

YUSR: Speech Recognition Software for Dyslexics

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Abstract. Learning disability is a classification including several disorders in which a person has difficulty learning in a typical manner. Reading disability or difficulties in reading is one of these disorders. Many researchers assert that there are different types of reading disabilities, of which dyslexia is one. Dyslexic children suffer from reading difficulties and face many challenges in their educational life. In this paper we propose an Arabic reading assistance solution for dyslexic children, it is an automatic speech recognition software based on analyzing phonetic isolated Arabic alphabet letters. The software application provides an environment for dyslexic children to develop and improve their skills of reading and spelling.

Keywords: Dyslexia, Speech Recognition, Usability.

1 Introduction

There are many learning disabilities that may impede the child's progress in learning and developing his capabilities, the most prevalent one is the disability in reading called dyslexia. One of the core problems of children suffering from dyslexia is the difficulty of learning how the printed word maps into spoken language [1]. Moreover, most dyslexic children have been found to have problems with identifying the separate speech sounds within a word and/or learning how letters represent those sounds. The causes of dyslexia are still not clear, but anatomical and brain imagery studies show differences in the way the brain of a dyslexic person develops and functions [2].

We are concerned that dyslexia is still not widely known in the Arab world; and academic researches on this specific condition in the region are extremely scarce. Some studies reported that dyslexia has analogous underlying causes in both English and Arabic and that there is potentially a common causal pathway for the phenomenon across different languages [3]. With regard to the prevalence of dyslexia in Arab populations, a nationwide study by the Kuwait Dyslexic Association reported a rate of 6% among Kuwaiti nationals [4]. A later study has identified a higher prevalence of 20% among young Kuwaiti offenders [5]. Internationally, the number of students with dyslexia entering higher education has been increasing steadily. Alarmingly, the overall incidence of dyslexia in English-speaking higher education institutions increased by almost 41% - 47% between 1994 and 1996 [6].

With the aim of developing the skills of reading and spelling of dyslexic children and dealing with the increasing rate of dyslexic children in the Arab world, an automated speech recognition system called YUSR is proposed. It focuses on interface design and interaction and how to make them more supportive for the preferences and learning styles of dyslexics.

Developing software for dyslexic children is very useful since they are increasingly using computer technologies. It helps parents and teachers and facilitates their task to teach dyslexic children to read.

The rest of the paper is organized as follows. In section 2, a brief overview of related work is given, followed by the description of the proposed software application in section 3. Section 4 presents the discussion of the results obtained after using the application by dyslexic children. Finally, the section 5 concludes the paper.

2 Related Work

Many researches concentrate on the use of computer technologies to address the problem of dyslexia. In [7], speech recognition and eye tracking are used to adapt to readers' progress. And in [8], speech recognition and image recognition are used in AGENT-DYSL, which is an adaptive reading assistance system that allows dyslexic students to read arbitrary text documents. Speech recognition is also used in [9] to propose an automatic speech transcription for dyslexic children, it uses a speech recognition engine trained on lexical and language models specifically constructed based on their recorded readings. As example of commercial software applications there is Kurzweil 3000¹ and ReadOn². Most of the software applications process the English language.

Regarding to Arabic reading applications for dyslexics, there are relatively few software applications that are targeting dyslexia and its specific problems.

3 YUSR Methodology

YUSR³ is an Arabic software for dyslexic children. It is an automatic speech recognition (ASR) system based on analyzing phonetic isolated Arabic alphabet letters. YUSR is built to be an assistant software application for dyslexic children to learn Arabic letters pronunciation . This application aims to develop skills of reading and spelling, it provides an environment for dyslexics to use their senses in learning (vision – speech – hearing).

YUSR is an Arabic software dedicated to dyslexics of early ages depending on the discovering of the dyslexia. Target users are often of age between 5 and 10 years old.

¹ <http://www.kurzweilededu.com>

² <http://www.readonsoftware.com>

³ In Arabic means to facilitate.

Research, questionnaire and interviews were conducted to understand the users' needs because this understanding is one of the most important factor to design user interface and ensure a high level of usability. The goal is to design and build the best suitable interface for dyslexics. As results, the following requirements were taken into account:

- Using large text and white space, this helps to make the text more readable[10].
- Considering the colors used in background and texts.
- Avoiding online classes entirely because of the reading requirements in them.
- Providing feedback about performance correctness [11].
- Providing easily clickable button size and using of meaningful icons instead of words.

YUSR is designed to provide two learning levels for users. Figure 1 illustrates the main interface of the software, it contains three buttons . The first button, represented by the cloud on the right side of the rainbow, leads to first level of the application where the user can learn the letters pronunciation. The second button, represented by the cloud on the left side of the rainbow, leads to the second level of the application. The word YUSR in Arabic is written on it. And the third button is the help button, it is in the left bottom side of the interface .



Fig. 1. YUSR's main interface

Learning the Arabic letters and their pronunciation is considered as the first stage to learn Arabic language. The first level of YUSR is dedicated to learn the dyslexic children the 28 Arabic alphabets, the first level interface is shown in figure 2. The main function of this level is providing the speech recognition of the Arabic letters; the child can record his pronunciation of the chosen letter, by clicking on the

microphone icon, and get a feedback from the application. The feedback is displayed in window messages as shown in figure 3. If the pronunciation is accepted by the speech recognition system, the figure 3.a is displayed as a feedback to congratulate the child. Otherwise, the figure 3.b is displayed to ask the child to pronounce the letter again. By clicking on the headphone icon, the child can listen to the correct pronunciation of the letter with its three Harakat (short vowel marks). The pronunciation of each letter articulation is played by clicking on each of them. The pencil icon shows the child an animation of how to write the letter. Also, in this window there is the letters' bar, in the left side of the figure 2, it contains all the Arabic letters as clickable icons to move between letters windows.

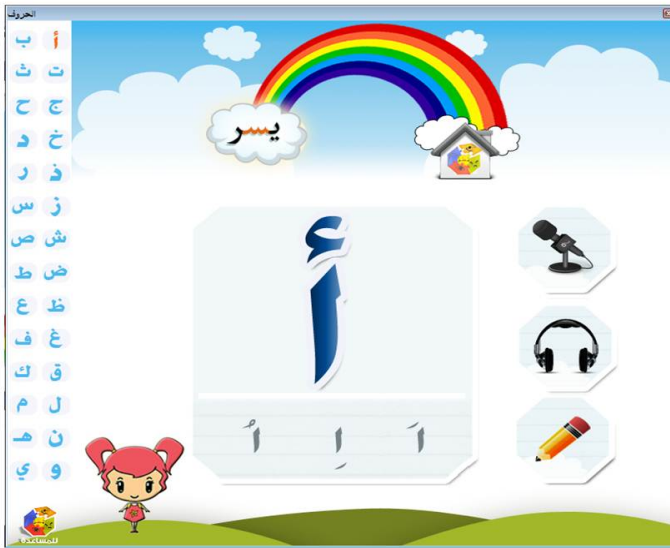


Fig. 2. YUSR first level interface



(a) Congratulation message



(b) Warning message

Fig. 3. Feedback messages

The second level of YUSR is about using the letter in words, as shown in figure 4. It allows the user to listen to the pronunciation of the chosen letter in three positions; at the beginning, in middle and at the last of the word. This level helps the dyslexic child to connect the knowledge of pronunciation learned in level one to the spelling and the utilization of the letter in words. Giving word examples with their associated figures supports learning and memorization.



Fig. 4. Level two of YUSR interface

The speech recognition is done by extracting the features of the sound using Mel-Frequency Cepstral Coefficients (MFCC). While The statistical model used in the recognition process is developed using Hidden Markov Model (HMM) and implemented in Hidden Markov Model toolkit (HTK toolkit). The application was trained by more than 500 samples of the Arabic alphabets with different volumes and different sounds of males and females to provide variety. The recognition rate achieved by the application is 82 % (recognition of 23 letters out of 28 Arabic letters).

By testing each letter individually, the system recognized the Arabic letters with different rates; results are shown in figure 5. Some of the letters have high rate of recognition (like the letters Jeem جيم and Ha'a حاء). However, there are some letters with a low rate of recognition (like the letters Dal دال and Seen سين) because of the confusion with similar letters (Thal ذال and Sheen شين).

- Some of the children click the letter to listen to its pronunciation instead of the headphone icon.
- There was a task asking the user to switch to word section from the letter section. many of the users click back to home page and choose the word section instead of using the above switcher on letter level.
- Some of the users took a long time to realize the need of click on the recording result button to get the result of their letter pronunciation.
- The recording process needs to click the *play* button to start and *stop* button to stop recording. Some of the users just click play without stopping the recording immediately as they finish recording.
- The three letter's articulation is clicked curiously by some users while others never thought that there are clickable.

The children were interested in using the application and switching between letters and words. They found the interfaces friendly with suitable colors, and the characters of the application attracted their attention.

5 Conclusion

We have presented a speech recognition software for dyslexic children called YUSR. The aim is to provide an assistance to dyslexic children to improve their skill of reading. The proposed software application covers the 28 Arabic letters. For each letter, the application provides the letter pronunciation, how the letter is written and gives examples with words containing the letter at the beginning, in the middle and at the end of a word. After testing, results showed that the application reached its goal of providing a suitable and useful environment for the dyslexic child to use his/her senses in learning and encourage the interaction with the application.

For future work, we recommend to upgrade of the application by including the foundations of education for advanced cases of dyslexia, such as learning word pronunciation and assess these skills in speech recognition at the level of words. Also, add more activities to the application such as exercises with gaming functions to provide a test for the users' learning. It is also important to evaluate the application by involving more dyslexic children in the testing phase, this will help to adapt the application according to their assessed needs.

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