Didactic Toy for Children with Special Needs

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Abstract. In the last years, technology is receiving an important role in the development of new games and toys for children with special needs. In this paper a configurable prototype game is presented specially designed for children with special needs. The goal is to promote reaction and memory skills as well cooperative work in these children. The toy is capable of producing audio and visual sensations and it has more than one playable game (a reaction game, a memory game and a multiplayer game). Furthermore, it is an important tool for the therapists, since all gaming plays are tracked and registered in a database to posteriorly being filtered and presented using statistic methodologies. Preliminary tests were performed in real environment with children mainly with cerebral palsy. The feedback is promising enough to take it to the next step, which will be the integration of artificial intelligence approaches.

Keywords: Serious game · Adapted toy · Inclusive technology

1 Introduction

Play is a right of every children. This simple action has even more importance in the early ages, when children acquire basic skills [1]. In children with special needs, besides all the different impairments, there are some competencies that are not developed in early stages but can be stimulated while playing an adapted toy. Following this idea, the action of play gains an extra importance as it may help children to promote their skills, overcoming their impairments, in a pleasant environment [2, 3]. Also, therapists lack tools to automatically register and analyze the evaluation of their patients, being restricted to their experience and direct behavior observation [4].

Even though the technology advance, the inclusive toys are not going along. The few ones available hardly keep the children focused for a long time, becoming boring and monotonous. The solutions found are now restricted to the digital world and the toys are substituted by the electronic devices [5–8].

The goal of this work is to design and develop a configurable game play for children with special needs that promotes reaction and memory skills as well

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cooperative work. The first steps of this on-going work were the proof of concept of the game. Further actions are taken in order to include adaptation in the game based on child actions and performance.

This paper is organized in four sections. Section 2 presents the toy development, Sect. 3 shows the preliminary tests and results obtained and the last Sect. 4 addresses the conclusions and future considerations.

2 Toy Development

In order to achieve a versatile solution there were developed three different games. The type of activities, the game configuration, and user interaction were defined in collaboration with the therapists that accompany the children. This first prototype took in account the therapists' needs in their intervention sessions.

The modes of the gamepad are automatically remapped to the buttons which are randomized for every new game. The game includes a Backoffice interface for the therapists to observe the children evolution in the games.

The first game is called the reaction game. It was developed in order to the players test their reaction and audio memory. The game occurs in a loop mode limited by the number of plays. When a button is activated a timer is initiated, and the player must press it as fast as he/she can. The timer stops and the time spent is saved in a file.

The second game is focused on memory training and rapid response. There is a random sequence of active buttons and the players must press the buttons in the same sequence. If the players get it right, the next sequence will be faster and if he/she fails, it will be slower. Also, the play times are saved.

The third is a multiplayer game. The board is divided in two identical parts for each player. In the left part one presses the button and the other player must press the symmetric one. The player who press the buttons faster wins.

2.1 Toy Design

The toy gamepad was created in a way to provide a visual sensation capable to arouse the interest of the children. As shown in Fig. 1, this consists of ten light buttons: one small white, one small blue, two small green, two small red, two big blue and two big yellow.

All of them are used in the games except the white button that only needs to be pressed to restart the game. Each button is integrated with a LED, which is respectively associated in the processor. The button disposition was designed in a way to call for the children's attention and to provide difficulty levels by having the small ones in a second line.

2.2 Game Architecture

The game is controlled by an ATMega328p microcontroller that executes all the tasks [9], mainly the activation or deactivation of a LED, button information capture, trigger or stop a sound, and read or write in the SD Card. The card is located on the right side of the game box, and it stores the player identification and performance in each gameplay for further analysis by the therapist.

Fig. 1. Toy gamepad (Color figure online)

In Fig. 2 is the block diagram of the game architecture.

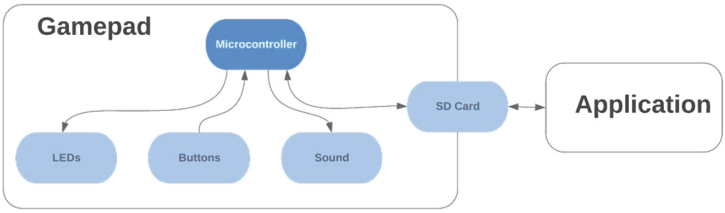

Fig. 2. Game architecture

2.3 Gamepad Images

An alternative to the gameplay is to have images and sound instead of sequences of light buttons. The available categories are animals, musical instruments and numbers. The therapist place the images on the buttons (Fig. 3). When the game starts, a sound of an onomatopoeia, a musical instrument or a number is activated and the child must press the corresponding button. The system may be configured to have other categories.

Fig. 3. Gamepad images: animals, musical instruments and numbers.

2.4 Games Development

The game development was based on C++ language and is implemented in the micro controller. First, the toy has a menu function, where all the information about settings is processed. The player must enter his/her identification by pressing four buttons that represent four digits. After, he/she chooses the game that is represented on the three activated buttons and each one represents a different game. When the game finishes, the player has the option to play it again by pressing the white button.

2.5 Interface Application

The application was developed using the QT Platform using the program language C++. It has as main objective to permit the therapists the access to the saved information regarding the registered times from the games of reaction and memory in a simple and intuitive way. In this, the information saved in the SD Card is sent to a database and analyzed for all the statistics presented.

In Fig. 4, there is the general and graphical information where it is possible to see the evolution of the player through time. Beside that it is also possible to change all the settings of the game, such as the number of plays for all the games, the buttons in game, the sounds and the volume.

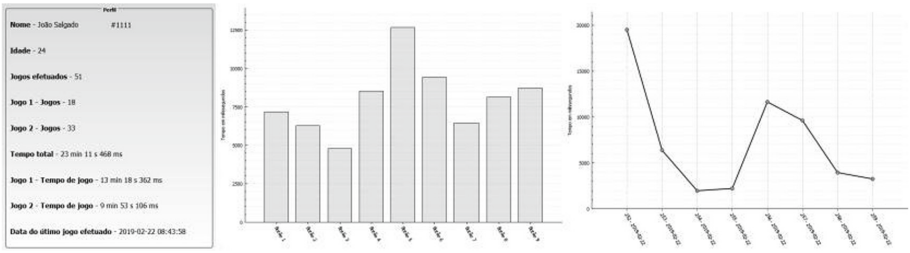

Fig. 4. Different view of information - on the left there is the user information, in the middle there is general graphical information and on the right there is the graphical user profile.

3 Preliminary Tests and Results

The tests were performed in an association with children with special needs, mainly with cerebral palsy and autism. Most of them have similar competences underdeveloped, like the lack of attention, autonomy, cognitive skills and communication. There were three different sessions with each of the ten children supervised by the therapist up to 12 years old (6 boys and 4 girls). They have played the reaction and memory games in all sessions, being the multiplayer game optional. Both games were played using the animals' sounds where the therapists encouraged them to tell the name of the animal before pressing the right button. The sessions took between some seconds and some few minutes depending on the children performance with the presence of the children, the therapist and the researcher.

The feedback of therapists was positive, indicating that this game platform can be useful in the area of occupational therapy. Almost all children have shown moments of concentration in the game and also they enjoyed the playtime. It was possible to note some improvements on the autonomous play, after they understand that pressing the white button they could repeat the selected game.

As an example, Fig. 5 shows the evolution of a child in two different sessions. It is possible to see that in both sessions, along the playtime the player decreases the average time to press the correct button, performing better and keeping focused and entertained.

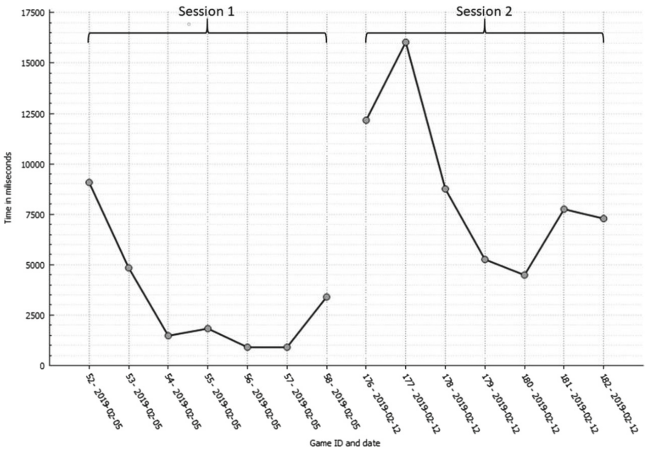

Fig. 5. Evolution graphic from the reaction game in two different sessions: average time to press the correct button.

4 Conclusions and Future Work

The main goal of this on-going work was to develop the first prototype of a configurable toy for children with special needs. Reaction and memory skills as well cooperative work were the designed activities, previously defined in collaboration with the

therapists. It is worth pointing out that the therapists are crucial to the game challenges configuration and interface as well as for the game evolution requisites.

The toy is capable of producing audio and visual sensations. The game can be adapted to any child by changing the settings values and all plays are tracked and saved for further analyzed on the application.

The results obtained in the preliminary tests allowed to conclude that the prototype developed may be an interesting tool to work with impaired children in intervention sessions. Also, the audiovisual sensations created are sufficient to keep the children entertained and focused while playing.

Next steps in the research includes, game optimization and well-defined test sessions. In particular, the game improvements include the application of artificial intelligence algorithms in order to automatically adapt the game to each child preferences and performances and continuously motivating for them. It is also important to improve the communication between the game and the interface. A possible solution to this, is to include a wireless communication in real time, and have the application stored in an online server, providing more efficiently the tools needed for the therapists.

Considering the reaction and memory games, the buttons instead of being activated randomly, this could be done by an algorithm that checks the user profile and gets the ones that the player shows low performance.

An optimized solution of the toy would be achieved by substituting each top part of every button by a round LED display that could fit on it and the therapist could choose any image for any button. This would bring more possibilities for the games. As an example, a spell game, where the therapist chooses a list of words, and in every round, the players should click by the correct order the syllables. Also, for a simple game like the reaction game, the possibility of changing in every round the disposition of the images shown could bring another complexity to the game, challenging even more the players.

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