewing and auditing of the texts and audios in phase four. Thereafter, the verses are partitioned in phase five into sub-verses (using labels for each section in the recorded audio) according to the length of the verse and at stopping points. Phase six involves linking audio recordings, principles and Quranic Farsh words with the displayed Quranic verses/sub-verses and the poem-verses of Al-Tayyibah and Al-Shatibiyah. It was necessary to make a software program that would assist in this process. Those data items were stored in the form of audio and text files to be modeled using relational database concepts (mentioned in section 4.3) for the proposed system. Finally, phase seven involved extracting the recitation methods based on the symbolic codes used in Al-Tayyibah and Al-Shatibiyah.

Al-Tayyibah provides complete rules for combined-recitations, and from which the individual-recitations can be extracted based on the symbolic codes found in it. Such symbolic codes appear in the form of letters or strings that represent the ten imams, their twenty narrators and their primary and secondary methods, in order to distinguish each imam when they agree or when they differ in recitation. The method used to extract individual-recitations adhere to the same conditions that Al-Shatibi

adhered to in his text, and as followed by Ibn Al-Jazri when he used the symbolic codes of imams and narrators together and separately with the Quranic word.

The proposed system contains the required data required for operating the system, which namely includes; the data of the verses, the different modes of combined-recitations, the principles, the Quranic Farsh words, the evidence from the texts of Al-Shatibiyah, Al-Durrah, and Al-Tayyibah through audio and text files. The voice recording provided only relates to the ten major recitations, with written explanations of the recitation steps for the ten major and the ten minor recitations.

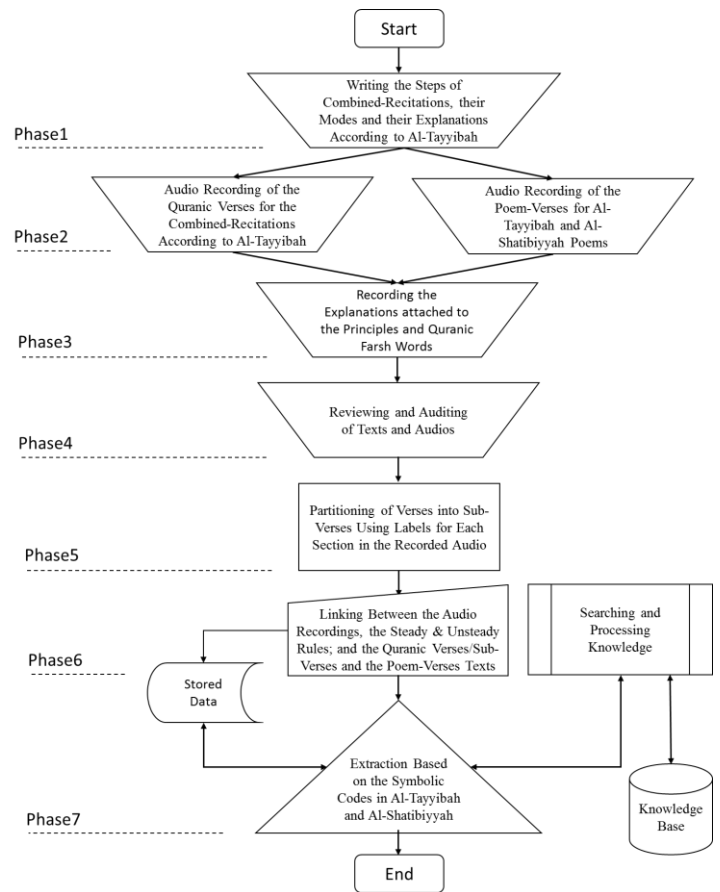


Fig. 5 Flowchart of the extraction methodology.

5.2 System Features and Operation

The proposed system provides recitation of the Holy Quran and provides a display with text and voice; after selecting the Chapter you can displaying it completely or select some verses to be displayed. It also displays the principles and Quranic Farsh words of each verse according to the narration and the chosen recitation mode.

The stages involved when using the system can now be summarized:

- 1) Selecting individual-recitations for the imam or the narrator or the method to be learned, or selecting the group of imams or, the ten major-, or the ten minor-, or the seven- or the three-recitations.
- 2) Selecting the desired Quranic Chapter to be learned. It provides recitation in whole or in part; and allows selection of a number of consecutive verses or to choose any verse from a Chapter.
- 3) Selecting one sub-verse from a verse if it has several sub-verses.
- 4) Listening to the recitation of the verse or the sub-verse of individual-recitations or combined-recitations with the text of the verse or sub-verse displayed during the recitation.
- 5) Displaying the steps/modes of combined- or individual-recitations through writing text and voice instructions.
- 6) Introducing the explanation of the steps/modes while mentioning the evidences from the Text of Al-Shatibiyyah or Al-Durrah or Al-Tayyibah; this feature is also supported using text and voice.
- 7) Displaying the principles and Quranic Farsh words (if any) for each verse of the chosen narration and recitation mode.
- 8) Possibilities of repetition with the aim of learning whether for recitation or for explanation.
- 9) Providing sufficient and organized information about the imams, their narrators, their methods and modes, as well as a user guide to show how to use the system.

An example of the result after following the above stages is shown in Fig. 6.

6. Conclusions and Future Work

One of the main goals of this study was to spread the correct teaching the Holy Quran in its various recitation approaches according to the multiple Quranic recitation methods and modes. This study is unique in that it will propagate teachings of the science of recitations from traditional methods to new learning methods in the world of information technology. Hence, information technology was used to recite the multiple recitations and extract them from the method of combined-recitations, with the possibility of choosing the narrator of an imam to view his different recitation methods and modes for a selected verse which the learner chooses between individual- and combined-recitations with the textual and audio explanation (evidence) of the principles and Quranic Farsh words from the famous Qira'at poems.

The concepts of knowledge-based systems were applied through the establishment of knowledge bases derived from expert scholar in Qira'at and through which the steps and modes of recitation are extracted textually and vocally. An expert system was presented for the creation of an online platform to facilitate the teaching and training of the Quranic Qira'at using combined- and individual-recitations extracted from the ten major combined-recitations according to Al-Tayyibah.

A prototype of the proposed expert system was applied to the fourth verse of Chapter Al-An'am; it was necessary to write the steps/modes of combined-recitations together with their explanation for the principles and unsteady rules in such a way that individual-recitations can be extracted for each method, narrator or imam, without the involvement of other imams and narrators when their mode of recitation was similar.

There is a future plan in the short term to complete the development of the system and test it as a web-application and mobile-application for smart devices. Hence, first step in future developments shall involve completing the work for the rest of the Quranic Chapters in order to include a full multiple Quranic Qira'at system, and this is achieved by recorded voice of recitations and voice of explanations for the three Qira'at poems as well. Future work shall also involve updating the knowledge base by adding the remaining rules derived from expert scholars in the field of Qira'at. Therefore, by following the same methodology for extracting individual-recitations from the combined-recitations and adding the remaining rules to the knowledge base; an automation of this work using artificial intelligence techniques will be done to include the remaining parts of the Quran. However, with the ten major Quranic recitations, this becomes a more difficult task due to the multiplicity of the modes and methods for a single narration. Consequently, the implementation of this study



Fig. 6 Example screenshot of the interface displaying steady and unsteady rules.

shall be completed in several phases. Additionally, attention will be paid to the importance of teaching this science to disabled people through the additional of special features in the proposed system.

It is also suggested to explore other artificial intelligence techniques to solve the problem considered in this paper and compare them with the method used in this study. This is because the reference of measurement is the traditional method, which is used to correct and modify the computerized methods during the analysis and extraction of individual-recitations using artificial intelligence techniques. Finally, the translation of the system interfaces in other languages shall also be considered as a further opportunity for future development before translating the content itself.

Acknowledgments

The author would like to thank Amir Adel Eldeib (Ph.D. in Quranic Qira'at), from the Islamic University in Madinah, for providing useful comments on specialized knowledge in Qira'at and reviewing the rules of knowledge in the proposed system.

References

- [1] A. F. Al-Shatibi Al-Andalusi, Al-Shatabiyyah called Hirz Al-Amani Wa Wajh Al-Tahani in the seven Qira'at, checked, corrected and reviewed by Mohammed Tamim Al-Zu'bi, Medina, KSA: Dar Al-Huda, 2010.
- [2] Sh. A-D. M. M. Ibn Al-Jazari, Al-Durrah Al-Mudhiah in the three complementary Qira'at of the tenth, verified by Mohammed Tamim Al-Zu'bi, Medina, KSA: Dar Al-Huda, 2nd edition, 2000.
- [3] Sh. A-D. M. M. Ibn Al-Jazari, Al-Tayyibah called Tayyibat Al-Nashr in the ten Qira'at, verified, checked, and commented by Ayman Roshdy Swaid, Damascus, Syria, Dar Al-Guthani for Qur'anic Studies, 2013.
- [4] R. H. Al-Zanfally, and M. I. E-K. Ghembaza, "A Web-based System for Learning the Quranic Qira'at Using the Tayyibah", International Journal on Islamic Applications in Computer Science and Technology (IJASAT), ISSN 4020-2289, Vol. 5, No. 2, June 2017, pp.01-21.
- [5] R. H. Al-Zanfally, A. M. Al-Ben Ali, and M. Y. Bani, "Using Computers in Teaching, Training and Reciting the Great Quran Through the Seven Quranic Recitations from Al-Shatabiyyah", Symposium of the Holy Quran and Contemporary Technologies, King Fahd Complex for the Printing of the Holy Qur'an, Medina, 2009, pp. 1-24.
- [6] R. H. Al-Zanfally, and M. I. E-K. Ghembaza, "An Educational System for the Individual Quranic Recitation Methods based on Al-Shatabiyyah", International Journal on Islamic Applications in Computer Science and Technology (IJASAT), ISSN 4020-2289, Vol. 3, No. 4, December 2015, pp.01-14.
- [7] Khayma. <http://www.khayma.com/tajweed/quran.htm>. Last Visited (November 2018).
- [8] Albodoor. <http://www.albodoor.com>. Last Visited (November 2018).
- [9] Islamweb. <http://audio.islamweb.net/audio/index.php?page=rewayat>. Last Visited (November 2018).
- [10] Nquran. <http://nquran.com/quranplayer>. Last Visited (November 2018).
- [11] Mosshaf. <https://mosshaf.com>. Last Visited (November 2018).
- [12] Quraat. <http://www.quraat.info>. Last Visited (November 2018).
- [13] P. Jackson, Introduction to Expert Systems, 3rd Edition, USA: Addison Wesley, 1998.
- [14] I. Watson, and F. Marir, "Case-based reasoning: A review", The Knowledge Engineering Review, Vol. 9, No. 4, December 1994, pp. 327-354.
- [15] A Patel, S Jain, Formalisms of Representing Knowledge, Procedia Computer Science, Elsevier, Vol. 125, 2018, pp. 542-549.
- [16] J. Prentzas, and I. Hatzilygeroudis. "Categorizing approaches combining rule - based and case - based reasoning", Expert Systems, Vol. 24, No. 2, May 2007, pp. 97-122.
- [17] N. Van Do, "Model for Knowledge Bases of Computational Objects", International Journal of Computer Science Issues (IJCSI), Vol. 7, Issue 3, No. 8, May 2010, pp. 11-20
- [18] R. Elmasri, and S. B. Navathe, Fundamentals of Database Systems, 7th Edition, UK: Pearson, 2016.

Dr. Moulay Ibrahim El-Khalil Ghembaza is currently an Assistant Professor at the Department of Computer Science, College of Computer Science and Engineering (CCSE), and the IT Research Center for the Holy Quran and Its Sciences (NOOR) at Taibah University, Saudi Arabia. He received his Ph.D. in 2005 in Computer Science, in the field of Intelligent Systems from Paris-Est Créteil Val-de-Marne University (UPEC) (previously Paris XII University), France. His M.Sc. was in the field of Virtual Reality from Versailles Saint-Quentin-en-Yvelines University (UVSQ), France; which he completed in 2002. His research interests include Artificial Intelligence Systems, Natural Language Processing, Language Engineering, Quranic Learning Systems, Quranic Applications Development, Virtual Reality and Haptic Rendering Systems.