9ootik We9al (We Hear You): An E-learning Environment for a Rehabilitation Program for Arabic Speaking Children with Cochlear Implants

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ABSTRACT

Auditory Rehabilitation for children with cochlear implants is part of the implant process. Young children with a cochlear implant require a comprehensive rehabilitation program to help them utilize the auditory signal and to naturally integrate the various components of communication including listening, speech, language, reading and thinking.

In this paper, we introduce "9ootik We9al" which is an e-learning environment for a rehabilitation program for Arabic speaking children with cochlear implants developed by us. It can be used in clinics, hospitals or schools. The purpose of the project is to provide Arabic speaking children with hearing impairment, especially those with cochlear implants, with computer software that works as a rehabilitation program in order to build their communication skills.

General Terms
Education, e-learning for rehabilitation.

Keywords
Computerized rehabilitation program, building listening skills.

INTRODUCTION

Aural rehab started as a result of the number of soldiers that incurred hearing loss in World War II and were in need of services. Back then, audiologists and speech-language pathologists would put emphasis on speech reading (lip-reading) auditory training, and would fit the soldiers with very primitive hearing aids [1]. In the past, the main components of the rehab process were training clients in lip-reading techniques and listening exercises. Today, the list includes auditory training, communication skill training, voice therapy, speech production training and much more.

Computerized aural rehabilitation programs for cochlear implant recipients have recently been developed[4]. '9ootik we9al' (We Hear you) is a rehabilitation program that is divided in multi-levels; each level provides test and in order to move to the next level the child must pass the current level first.

The rest of the paper is organized as follows:

- Section 1 outlines the problem and related statistics.
- Section 2 describes the design of 9ootik We9al.
- Section 3 provides snapshots of using 9ootik We9al.
- Section 4 gives assessment of the project and points to possible future enhancements.

1 PROBLEM IN MORE DETAILS

1.1 PROBLEM

In 2005, about 278 million people had moderate to profound hearing impairment [2]. Children with hearing impairments typically have problems in the development of their listening, language, speech, and reading skills. Solutions for hearing impairment focus on early detection, followed by treatment and rehabilitation.

According to the U.S. Food and Drug Administration (FDA), as of December 2010, approximately 219,000 people worldwide have received cochlear implants [3]. This type of surgery gives children useful representation of sounds. After the implantation of these devices, children are required to follow comprehensive rehabilitation programs to assist their ability to recognize sounds, understand speech, and improve their communication skills. However, as far as we know there is no auditory rehabilitation computer software targeting Arabic speaking children.

We collected requirements by visiting the Sada educational center in Kuwait (http://sadacenter.org/). Sada center specializes in helping to rehabilitate kids (age 2-4) who had cochlear implant. In an interview with one of the professors who supervise the program at Sada, she had mentioned that no Arabic software programs had been used in the center for educating the children. They mainly depend on the oral education in their rehabilitation program for building the children's vocabulary and auditory skills.

1.2 STATISTICS

Kuwait is a small country situated in the Persian Gulf region (GCC). Kuwait has a population of about 3 million residents. With a 40% expat population, the government of Kuwait is working hard to encourage local employment and to generate qualified local caliber. Within this context, the Kuwaiti government is reinforcing educational reform at all levels.

Shaikh Salem Al Ali center for speech and hearing was established in Kuwait to host cochlear implant surgeries. According to the center, there were 103 patients had their cochlear implant surgeries in the year 2011. The center does not provide a rehabilitation program for cochlear implant recipients. They said it is the parents responsibility to send their children to a specialized center for improving their hearing and speaking skills. Shaikh Salem Al Ali center is only responsible for checking that the cochlear implanted works successfully. Also they receive some patients who had their cochlear implants surgery in Zain hospital (one of the main governmental hospitals in Kuwait). Statistics show that they received 69 patients in the year 2011.

2   DESIGN OF THE SOLUTION

'9ootik we9al' (We Hear You) is a computer software that provides the cochlear implant recipients with a rehabilitation program in order to build their listening skills. It is mainly targeting kids (age 2-4) whose native language is Arabic.
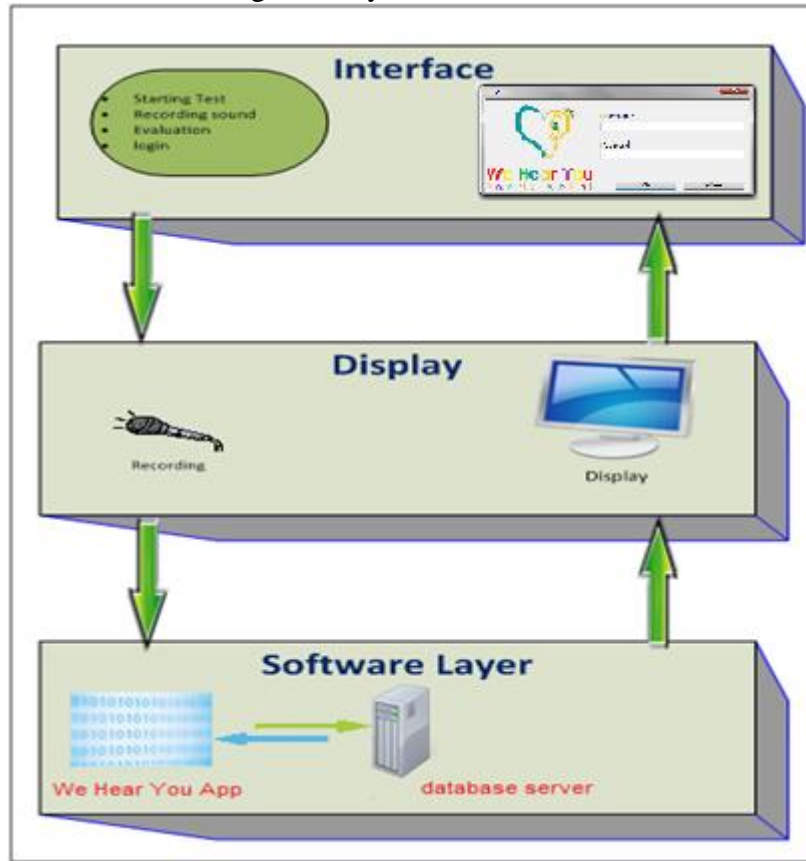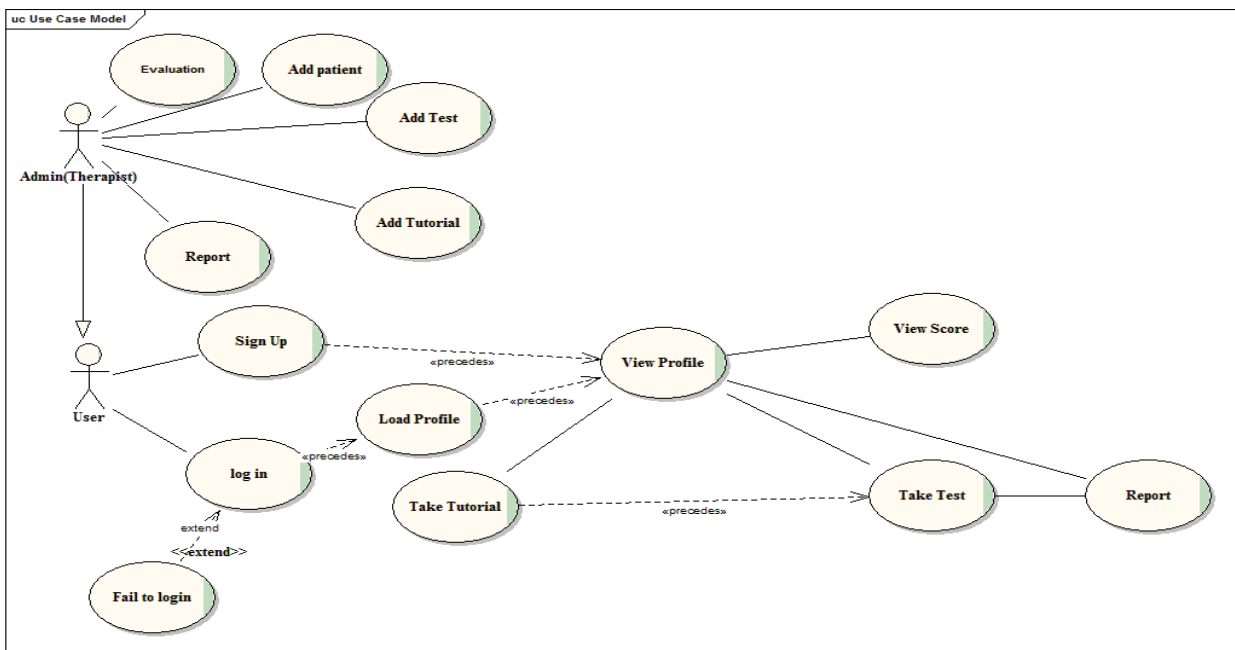
2.1 ARCHITECTURE

Figure 1: System architecture

Figure 1 depicts the overall architecture of 9ootik We9al. It consists mainly of 3 layers: the user interface layer, the display layer, and the Software (database) layer. The main interface has a user friendly interface. Users interact by recording their voice. The database layer includes the pictures and questions of the tutorials and tests.

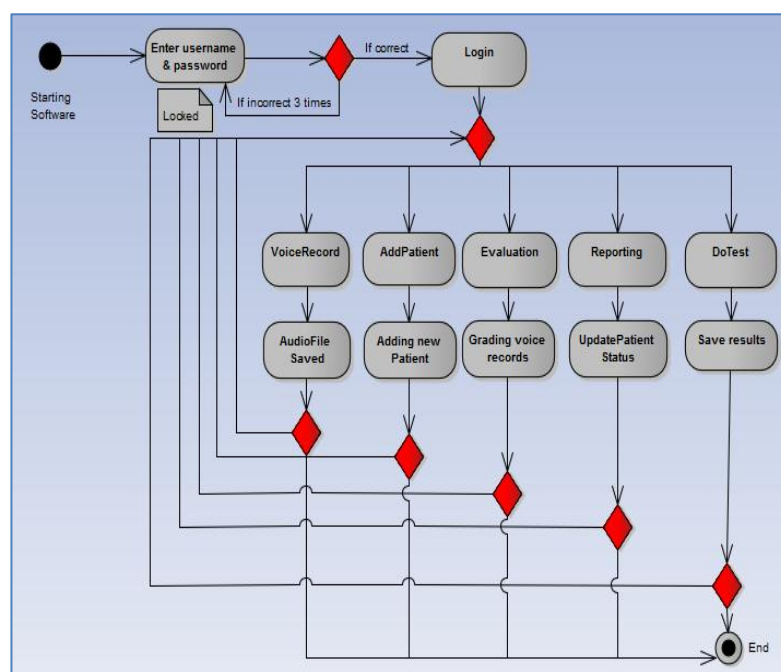Figure 2: Use Case diagram

2.2 USE CASE DIAGRAMS

Figure 2 shows the major use-cases of 9ootik We9al. It depicts different users of the system and most of the crucial use cases. The system has two main users:

- Patient (User) can log in, do test, and record his/her voice.
- Therapist (Admin) can log in, Add new patient, get reports, update patient's status, and evaluate patients' voice records

2.3 ACTIVITY DIAGRAM

Figure 3 depicts an overall activity diagram for the system. Once the user inserted his\her name or password, if it is incorrect then he/she has three times to reinsert the information correctly. After the third time, the application will be locked. If the information inserted is correct, then the user can login to the application (9ootik We9al). The user will have the following options: DoTest, Evaluation, Reporting, VoiceRecord, AddPatient and UpdatePatientStatus. In case the user wants to record his/her voice, the audio file will be saved in his profile database. If the admin chooses, AddPatient tab, a new patient will be added to the database of users. For grading the voice record the admin should press the Evaluation tab. Finally, after finishing the test the results will be saved in the database.
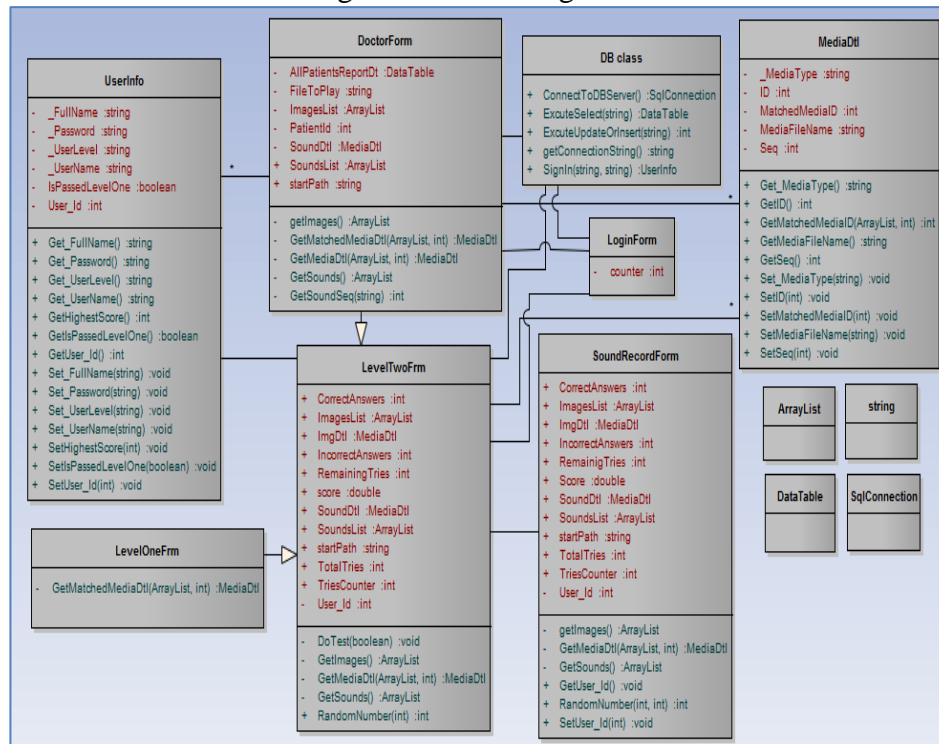
Figure 3: Activity Diagram

2.4 CLASS DIAGRAM

Figure 4 shows the relationships among 9ootik We9al main classes. 9ootik We9al has eight classes. These classes include: DB, MediaDtl, LoginForm, DoctorForm, LevelOneFrm, LevelTwoFrm, UserInfo, and SoundRecordForm.

- DB starts up a connection with the database, and contains shared methods for execute select, update, or insert query in the database. For the initial prototype, we have 10 different sounds and 10 words. The sounds were selected based on a specialized doctor's recommendation.

- DoctorForm allows the therapist to get reports about all patients, evaluate patients' voice records, update patient status, and add new patients
- LevelOneFrm, LevelTwoFrm both together represents the patient form where the child can do tests. The questions of the tests are generated randomly from the database of questions.
- SoundRecordForm allows the child to imitate sounds
- UserInfo has several setters and getters for user information
- MediaDtl has several setters and getters for different types of media; images, or sounds. We used 10 words and 10 sounds in the database, some of them are environmental sounds and others are animals' sounds; we chose them based on Dr. Saleh requirements.

Figure 4: Class Diagram

2.5 TECHNOLOGIES USED
Hardware Resources
- High quality speakers
- High quality microphone

Software Resources
- SQL server
- Microsoft .net
- Windows7

3   USING 9OOTIK WE9AL

3.1 SNAPSHOTS & ASSOCIATED SEQUENCE DIAGRAMS

Figure 5 shows a level one test (sound detection). As shown the user should choose the number of tries then clicks on start test button. After that he/she will be able to see pictures and listen to their sounds. He/she will click on the "I heard" button if he/she hears sounds, and clicks on the "I did not hear" button otherwise.

Figure 5: Level one test

Figure 6 shows a stage one test of level two (sound discrimination). In this level, the patient will choose number of tries, and click start test button. Then he/she clicks the "Picture match" button if the sound is matching the shown picture, and clicks on "Picture did not match" button otherwise.

Figure 6: Level two test

Figure 7 shows the interaction of the application and database, and how the answers will be evaluated.
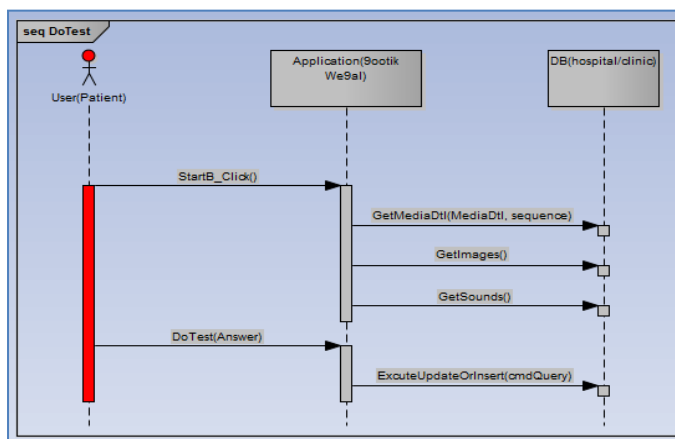
Figure 7 Do Test Sequence Diagram

Figure 8 shows the voice recording software. The patient will listen to the sound, and then he/she will click on record button and tries to imitate that sound, and then saves it. Figure 9 shows the process of voice recording, and interaction between the application and database.

Figure 8: Voice Record Form

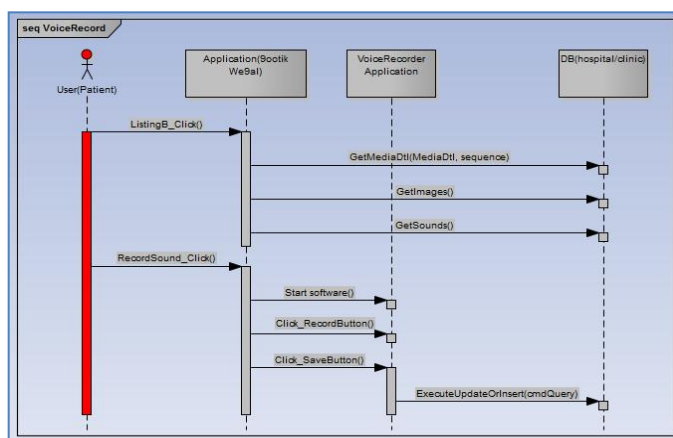Figure 9: VoiceRecord Sequence Diagram

Figure 10 shows Doctor Form selecting evaluation tab. Therapist should select patient name, then all sound records along with their pictures of that patient will be loaded in the form. Therapist can click on the listening to answer button, and grade each record. After that, he/she should click the save button.
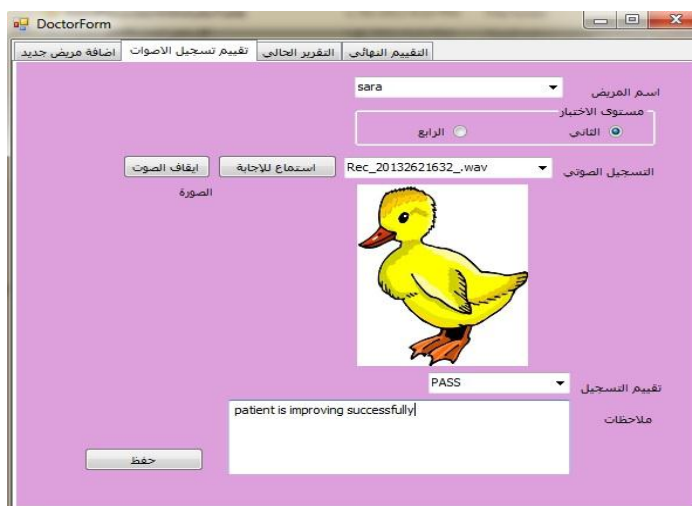
Figure 10: Evaluation tab

Figure 11 shows the interaction of evaluation process.
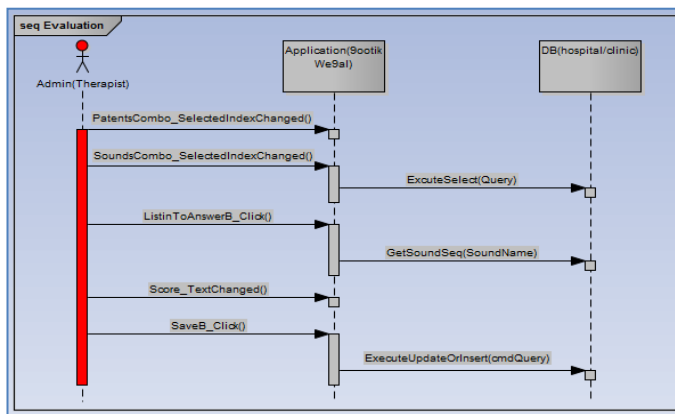
Figure 11: Evaluation Sequence Diagram

Figure 12 shows the reporting tab, including the update status button. When the doctor form is being loaded the table in reporting tab will be filled with data from database. If the therapist wants to see patients' reports he/she can select the reporting tab. Furthermore, if the therapist wants to update the patient status, he/she can choose pass/fail from the combo box and then click on the update button.

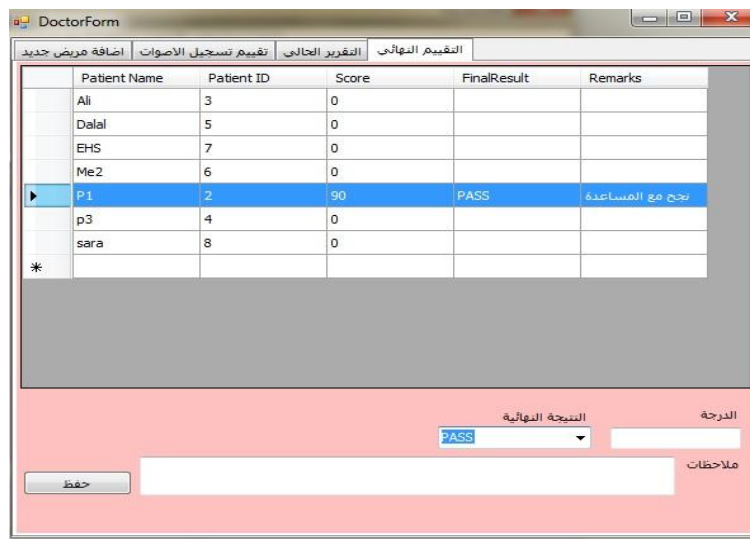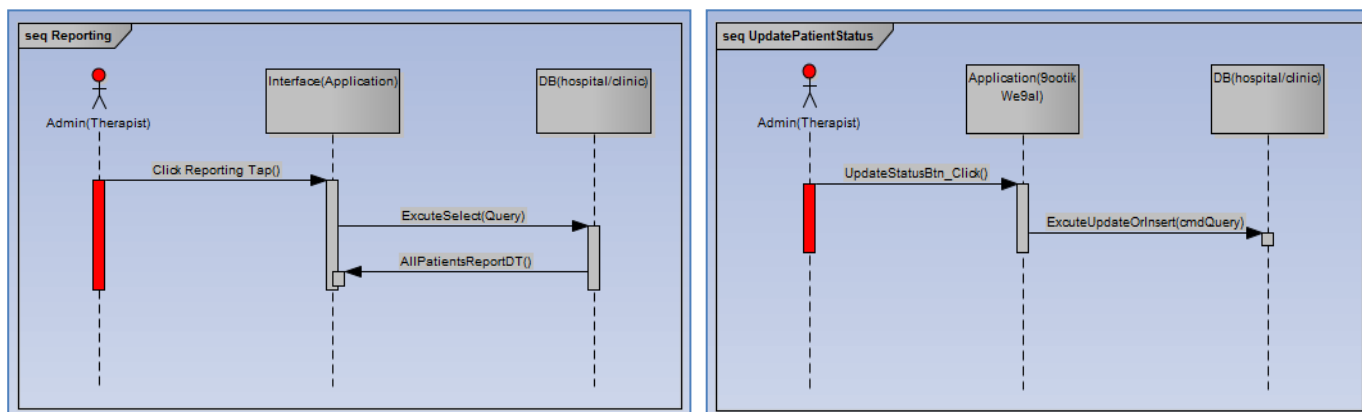Figure 12: Reporting tab along with Update patient status

Figure 13 shows the interaction between application and database while selecting reporting tab and what happens when updating patient status.

Figure 13 Reporting Sequence Diagram

4   ASSESSMENTS, SIMILAR PRODUCTS AND POSSIBLE ENHANCEMENTS

4.1 ASSESSMENTS

An interview was conducted with Dr.Saleh Alsha'alan, head of hearing and speech therapy in "The New England Center for Children" in UAE. Dr.Saleh had confirmed that till now he didn't receive any rehabilitation software program for cochlear implant recipients targeting Arabic speaking children. Furthermore, Dr.Saleh showed that the auditory verbal therapist's main role is to train parents on how to maximize child's hearing and listening skills by incorporating communication/listening activities in everyday situations. And despite this, Dr.Saleh said that the main obstacle in dealing with the rehabilitations programs is the lack of cooperation from parents and audiologists (who are responsible for ensuring cochlear implants are working properly). Therefore, the rehabilitation program may take years till the cochlear implant recipients could improve their hearing skills. Finally, when Dr.Saleh knew that there could be a software program for the rehabilitation stage targeting Arabic speaking children, he said "I think having such software enhances child's chances of developing their listening skills at home and gives parents a chance to work with their kids using a good program and material. It is a very nice addition to the rehab process".

4.2 SIMILAR PRODUCTS

There are many rehabilitation tools[4]. Cochlear.com provides links for tools for rehabilitation. What makes 9ootik We9al unique is its support to Arabic speaking patients. Only one other application supports such feature [10]. The following are some of the existing solutions for English speaking users:

1. AngelSound is an interactive listening rehabilitation software for cochlear implant users and hearing aid user. For details, please visit About Angel Sound [5]. AngelSound helps the users to take control of their listening rehabilitation by themselves at home. By using AngelSound, users can discriminate and identify sounds and speech components through a series of levels that cover different aspects of the listening process. Users can share the training and testing results with their clinician or therapists to gain advance.

2. AngelSim is a program that simulates cochlear implants and hearing loss [6]. This software is mainly concerned about simulating different sounds in different conditions. Users can experience various listening conditions by using simulation of bilateral cochlear implant feature, or simulation of bimodal cochlear implant feature.

3. i-CAST is an internet-based computer-assisted speech testing. It is a standardized speech assessment tool for research and clinic environment. The software consists of multi-tests, such as vowel recognition test, consonant test and voice gender test. User will hear different words and then he/she should choose from a wide selection of written words the word he/she heard [7].

4. Cochlear HOPE Words App is the first rehabilitation application found by an implantable hearing solutions manufacturer. Cochlear Hope Words app was developed to improve listening and speech skills for children with hearing impairment. The application is an Ipad/Ipod/Iphone app; it contains different flash cards with images and sounds for different objects ordered alphabetically. The user can see the image and click on it to hear the related word [8].

5. Rannan [9] is an aural rehabilitation system for Arabic speaking children. The tool can be easily customized by therapists to allow them to design exercises for children. Rannan is comprehensive aural rehabilitation software; it consists of different levels with different

activities. Users can interact with the software by engaging in any of the available games in different levels. It is a rehabilitation program for home-based aural therapy.

4.3 POSSIBLE FUTURE ENHANCEMENTS

The following enhancements are planned to improve 9ootik We9al:

- Develop a comprehensive web-based environment to provide accessibility over the Internet.
- Increase and categorize the available sounds. Categories will include: transportations sounds, animals' sounds, etc.
- Add automated grading for the voice comparison exercises.
- Add an interface for instructors to add their own tests. The environment includes adding pictures and associated sounds.

5 CONCLUSION

In conclusion, we believe that by using 9ootik We9al software there will be a big positive transformation in applying rehabilitation programs in the health sector. Furthermore, saving time of auditory therapists will save their efforts in which they can keep for other tasks. 9ootik We9al is different from the above mentioned similar software solutions in the following:

- It is clinic-based rehabilitation program
- It provides graded test for each level which allows the therapist to keep track of child progress

A lot of the Arabic speaking countries will benefit from using such program for cochlear recipients. We plan to start testing 9ootik We9al in Kuwait in specialized rehabilitation centers. The next phase will be to promote the application in the GCC region.

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