IOAN UNGUREAN

A MOBILE AND INTELLIGENT DEVICE FOR CUSTOMIZED LOGOPEDIC THERAPY

"Ştefan cel Mare" University of Suceava,
University street 13, 720229, Suceava, Romania,
The "Stefan cel Mare" University,
tel.: +40-230-216147, E-mail: ioanu32@yahoo.com

Abstract. An expert system for customized logopedic therapy must allow the training of children depending on its speech disabilities and former progress. The children's training is accomplished using exercises chosen by the expert system and can be performed either in the doctor's office or at home for each child using an intelligent mobile device. The expert system generates a set of exercises for each child depending on the doctor's recommendation. These exercises are transferred from PC to mobile devices using a Universal Serial Bus connection. The mobile device saves the result of each therapy session and when it is connected to PC it transfers the results to the expert system for analysis. Using the results of these analyses the expert system will decided whether a new session is needed and if that is the case, compute a new set of exercises.

Keywords: logopedic therapy, intelligent system, mobile device.

INTRODUCTION

The logopedic therapy [1] represents the science that carries out of tracking and correcting the language disorders (speech or writing). The language disorders can be: delaying on appearance and progress of language, difficulties on pronouncing some sounds, replacing certain sounds with others and stutters. The language disorders are frequently met to pre-school children. The logopedic therapy on children [1][2] also involves the participation of parents or adults that take care of children's growing and education [3][4]. What is worked within the logopedic consulting [5] room has to be repeated at home, also. Within this paper, a mobile device that can be used in the view of logopedic therapy is presented. This mobile device is used for home repeating of exercises, which are also performed at the logopedic doctor's consulting room.

For a better efficiency of logopedic therapy, an intelligent system [6][7] of customized therapy on speech deficiencies of pre-school children was designed and performed. This intelligent system is formed by an expert system set up on speech therapist's computer and a mobile device used for carrying out exercises need for correcting the speech deficiencies. The expert system is used in the view of establishing the therapy for each child and accomplishing the time historian of child's progress.

The mobile device is used by children in the view of accomplishing at home exercises of correcting the speech deficiencies, without being necessary the assistance of speech therapist. For developing the mobile device, the requirements to which this has to respond were taken into consideration. These requirements aim on to aspects:

- multimedia facilities (recording, processing, audio play-back);
- graphical facilities (friendly interface and easily to access).
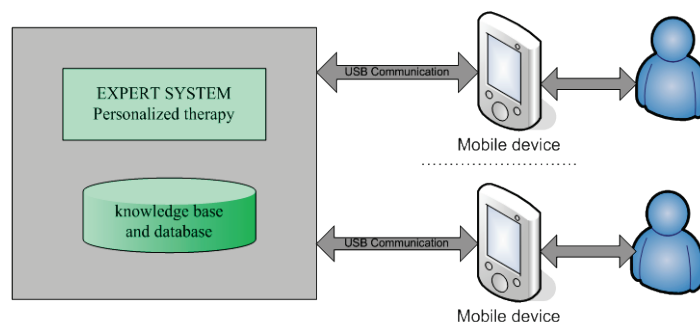

Fig. 1. The functioning mode of the mobile device

The mobile device has to communicate also with the PC on which the expert system on customized

therapy is set up. Taken into consideration these requirements for developing the mobile device, using a Pocket PC was chosen.

The functions of the mobile device are:
- carrying out at home specific exercises to speech deficiencies for each child;
- customized interaction with the human subject;
- evaluation and encouraging the progresses achieved by the human subject.

The expert system [6][7] establishes the exercises that a child has to perform at home until the next meeting. These exercises are grouped under the form of homework and transferred from the speech therapist's computer on the mobile device. The child performs these exercises at home, being assisted by parents or alone.

At the next meeting, the results of exercises made by child are transferred on PC to the expert system, in the view of being analyzed. The device will save for each exercise from homework the number of how many times this was made and the result of each exercise' solving test.

HARDWARE PLATFORM FOR MOBILE DEVICE

In the view of choosing the hardware platform on which the mobile device has to be developed, the following requirements were taken into consideration: to be able to play-back the audio sequences, to be able to record sounds, to be battery powered (a self-sufficiency of at least 24h), to be robust and easily to use, a known platform of developing the applications has to exist, to e able to communicate with a computer and to have as the best price/performance ratio.

In accordance to market offers analysis and of initial requirements, the development of mobile device by using a Pocket PC was chosen, having the following characteristics: Pocket PC ASUS A730, Intel processor PXA270 520Mhz, 640 x 480 resolution, integrated microphone and speaker, Microsoft Windows Mobile 2003 SE operating system , USB port for the communication with the PC.

The applications for the mobile device were developed by using Microsoft Visual Studio 2005 software developing package, C# programming language, under the form of little games. The applications developed in the view of being executed need Frameworks 2.0. Therefore, these applications can run on any Pocket PC that have Frameworks 2.0 set up and respect the initial requirements (to have at least a microphone and speaker).

ORGANIZING THE APPLICATIONS ON THE MOBILE DEVICE

The applications developed for the mobile device are:
- MonitorHomework – from where the homework that has to be solved will be selected.
- DetectingIntruder – that implements the exercise of detecting a sound from a word.
- Paronyms – that implements the exercise of selecting a word from a group of 2 paronyms. In this application, the words are companioned by images.
- ParonymsStreamers – that implements the exercise of selecting a word from a group of 2 paronyms. In this application, the words are not companioned by images – the selection of a word is made by selecting a little flag.
- PronouncingWords – that implements the exercise of pronouncing the words.
- PronouncingParonyms – that implements the exercise of pronouncing the pairs of paronym words.
- PronouncingOnomatopoeia – that implements the exercise of pronouncing the onomatopoeias.
- PronouncingSound – that implements the exercise of pronouncing a sound.
- PronouncingSentences – that implements the exercise of pronouncing sentences.
- PronouncingDirectSyllables – that implements the exercise of pronouncing direct syllables.
- PronouncingArticulatedSyllables - that implements the exercise of pronouncing articulated syllables.
- TransformingWords – that implements the exercise of pronouncing a word, which is determined by means of suggestive image.

After transferring the homework, the MonitorHomeworks module will run on the mobile device. Form this application, the homework that has to be done can be selected (more homework can be transferred on the mobile device). After selecting the homework, the exercise from current homework that has to be solved will be selected. Homework can be solved from the first exercise until the last exercise and there is a possibility of returning to exercises of which result is not satisfying. Each exercise can be made on unlimited number of times. There has to be mentioned that for each exercise, the number of repeating and the result of each solving test of exercise will be saved. This information are transferred from the mobile device to the PC of the speech therapist, in the view of being analyzed by the intelligent system of customized therapy on speech deficiencies. For staring the exercises, Start – Terapers or Start – Programs – Terapers will be selected.

From the speech therapist's computer, the applications used by the child on solving the exercises, the images and sounds used by these applications will be transferred on the mobile device. Therefore, on the mobile

device a folder with the name of child will be created (for instance), where the following data will be copied:

- MonitorHomework application;
- the Exe folder will be created, where the executable files specific to each type of exercise will be copied;
- the Homework folder will be created, where the description files for each homework will be copied;
- the Exercises folder will be created, where the description files for the exercises of each homework will be transferred (for each homework a subfolder with the name of homework will be created, subfolder where the description files of exercises will be transferred).
- the Media folder will be created, folder where the sounds and images used on exercises will be transferred.

At the next meeting between the child and the speech therapist, the results achieved on exercises' solving from homework will be placed in Results folder. In this folder, one subfolder for each home work will exist.

Homework can be done by starting from the first exercise until the last exercise and there is the possibility of returning to exercises of which result is not satisfying. Each exercise can be carried out by a unlimited number of times. There has to be mentioned that for each exercise, the number of repeating and the result of each solving test of exercise will be saved. This information are transferred from the mobile device to the PC of the speech therapist, in the view of being analyzed by the intelligent system of customized therapy on speech deficiencies. Two exercises are forwards presented, which were developed for the mobile device.

THE PARONYMS EXERCISE

This application executes the exercise implementation of recognizing a word from a group of two paronyms (for instance, duck – dog). On starting the application, a window where START button is placed will be displayed. After pressing the START button, a text will be displayed in the window (of presenting the exercise) and an audio sequence is played-back, by which the exercise is described.

Fig. 2. The Paronyms module

After listening the exercise's description, the two paronym words will be presented and the images accompanying them are displayed. In the view of solving the exercise, the following steps will have to be respected:

1. The instructions from exercise's starting will be listened.
2. Presentation of those two words will be also listened. For instance, for the set of paronyms duck – dog, the following audio sequence will be presented: "Here a duck is" (now, the first image has a red border with blink effect), and then the audio sequence "and here a dog is" is presented (now, the second image has a red border with blink effect).
3. The question gas to be listened (for instance, "Where do you see a lake?").
4. The image that represents the correct answer will be selected.
5. If the given answer is not correct or the time while the answer should have been given was overdone, then the question will be repeated once again at the end (a question can be repeated only one time). If the answer is correct, then a reward will be offered, under the form of an image with a rose.
6. The process will be resumed starting from point no. 2 until finishing all the questions.
7. The result of exercise will be displayed in accordance to figure 2 (for all the exercises, the results are presented the same way).
8. If repeating the exercise is desired, then "Repeat the exercise" button will be selected; if passing to the next exercise from homework is desired, then "Next exercise" button will be selected.

THE PRONOUNCINGWORDS EXERCISE

This application executes the exercise implementation of pronouncing the words. An image of this application is presented in Figure 3. On starting the application, a window where START button is placed will be displayed. After pressing the START button, the words that have to be pronounced by the child will be displayed in the window (only a part of them, because of space lack – after pronouncing these words, the next words will be displayed, which have to be pronounced by the child).

After displaying the words for solving the exercise, the following steps will have to be respected:

1. The module will enframe with red highlight the word that has to be pronounced and will present the word by using an audio sequence, which the child has to listen carefully (for instance, "Pronounce RRa").
2. After listening on the word, the child will have to pronounce the word, also.
3. Depending on pronunciation correctness, a grade starting from 1 to 4 will be given. Depending on the grade given, a reward will be offered, meaning an image that represents a little flower for grade 1, two little flowers for grade 2, three little flowers for grade 3 and little bouquet of flowers for grade 4 (at the same time, an audio sequence will be heard, meaning "Bravo, you have a little flower/2 little flowers/3 little flowers/one little bouquet"). All these rewards will be added to the right down corner of the screen.
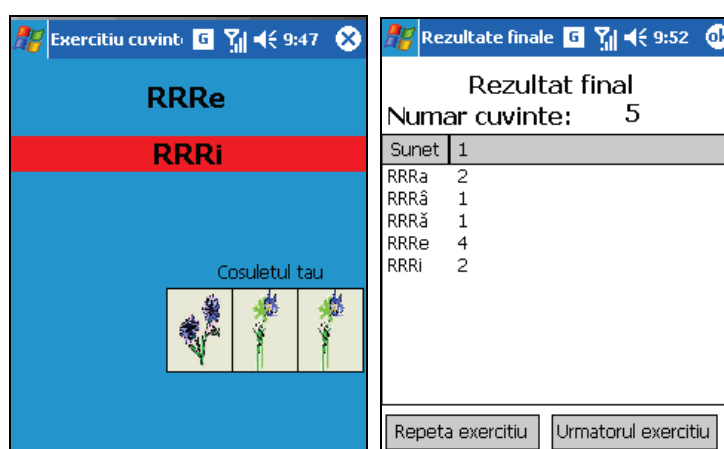

Fig. 3. The PronouncingWords module

4. Step one will be resumed until pronouncing all the words (the exercise can foreseen the pronunciation of a word for many times).
5. After pronouncing all the words, the final result will be displayed in accordance to figure 3. Therefore, the number of words that were pronounced by the child will be displayed on the upper part. Below, a list with the following columns will be placed: Sound – where the pronounced words will be displayed, 1 – the grade for the first repeating of the word, 2 – the grade for the second repeating of the word, … n – for the n repeating of the word.
6. If repeating the exercise is desired, then "Repeat the exercise" button will be selected; if passing to the next exercise from homework is desired, then "Next exercise" button will be selected.

CONCLUSIONS

In accordance to the research carried out, an integrated mobile device within an intelligent system of customized therapy on speech deficiencies resulted. The mobile device has the following functions: presenting the exercise that the child has to individually accomplish, evaluation – encouraging the progresses achieved by the human subject and the communication with speech therapist's computer. This can be used by children in the view of accomplishing at home the exercises, without being necessary the assistance of speech therapist or of parents. The results are saved and analyzed by the expert system [7][8] from the speech therapist's computer. By analyzing the results, a time historian of each child's progress can be performed and the exercises that have given the best results can be identified.

REFERENCES

1. Jeno Hirschberg, P. H. Dejonckere, Minoru Hirano, Kazunori Mori, H. -J. Schultz-Coulon, "Voice disorders in children",International Journal of Pediatric Otorhinolaryngology, Volume 32, June 1995.
2. E. Hilgert, B. Toleti, K. Kruger, I. Nejedlo, "Hoarseness Due to Bamboo Nodes in Patients with

Autoimmune Diseases: A Review of Literature", Journal of Voice, Volume 22, Issue 3, May 2008.
3. Anca, M.D., "Logopedie", Cluj-Napoca: Presa Universitară Clujeană, 2002.
4. Anca, M.D., "Implicaţii ale modificării aportului informaţional asupra limbajului oral", Revista "Societate şi handicap", nr. 2, 1999.
5. Jurcău, E., Jurcău, N., "Învăţăm să vorbim corect", Editura Printek, Cluj-Napoca, 1999.
6. John Durkin., "Expert Systems: Design and Development",Hardcover - Mar 23, 1994.
7. Jay Liebowitz , "The Handbook of Applied Expert Systems, Hardcover" - Dec 29, 1997.
8. Enrique Castillo and E. Alvarez, "Expert Systems: Uncertainty and Learning Hardcover", Sep 1, 1991.
9. CERLINCA, M., GRAUR, A., PENTIUC, Ştefan-Gheorghe, Simulation of Switch Box Routing in FPGA, Advances in Electrical and Computer Engineering, Suceava, Romania, No 1/2002, vol.9, pp.86-90.

IOAN UNGUREAN - PhD. student in Information Technology and Computer Science, "*Stefan cel Mare*" University of Suceava, Suceava, Romania.