

E-HALAGAT: AN E-LEARNING SYSTEM FOR TEACHING THE HOLY QURAN

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ABSTRACT

Recently, there has been a great interest in Islamic software that try to harness computer to serve the religion. This brought about some applications and programs for the Holy Quran and its sciences, Hadith "الحديث" (Prophet's Tradition) and its methodology, Fiqh "الفقه" (Islamic jurisdiction), and Islamic law in general. However, these computer-programs, especially those developed for the sake of the noble Quran are still limited and have been focused on a direct application of the Information Technology techniques, such as storing, listening, searching, etc, without using more elaborated techniques in the domain. To contribute in the improvement of these efforts, a project for Computerized Teaching of the Holy Quran (CTHQ) is initiated. It aims to introduce advanced techniques and methodologies to develop an appropriate environment for self learning of the Holy Quran and its sciences. Different sub-systems are being developed separately and will then be combined together to set up this environment. This paper presents the design and development of one of these subsystems devoted to teaching how to recite the noble Quran and to memorize it in a manner similar to the usual way followed in the Quranic schools and rings at mosques, known in Arabic as "halagat" (حلقات).

Keywords: Holy Quran, Quran recitation, Quran memorization, Quran sciences, E-learning.

1. INTRODUCTION

Interest to the recitation and memorization of the Holy Quran began since its revelation to the Prophet Muhammad pbh. It was directly memorized by heart and recited (by his companions) as taught by the Prophet and then transmitted orally from teachers to learners throughout generations. In addition, companions of the Prophet wrote it down to leave a hard copy (Al-Mashaf المصحف) for next generations.

Reciting the Holy Quran in the appropriate way is very important for all Muslims and is indispensable in Islamic worshipping such as prayers. For these reasons, teaching how to recite has been done through teachers who pronounce the Quranic sounds accurately. Such method has been considered, since the revelation of the Holy Quran, as the only way to learn how to recite it correctly until the twentieth century, where Technology produced recording systems and electronic devices that are able to keep both text and sound of the Quran with tajweed rules "أحكام التجويد" (rules of correct pronunciation of the Holy Quran). Since then, it becomes possible to listen to the Quranic recitations recorded from authentic reciters. Many software have then appeared to assist novice learners by letting them listening while following the corresponding text on the screen. However, the efforts spent by the computer scientists in general for the sake of the noble Quran are still limited and have only focused on the straightforward use of the Information Technology techniques, such as storing, listening, searching, etc, without using more elaborated techniques in the domain.

This paper is a part of a project aiming to build a computerized-environment for learning the Holy Quran and its sciences "CTHQ". It is an attempt to improve computerization of the Holy Quran by introducing advanced techniques and methodologies. Four main tracks have been designed to carry out this project. In the first track, the focus was on gathering and improving the most important aspects related to the recitation and memorization of the Holy Quran that are available in the existing Quranic programs, and then putting them in a comprehensive and consistent environment. In the second track, speech recognition techniques have been used to assist reading the noble Quran. A speech corpus of Quranic recitations has been firstly collected and used to extract Quranic sounds (Alghamdi et al, 2007; Elhadj, 2009a; Elhadj et al, 2009b). Next, these sounds are modelled by Hidden Markov Models (HMM) and trained on the developed corpus. They are now under consideration for building software-component to assist reading and memorizing by automatically detecting and correcting mistakes. In the third track, techniques for determining the similarity between verses (ayah آية) of the noble Quran were investigated (Alsughayeir & Ohali, 2007; Alsughayeir et al, 2009). Computer-tools have been developed for analyzing the text of the noble Quran based on complete words and their stems in order to link similar verses (Elhadj et al, 2009c). In the fourth track, a sub-system for teaching tajweed rules was developed (Elhadj et al, 2009d). A mathematical formulation of tajweed rules was proposed and then programmed in an engine that can be used to detect places of tajweed rules in the Quranic verses and also to assist to learn these rules. In the last

track, we integrate different developed subsystems in order to provide the user with a system containing the most important aspects and tools helping to learn the noble Quran and its sciences.

In this paper, we present our work related to the first track. It consists on the design and develop a platform for teaching how to recite the noble Quran and to assist memorizing it in a manner similar to the usual way followed in the Quranic schools and rings at mosques, which are known as "halagat". The speech recognizer can be integrated later on when it becomes ready to use. This can be seen as a true e-learning system for the teaching of the noble Quran.

2. SURVEY OF EXISTING TOOLS

To meet the requirements stated in the first track of the CTHQ project, a study has focused on surveying the most important existing systems in order to know and to collect together different aspects available in these systems (Elhadj & Alsughayeir, 2005; Alsughayeir & Elhadj, 2006). The methodology employed to conduct this study consisted of collecting a maximum number of Quranic applications, either desktop, web-based or hand-held applications. Each application is separately studied and evaluated in order to know the characteristics and services it offers. This is done in three phases:

- a) **In the first phase**, general information about the product is determined: the name, objective, efficiency (interface, speed of execution, etc.), availability and accessibility, price of the product as well as the name and address of its provider.
- b) **In the second phase**, the basic functions of the product are explored: memorization "tahfeez التحفيظ", perfect reading "tajweed التجويد", interpretation "tafseer التفسير", similarity "tashabouh التشابه", reasons of revelation "nuzoul النزول", scientific inimitability "Ejaz الاعجاز", translation "tarjama الترجمة", availability of different reciters "Qurraa قراء", ways of recitations "Qeraat قراءات" such as Hafs, Qaloun, Warsh, etc (Habash, 1986).
- c) **In the third phase**, the technical aspects of the product are devoted: display of the Holy Quran (image or text), availability and use of the index and colour coding, searching flexibilities, copying and selecting verses, repetition of the recitation as well as the possibility of recording which is helpful in the verification of the memorization.

From the collected software, we selected ten desktop applications, nine web-based applications, and seven hand-held applications. They are chosen based-on some criteria related to the existence of features that are important for learning the Holy Quran and its sciences. Next, an appropriate form has been designed and used to report together information about different applications in order to facilitate the extraction and comparison of the most important features. These features can be summarized and shortly analyzed as follows:

2.1. Memorization

Many products support this property, as it is important in any Quran product, and use different methods to implement it:

- a) **Repetition:** some products employ repetition of the recitation as a technique of memorization. Repetition can, either on the Quranic verse or on the whole section (set of verses) with specified number of repetition.
- b) **Memorization Chart:** some products use a table of memorization. This table contains different sections that need to be memorized and used to control and evaluate the level of memorization of each user.

2.2. Memorization Tests

Recording, fill in the blanks or printing words have been used in the evaluated products as methods to verify the correctness and the quality of the memorization.

- a) **Recording:** the user can verify its own memorization by first recording its recitation and then listening it in order to correct himself.
- b) **Fill in or Printing:** a Quranic verse or a section can be showed for a specified time to a user before being asked to fill in or printing some words or the whole section to verify its own memorization. He cannot pass any word without being sure of its spelling.

However, no product has tried to apply any kind of an immediate vocal recognition to follow the reader in its recitation in order to discover mistakes. This characteristic is one of our main objectives in the CTHQ project and is under consideration as we have already explained.

2.3. Recitation Rules "Tajweed"

Most of the evaluated products list tajweed rules as simple and traditional lessons (text or sound) independently of the Quranic verses to be recited. However, we need to link the tajweed rules directly to the verse at the same time with its recitation in order to memorize it correctly.

2.4. Interpretation "Tafseer"

Most of the evaluated products support more than one book of interpretation as references. However, they are also not directly linked, in most of the products, with the Quranic verses. Instead, they are accessed by navigating the whole book. We think that it is important that the learner be able to access the interpretation of a given verse directly from the Holy Quran (Al-Mashaf) without the need to go through the interpretation book.

2.5. Reasons of Revelation "Nuzoul"

The evaluated products that support this characteristic are very few in general. Some of them link every verse with its reasons of revelation, whereas others list them independently of the underlying verses.

2.6. Similarity "Tashabouh"

There are special products that support this characteristic, but are not linked to any of the surveyed products used for memorizing the Holy Quran. In fact, the similarity helps in clarification of the explanation and bringing to light the rhetoric of the noble Quran, and then makes the memorization much easier. So, it is important to be linked with other Quran sciences in the same product in order to be effective for learners.

2.7. Scientific Inimitability "Ejaz"

As for the similarity, there are also special products that support this characteristic, but are not linked to any of the surveyed products. Indeed, this property is very important, because it helps people explain some modern science discoveries concerning their specializations.

2.8. Translation "Tarjama"

Most of the evaluated products support the translation to more than one foreign language. Translations are given, in some of the evaluated products, for individual words of the Quran, whereas, in other products, they are given for the meaning of the whole verse. In both cases, they are often directly linked to the verse.

2.9. Reciters "Qurraa"

Many of the evaluated products offer recorded recitations of famous Islamic reciters. They are used in these software as a reference for learning how to pronounce Quranic words and to recite them properly.

2.10. Quran Display

The evaluated products displayed the Quran on the screen, either as an image of Al-Mashaf pages, or as a text using "Othmanic" or normal scripts. Indeed, the way used to display the Quran on the screen plays a significant role in the memorization, because people can remember verses or passages of the Quran basing on its appearance during its memorization. So, displaying pages of the Holy book on the screen is very helpful for the memorization.

2.11. Search Engine

The evaluated products propose search engines for the Holy Quran and for books of its sciences that are supported, like tafseer books for example. Many ways of search are supported, like the search about single words with or without prefixes and suffixes, or the search about sequence of words considered as consecutive or separated words. There is also a possibility to search by the syntax of Quran words. Some products are powerful in the term of speed and quality of retrieval.

2.12. Index "Fahras"

The Quran index is classified in some of the evaluated products according to the category of Surahs (Makiya مكية or Madaniya مدنية). The Quran index is often displayed on the form of a table that contains names of Surahs, their numbers, the number of their verses, the beginning of Quran parts (بدايات أجزاء القرآن) as well as the category and other information about the specified Surah. Some of the evaluated products show the rate of the user's memorization in the index.

As a conclusion from the survey and the analysis we made, it appeared that the software developed for the sake of the Holy Quran are still very limited either in their objectives or in the term of availability and relevance of features. No one of the surveyed programs gathers the main properties and services that have to be present in a convenient program for a computerized teaching of the Holy Quran and its sciences. None of them also tried to

follow the reciter during its recitation in order to detect his mistakes and to correct him. In addition, many of these products are very weak in term of design and technical quality.

To contribute to the improvement of the Holy Quran computerization, a specification of an environment for learning the Holy Quran and its sciences is thus proposed in the framework of the CTHQ project (Elhadj et al, 2008). It contains the most important aspects and tools helping to learn the noble Quran taking in consideration the opinions and suggestions received as feedback from some stakeholders. These features are organized in different sub-systems for flexibility and efficiency purposes. In this paper, only the part related to the memorization of the Holy Quran is presented. A general description of this e-learning system and its architecture is given in the next sections.

3. SYSTEM DESCRIPTION

3.1. Approach and Methodology

It is important to remember that our proposed system is designed to simulate the usual way to inculcate the Holy Quran either in the Quranic schools or in the Quranic rings at mosques. In the Quranic schools, learners (or simply students) are distributed on different levels according to specific criteria such as age, ability of memorization, etc. In the Quranic rings, learners are organized in a set of groups, called "halagat", but not necessarily according to the same previous criteria. The main difference resides in the fact that students of a given level follow the same program, while learners of the same halaga may have different contents. Each halaga has its own tutors (teachers), which are responsible of the teaching side, and may share with other halagat a supervisor, which is responsible of its administration issues. Halagat are most spread in the teaching of the Holy Quran due to their flexibility and are present under different forms in Islamic countries.

Our system is designed based-on the halagat approach that we will call "e-halagat" (i.e. electronic halagat). Each ehalaga (singular of ehalagat) simulates the real one in having tutors, supervisor, and registered students. As we will see below, the creation of ehalagat is done by its supervisor, which is in turn created by the system administrator either directly or by approving an online request from the supervisor itself. The supervisor is responsible of running the ehalaga in terms of adding or deleting tutors, distributing learners and following up in general. This is to have a hierarchical distribution of roles. For a full picture, we will describe the different involved users and their roles in the following sections.

3.2. Users and Their Roles

The ehalagat system is built around for main kinds of users: learners, parents, tutors, and supervisors. The system administrator can be seen as a fifth kind of registered users. For the sake of efficiency and flexibility, responsibilities and roles are distributed hierarchically. The administrator is just managing supervisors, whereas supervisors are responsible of running ehalagat and their tutors. Tutors in turn are directly concerned with learners.

Description of these users and their roles are given in the following subsections.

3.2.1. Learners

Learners constitute the main target group; they can be classified at least into two categories according to their ages: adults and children. The age is important here to determinate access rules to the learner. For example, accessibility of children to some features is only allowed via their parents.

Registration of learners and how they can work are explained below.

3.2.1.1. Registration

Learners have two ways to register in the system according to their age group:

- a. **Adults:** the system allows learners (who are over a certain age indicated in the ehalaga settings) to register themselves online in a page in the system.
- b. **Children:** the system does not allow learners who are below a certain age to register alone; this would rather be done through their parents in the parent's page.

In both cases the system asks for fill in the learner's personal data as well as the parameters of the teaching method. It is worth to mention that memorization of the Holy Quran in the halagat consists in specifying for each learner a daily amount to be memorized starting from somewhere in the Quran. This amount can be measured by either ayah (Quranic verse) or page (page of the Al-Mashaf). It is generally preferable to use Al-Mashaf pages as they allow an easy switching and retrieving. As the learner progresses, he needs to have in parallel a revision program for memorized parts to improve their quality. So, for our ehalagat system, we have to specify the following parameters:

- a. **Beginning of Memorization:** the learner must designate a starting point to enable the system to add next parts to be memorized progressively. This is done by indicating the ayah (Quranic verse) and the surah (Quranic chapter). The system will then retrieve the corresponding page based-on our well-designed database of the Holy Quran, which includes different tables storing basic information related to the Quran in its both formats (textual and Al-Mashaf), Reciters, Ways of recitation, etc.
- b. **Length of the text to be memorized:** the default length is one page, but it can be changed to any number of pages according to the capability of the learner.
- c. **Length of the text to be revised:** it should be at least twice as long as the text to be memorized. We think that the learner need to continuously revise from the beginning up to the verse he just memorized and then backward again up to the starting point. This explains why the revision amount needs to be greater than the memorization one. Revision is a very important stage to perfect the learner's memorization.
- d. **Reviewing previously-memorized texts:** the system allows the learner to enter his previous memorized texts, which he covered before registration. In doing so, the system will include the previous memorized texts in the revision program for the perfection of memorization. This is an extra feature offered by the system.

Having set all needed data and parameters, the learner can choose the way of recitation (Qeraa) that he likes. He will be given a list of the ehalagat that support the selected way of recitation to join one. If there is no one supporting the way of recitation required, the learner will be asked to change it; otherwise he will not be registered. Once an ehalaga is selected, a list of registered tutors that have not reached their teaching load (a default value specified in the ehalagh settings) will be given according to choose one. It is noteworthy to mention that once tutors got their teaching load, the system will automatically add learners in a fashion that guarantee a maximum load-balancing of the teaching.

Having fixed all above information, the system will provide the learner with a specific user name and password enabling him to follow his specific program in the system.

3.2.1.2. How Learners' System Works

Once a learner logs in, he will be redirected to the memorization/revision part where he can find a list of useful options. He can browse his own profile and change it as needed (only for adults), measure his performance during a given period of time on charts that draw the number of sections perfected, times of failure in every section, duration of memorizing, print out his transcript, etc.

If a section of the memorization/revision is chosen, the corresponding pages of the Holy Quran are displayed to the learner. Using Al-Mashaf pages in the display of the Holy Quran plays a major role in the process of memorization since the learner may recall the shape and position of the verse afterwards. This makes the process of memorizing easier.

While browsing/reading the section's pages of a memorization/revision, the learner can listen to an ideal recitation taken from one of the famous reciters stored in the system as a reference for perfect recitation. Reference recitation can be solicited for a single verse or for a range of verses in the current section and can be repeated as many as needed. If the learner wants to know for a given verse, the included tajweed rules, tashabouh, nuzoul, tafseer, erab, etc., he can highlight it and then chooses whatever needed. Such features were developed as independent subsystems in the CTHQ project (Elhadj et al, 2009e) and are being integrated together in the global environment. After listening to the reference recitation several times, or reciting directly, the learner can test his memory by clicking on an icon to record the section. Then the pages of the section will disappear to test his memory. Clicking on the button of "end recording", the pages will appear again so that the memorization can be verified in one of two ways:

- a. **Self Verification:** as the learner listens to his own voice, he can find out his mistakes by reading the section or by listening to the reference recitation of it.
- b. **Automatic Verification:** this is the target method of correction that we are developing now. It consists to use automatic speech recognition techniques to follow the reader and to correct its recitation. For this reason, we have started by building a speech database of the Holy Quran recitations that can be used to learn statistical models for Quranic sounds. Recitations of ten chosen reciters have been recorded in an appropriate environment and then manually transcribed at three levels: word, phoneme, allophone (Alghamdi et al, 2007; Elhadj, 2009a; Elhadj et al, 2009b). Quranic sounds at phoneme and allophone levels are modelled by Hidden Markov Models (HMMs) with three emitting states each and a mixture of sixteen Gaussian distributions per state. Hidden Markov Model Tool Kit (HTK) is used as an environment for developing our Quranic-sound recognizer. The average recognition rates reached 89% for allophones and about 96% for phonemes without using any language model. A direct explanation of

this difference in the recognition rate is related to the number of phonemes which is roughly the half of allophones. Another reason is the difficulty to distinguish between allophonic variations of some sounds, which may necessitate a good training on a huge corpus. Different kinds of tunings are under considerations to improve the quality of the recognizer. The details of the development of these Quranic recognition tools and their tunings are being published separately.

The learner can repeat the recording and verification as described above till the perfection of memorization. At each test, the old recording of the section to be memorized is replaced by the new one. The audio file corresponding to the recording is named uniquely by combining the learner's user name and the number of the section to be memorized and is temporarily kept on the local machine. Once the learner approves his recording, the audio file is uploaded to the server and the learner will not be able to modify it. The tutor is then notified (by a short message or when he logs on) with an unmarked recorded section of that learner. After the tutor marks the section, the learner can benefit from the tutor's audio and/or textual remarks (see the section about tutors) related to the mistakes made by the learner.

It is noteworthy to mention that while the learner is waiting for a feedback from the tutor on an uploaded recording, the system can progressively add more sections to be memorized unless a certain number specified in the settings is reached. This is to ensure that the learner's progress in memorizing will not be affected by the tutor being behind schedule.

3.2.2. Tutors

They supervise and follow up the memorization of the learners. Their job can be summed up as follows.

3.2.2.1. Tutor's Role and Registration

The tutor can supervise several learners. He listens to the learners' recitation during the process of memorizing and revising, and then he corrects their mistakes and gives them their due score and audio/textual remarks. The tutor has a free hand to modify the learner's score and issue a record of his score. He can also report his remarks about the learner to the supervisor of the ehalaga.

The registration of the tutor in the system can be done either directly by the supervisor of an ehalaga or by fill in an online form and requesting an approval from the supervisor of the selected ehalaga. After registration, the tutor will receive a user name and password for authentication purposes.

3.2.2.2. How Tutors' System Works

Upon logging on, the tutor will have a list of the learners under his supervision. Once he selects one learner, he will see all his record, marked and unmarked memorized sections. He can update the record or modify it by clicking on the audio file attached to the memorized section where he will be transferred to a page in the system in which the section can be browsed and the learner's recording can be played. Then the tutor enters the score and can add textual and/or audio comments to help the learner correct his mistakes in a better way. The score and textual comments are directly stored as a record in the learners' database, whereas the audio comments are uploaded as a file to the server and becomes visible to the learner. If the mark given for a section is less than the default success-score specified in the ehalaga settings, the system will leave the learner in the same section. If not, he passes to a new section to be memorized and the previous section will be added to the revision list.

Notice that there are other options available in the system for the tutor.

3.2.3. Parents

Parents can follow up the performance of their children in memorization. This function is an extra feature for children. An adult learner is not required to have parent to follow up his performance. Parents can register themselves and their children (at the same time or later on) in a specific page in the system. Accordingly, they can follow up the performance of their children in memorization, in terms of how perfect their memorization is, times of failure, absence, etc. by reading the charts and reports which can be printed out, in addition to notices that can be sent by the system automatically.

3.2.4. Supervisors

They are responsible of all the persons concerned with the process of memorization: tutors and learners. Every ehalaga is managed by a supervisor, who can add or delete tutors. If a new tutor is added to an ehalaga, the system will look for tutors of extra loads and move the extra learners (lastly added) to the newly-added tutor. Upon deleting a tutor, the system will distribute his learners among tutors who are below the teaching load, or as equal as possible. Adding a tutor to an ehalaga must be done by its supervisor either directly or by approving an online request received from the tutor itself as we said before. In a similar manner, the supervisor can be created and activated by the system administrator either directly or by approving a request from him. Once created, the

supervisor can initiate one or more ehalagat and adjust their settings, such as specifying the teaching load for tutors, success scores for memorization and revision, number of new sections to be memorized or revised before tutors finalizing previously-sent sections, the default value of age groups, etc. The supervisor can follow up tutors by generating reports about their performance, their quick responses, etc. He can also evaluate learners through charts that show their seriousness in memorization, quality of performance, times of failures in memorizing the assigned sections, absence, etc.

3.2.5. System Administrator

The system administrator is who adjust the general settings for the different functions in the CTHQ environment. In the ehalagat subsystem, the administrator is mainly managing supervisors as responsibilities and roles are set hierarchically. He can also set the time for the lifespan of audio files of learners and tutors. On another hand, the administrator is he who controls adjusting and updating in general; he can add reciters, new ways of recitation (Qeraat), holy books (mashafs), etc.

4. TECHNICAL DESIGNING AND IMPLEMENTING ISSUES

The system was designed and implemented as web-based application to particularly help people who have no appropriate channels for memorizing and studying the Holy Quran, though they have access to modern technology that facilitate communication. Many features and considerations have been taken into account to simplify interaction and use of the system, especially for those who are not so familiar with computers such as tutors as we guess. One of the most important features is that we keep all the files and information at the server side so that the user will not have to download them when he changes the computer. Therefore, in most cases, procedures are done at the server side while keeping in mind speed. Streaming techniques have been used for the sound files of either reference recitations, or learners' recording that need to be listened by tutors or vice-versa. Learners' audio files are recorded at the client side as waves and are temporarily kept on the user's computer so they can be used, if needed, for automatic verification by the HMM-based phone recognizer. When the learner approves his recording, it will be converted to an mp3 format to make it as compressed as possible and then uploaded to the server where it is saved in the learner's folder and becomes visible to and accessible by the tutor for correction and marking. It is noteworthy to mention that the conversion to the mp3 format is done at the discretion of the user and handled in a manner that does not need installing anything on the client machine.

It is also important to notice that, due to the problem of the size of audio files and maybe the quality of the available connection, the user should be restricted to a number of pages while recording his memorization, i.e. the recorded audio file should not exceed a certain size; otherwise it should be divided into more than one and then sent separately.

5. CONCLUSION AND FUTURE WORKS

In this paper, we presented an e-learning system (ehalagat) for the interactive teaching of the holy Quran simulating the usual way followed either in the Quranic schools or in the Quranic rings at mosques. It provides all the required computational tools for the perfection of the learner's recitation, following up, and correcting his memorization electronically. In our knowledge, it is the first of its kind which is built for the sake of the holy Quran. This does not mean that the system is now perfect and ideal; it still needs some improvements and adding new features. One of the important features that we plan to add is a voice-chatting component that can be used for a direct oral communication between students and their tutors, when they are connected at the same time. Indeed, we need a real-time VoIP conference call component that can be hosted on our web server and controlled by the system itself. We are thinking about developing our own component or looking for an available one that can be customized and integrated in the system. This will be decided later on and maybe added as a new feature in a next version of the system.

Our main focus in the near future will be devoted to the improvement of the developed Quranic-sound recognizer in order to be highly accurate as the holy Quran needs. Once it became at the desired level of maturity, we will integrate it in the ehalagat system and open it for public use in different ways other than its main objective in the memorization process. It can be used to teach how to pronounce both Arabic and Quranic sounds correctly.

The ehalagat system is now under final testing and verification by a targeted sample of users. It will be opened soon on the link <http://www.qtadarus.net>. We hope that this system becomes an effective and useful tool for learning the Holy Quran for interested persons around the world. We think, it will be very helpful to the Muslim migrants or those who seek to benefit from one of the Quran scientists (scholars) without need to see him.

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