

Interactive System for Solving Children Communication Disorder

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Abstract. The recent development in information technology contributes significantly in solving special needed people problems. This paper describes an ongoing project to help those children suffering from speech disorder problems. The current application is an interactive game using speech recognition technology; kid can interact with an animated picture using his/her voice. There are several levels for improving the speaking skills of children at different stages. Firstly, by encouraging child just to produce sounds then by improving his/her pronunciation skills by pronouncing short vocal Arabic words. This application solves speech disorder problems such as difficulty producing speech, dysfluency, shuttering and voice disorders. The current work is pioneer in developing an Arabic language application and targeted to children aged from 2 years to 7 years.

Keywords: children speech disorder, speech recognition, interactive applications.

1 Introduction

Children speech or language disorder can be considered as a critical problem not only affecting the child and his own family but also the whole society. If the child doesn't receive the proper therapy in the proper time he/she may suffering from that problem the rest of his/her life not only on educational performance but on his/her opportunity to get good jobs and to communicate with the whole society.

The concept of communication disorders comprises a wide variety of problems in language, speech, and hearing. Speech and language impairments include articulation problems, voice disorders, fluency problems (such as stuttering), aphasia (difficulty in using words, sometimes as a result of a brain injury, viral infections, cardio-vascular accident, mental retardation), and delays in speech and/or language. Hearing impairments include partial hearing and deafness. Deafness refers to a kind of loss sufficient to make auditory communication difficult or impossible without amplification. A good number of communication disorders can equally result from other pathological conditions such as learning disabilities, cerebral palsy, mental retardation, or cleft lip or cleft palate [1].

Different researchers have studied speech and language dysfunctions depending on their disciplines and orientations. Not all speech variations are clinical problems.

A speech difference is a problem if it interferes with communicabilities attracts undue or negative, attention or causes the speaker to be emotionally disturbed or socially maladjusted[2].

Freeman & Silver [3] had noted that distinguished speech disorders are typically more difficult in children than adults, and most difficult in cerebral palsied subjects. However, these children are not placed in treatment for speech disorder until it was clear that they were not going to outgrow the problem in addition to limited professional and financial resources. As consequence, most subjects did not receive professional assistance until they were over 7 years old. In these older subjects, deviant speech patterns were firmly established [4].

Children suffering from communication disorders tend to manifest a number of peculiar cognito-behavioural features. For instance, a child with speech or language delays may present a variety of characteristics including the inability to follow directions, slow and incomprehensible speech, and pronounced difficulties in syntax and articulation. Articulation disorders are characterized by the substitution of one sound for another or the omission or distortion of certain sounds. Stuttering or dysfluency is a disorder of speech flow that most often appears between the ages of 3 and 4 years and may progress from a sporadic to a chronic problem. Stuttering may spontaneously disappear by early adolescence, but speech and language therapy should be considered. Typical voice disorders include hoarseness, breathiness, or sudden breaks in loudness or pitch. Voice disorders are frequently combined with other speech problems to form a complex communication disorder [1].

"Speech or Language Impairment" means a communication disorder, such as stuttering, impaired articulation, language impairment, or a voice impairment, that adversely affects a child's educational performance [4].

Types of Speech Disorder Includes:

- **Dysfluency:** an interruption in the flow of speech, such as stuttering e.g. some person who stutters may repeat the first part of a word (as in wa-wa-wa-water) or hold a single sound for a long time (as in caaaaaake).
- **Articulation or phonological disorders:** difficulties with the pitch, volume or quality of the voice while the sound is formed e.g. Substituting a "w" for an "r" ("wabbit" for "rabbit"), omitting sounds ("cool" for "school"), or adding sounds to words ("pinanio" for "piano") are examples of articulation errors.
- **Aphasia:** is the loss of the ability to understand language, whether spoken or written, and occurs due to disturbances in the areas of the brain that are used in language processing.
- **Dysarthria:** Dysarthria refers to a difficulty in pronouncing certain sounds or words that is usually due to a problem with muscle control.
- **Dyspraxia :** is a motor learning difficulty that can affect planning of movements and co-ordination as a result of brain messages not being accurately transmitted to the body.
- **Slurred Speech :** speech in which words are not enunciated clearly or completely but are run together or partially eliminated

- Speech Disturbance : Difficulty with speech can be the result of problems with the brain or nerves that control the facial muscles, larynx, and vocal cords necessary for speech.
- Speech Impediment.
- The Language Disorders is the situation that the child has a large amount of vocabulary but he/she can't use them at sentences and doesn't use the grammatical patterns for making sentences.

While Types of Language Disorders includes:

- First type: improper use of words and their meanings.
- Second type: inability to express ideas, inappropriate grammatical patterns.
- Third type: reduced vocabulary and inability to follow directions.

As mentioned in the above sections speech disorder is a critical and important problem and it is better to find solutions for it in early stages to overcome its drawbacks. So, in the current work we tried to introduce an easy, cheap, and interactive solution for the families have child suffering from this problem and also for therapists.

The current work is an Arabic language application based on the idea that, a particular beneficial feature of human-computer interaction (HCI) is that children find them a “safe” and enjoyable experience. This can be explained by the fact that interaction with computers does not pose the expectations and judgment issues that are associated with social interaction. Computer systems tend to function in a controlled environment with minimal distractions and this makes them an attractive option for the education of autistic children [5]. Consequently this type of interaction elicits positive feelings, whereas communication with humans is frequently fraught with problems [6]. The positive feelings appear to be generic and uncorrelated with the type of software interface [7].

Out training strategy followed the suggested strategy illustrated on [4] to start by training speech muscles: by slow abdominal respiration to increase expiration and use air amount for speaking; first for voices then letters then words then sentence [4].

The current work is targeted to children ages from 2 years to 7 years.

2 Related Work

Many commercial application deal with speech disorder problems such as Speech-Language Pathologist Package[11] and Bungalow Software [12].

Regarding to Arabic reading applications for communication disorder therapy, there are relatively few software applications that are targeting speech disorder problems.

3 Methodology

Our proposed application consists of several levels in order to help in children speech disorder therapy. This application aims to help kids to learn and improve their communication skills in an easy, interactive manner, like playing a game. The current application main advantage is that it is in Arabic where most of the available commercial applications are in English. This application can be used easily at home, institution or any place. It also helps adults (therapists or parents) to keep tracking of the child progress by recording his/her score each level.

We combine animated picture and speech recognition technologies in order to develop the current system. The first level is very basic to help child to improve his/her speech skills and making sure that the child doesn't have any health problem preventing him from speaking. This level aims to encourage the child to produce sounds. It provides an interesting interactive interface shows friendly simple objects. These objects start to animate as the child produces sounds and this behavior changes when sound threshold level increased in an interesting manner. For example, one interface story contains a car starts to move as a child starts to produce sounds and it will stop if he/she stops producing sound. Then, it changes to become a 2 racing cars as the child increases his/her voice (as shown in figure 1). Figure 2 and 3 show another two stories just like the first figure but with different animated object popular to children.

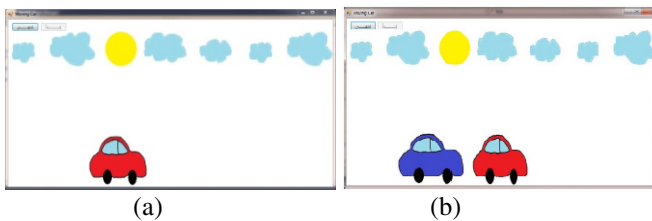


Fig. 1. Sample screenshots of the first level interactive interfaces (car story)

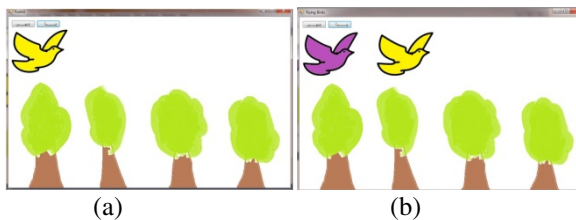


Fig. 2. Sample screenshots of the first level interactive interfaces (bird story)

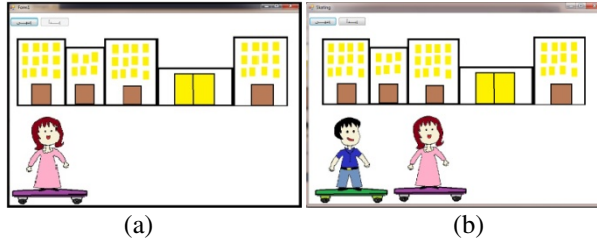


Fig. 3. Sample screenshots of the first level interactive interfaces (girl and boy story)

The second stage is devoted to those children who got the ability to pronounce letters but in a wrong way, this stage aims to correct their language disorder problems by providing short vocal words such as cat or beer in Arabic (دب - قطه) with related pictures and encourage them to pronounce words correctly by producing clapping sounds, saying words in Arabic language such as "Good job" and rewarding children by giving them marks if they saying word correctly. This stage based on a simple speech recognition system consists of pre-processing stage (Butter worth band-pass filter) for noise removal followed by Dynamic time warpping and feature extraction stage using Mel frequency Sepstral coffecianat, finally performing classification stage by compaing the distance between input features with the saved corresponding one from system database as shown in figure 4 [8 - 10].

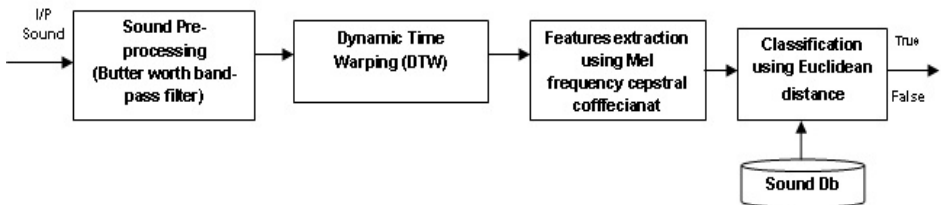


Fig. 4. Level 2 simple speech recognition system

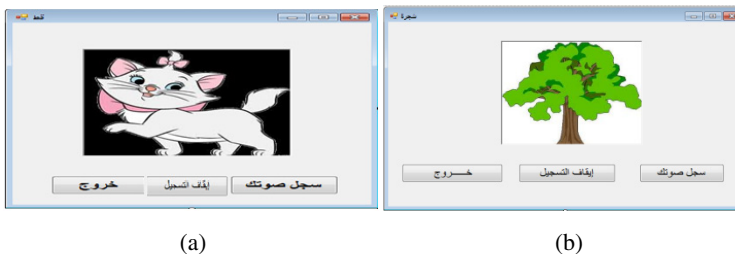


Fig. 5. Sample screenshots of the second level interactive interfaces (Cat word)and (tree word)

The third level designed for improving the communication skills by involving the kids into a conversation and asking them to complete it in a right way but we still work on it and didn't finished.

4 Results and Discussion

The test was conducted on two groups of users 5 therapists and 10 parents as one group and 8 children their ages ranges from two and half years to seven years, six of them were girls as second group. The tests started by giving the each group (therapists, parents and children) an overview about our application, and then giving them tasks to perform. While the most three important parts of the system are Registration(for therapists and parents), Playing Level One and Playing Level Two(for children), the testing process will focus on those three parts. Testers observed tests and recorded information about time needed to perform each task and the number of correct clicks and wrong clicks. An interview is conducted with children about the software application and the problems they faced after using it.

The Following Are the Tasks Given to Users:.

Giving a certain users 6 tasks for testing our application that include:

1. Create an account that contains your information as supervisor's account.
2. Log in to your account that u had create it in pervious task.
3. Add a child with this information: (name : Muhammad Husain Ali ,gender : boy , birthday 18/3/2005 ,city : Jeddah , address : Al-Rawdah neighborhood , Phone No. : 02-6666776).
4. Make the child that you registered before start playing with the level that measure the child's ability to issue votes (Level One).
5. Make the child that you registered before start playing with the level that tests the child pronunciation (Level Two).
6. View the child statues from the children.

After observation of the testing process, the results of the usability test shows that all of 5 therapists and 8 of 10 of the parents did all the tasks directly and navigate through the application windows easily without mistakes. The children test results shows that for the first level 7 of 8 children play it in a short time, while in the second level test 6 of 8 play it in a short time. Generally the children impression was good and they like the animated pictures response a lot.

The results of the usability test show promising results for both speech therapist and kids. Most of the users performed the required task in a reasonable time and number of clicking.

After task session completion, participants of first group (therapists and parents) rated the System by six overall measures, these measures include:

1. Ease of use
2. Clarity of the buttons meaning.

3. Clarity of menus and its contents.
 4. Clarify of help windows
 5. The quality and consistency of colors and fonts.
- Table-1 shows analysis of the results from the post test questionnaire.

Table 1. Analysis of post test questionnaire

Question	Answer	Sum	Average
Using the software was	very easy	12	80%
	Easy	2	14%
	Neither easy nor difficult	0	0%
	difficult	1	7%
	very difficult	0	0%
Clarity of button meanings	very clear and understandable	11	73%
	clear and somewhat	2	14%
	not clear	1	13%
Clarity menus and its contents	very clear and understandable	14	93%
	Somewhat clear	1	7%
	not clear	0	0%
Clarity of help windows	very clear and understandable	15	100%
	Somewhat clear	0	0%
	not clear	0	0%
The quality and consistency of fonts and colors	Comfortable and consistent	4	80%
	Somewhat Comfortable and consistent	1	20%
	Inconsistent and Uncomfortable	0	0%

5 Conclusion

We present an ongoing project to produce a software package to be used in the thereby of those children suffering from speech disorder in an interactive game manner. The current work covers two stages in our way to improve children communication skills. The first stage was concerning of encourage children to produce sounds and the second stage improving the pronunciation of letters through short vocal words in an interactive manner. We also provide a record for each child score through levels to help therapists and parents watching the child progress.

The main advantage of this application is that it is in Arabic where most of the applications available in market are in English. The application can be used easily at home, institution or any place so, it is an expensive way to overcome speech disorder problem.

In near future we aim to complete the third stage which helps children to pronounce long vocal words and sentences through long interactive stories combining animated cartoon characters with sound recognition to produce dialog system. We also aim to test the system with much more number of children.

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