Low Cost Technologies for Measuring the Psychomotor Coordination in Children from 7 to 11 Years

Ricardo Ruvalcaba Manzano[1], Carlos Delgado-Mata[1], Jesús Ibáñez[2]

[1] IPIT (Instituto Panamericano de Investigación Tecnológica)
Escuela de Ingeniería, Universidad Panamericana Campus Bonaterra,
Aguascalientes, México, C.P. 20290

[2] Grupo de Tecnologías Interactivas,
Departamento de Información y Tecnologías de Comunicación,
Universitat Pompeu Fabra,
Barcelona, España

ricardo.ruvalcabam@up.edu.mx, cdelgado@up.edu.mx

Abstract. Currently, there are psychometric instruments that are used to observe, evaluate and intervene on the children's motor coordination. These instruments are made with materials, that, occasionally rely on the use of technological elements. Therefore, the measurement process can be slow due to the amount of information that needs to be analyzed to get relevant results. The work presented herein describes a project to help improve the psychomotor coordination using a video game that unifies different multimodal technologies. Furthermore, this work assists in the measurement of the movements made by infants.

Keywords: children, motor coordination, video game, multimodal technologies.

1 Introduction

The main goal of the game development industry is focused on the entertainment of people. However recent research has shown that goals can go beyond entertainment. One such example, is the research, where videogame use was found to improve attention skills [1] . Other types of video games are focused on teaching or training of personnel in a specific area. Such is the case of the United States of America Army video game, America's Army, which was released in 2002 [2]. The game was used as pre-training and for future recruitment. Other games are used to assist the learning process [3].

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1.1 Psychomotor coordination indicators

The environment evaluates and stimulates coordination, which is part of the dimensions of the psychological development [4]. Psychomotor coordination is defined as the combination of body movements that synchronizes and harmonizes all the internal forces that result in intended actions [5]. Table 1 shows coordination indicators, which are elements that help in the evaluation of coordinated acts. Each can be evaluated with a corresponding level of *"Adventures in the Jungle"*.

Psychomotor coordination indicators Description	Description
Efficacy	Fulfillment of the task.
Economy	Lower energy consumption.
Precision	Accuracy of the movement.
Force	Intensity with which the motion is carried.
Balance	Ability to control the body in space. (Static or dynamic).
Flexibilidad	Transition from static to dynamic and vice versa.
Peripheral Vision	Ability to see in an approximate range of 180 degrees.
Rhythm	Controlled or measured movements, sound or visual, usually produced by a sort of external stimuli.
Speed	Ability to quickly initiate and continue appropriate motor actions of short duration in response to a given signal.

Table 1. Psychomotor coordination indicators based on [6]

2 The Environment

The work presented in this document is focused on developing an assessment tool to measure psychomotor coordination in children aged 7 to 11 years. The research carried out is the construction, development and implementation of a tool to assist child experts (doctors, psychologists, physical therapists), so that the tool proposed herein might be helpful to meeting two significant needs:

- a) Assess and diagnose the motor coordination performance in children.
- b) Use the information stored in the database that this instrument collects for further research in the area of interest.

In order to solve this concern we developed: "The environment", which is a set of low-cost technology components, such as: A multi-touch screen, a *"Dance Dance*

Revolution" mat, a development platform (Framework) and a video game that unifies the above components "Adventures in The Jungle". Moreover, the environment was developed in order to facilitate the addition of new devices, it helps to capture the information of the actions taken by the child.

1. *Multi-touch screen:* It consists of a low-cost screen that captures finger movements, and whose primary function is to measure fine motor skills [7].
2. *Dance Dance Revolution:* It's a mat that captures the movements of the feet [8]. The aim of this device is to assess the child's gross motor activity.
3. *Development Platform (FrameWork):* Contains a set of routines needed for the development of applications [9] that require multimedia resources capable of responding to events generated by interfaces that work with the TUIO communication protocol.
4. *Video Game:* The first two technologies are unified by the videogame, which is composed of different levels. Each of them provides an indicator of psychomotor coordination. This information is stored in a database for later analysis.

2.1 Multi-touch screen

The multitouch screen is a device that is responsible for interacting with children finger movements [10]. Figure 1 shows an overview of the screen developed for the project described herein. The first component observed from left to right, is the computer that stores the application (video game) *"Adventures in the Jungle"*. This device sends a signal to the projector which then transmits the images to a mirror that is at the bottom. The mirror causes the image to scale up. The camera located on the side the mirror is responsible for capturing images or pointers generated by the user. As it can be seen, there is a final component a source of infrared light.

Having described touch screen components, it is worth mentioning that the disign of the screen cover is based on a jungle theme. The characteristics of the size and shape of the screen was based on average anthropological measures of children . This information was obtained from an investigation carried out on 1218 children assessed in the country of Costa Rica [11]. These measures may vary according to geographic location, diet and other factors. However, this information was used because of the anthropometric similarities amongst mexican and costarican nationals.

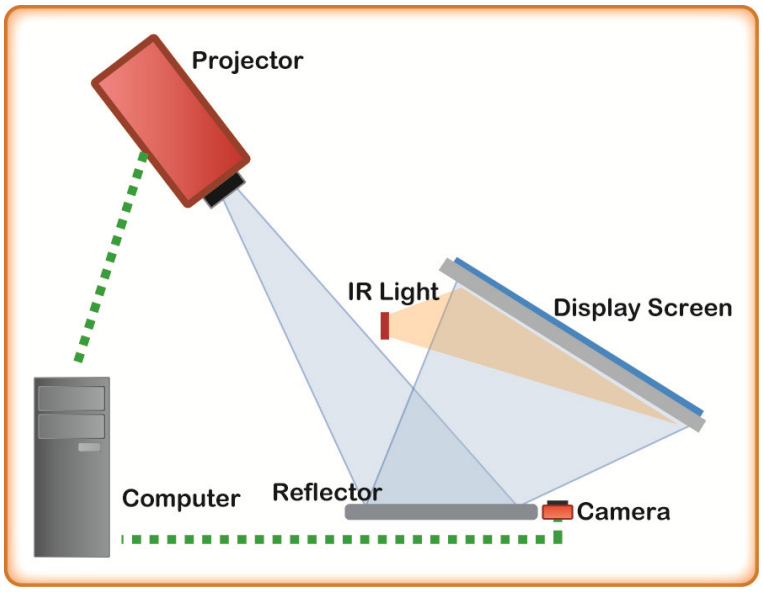

Fig. 1. General scheme of the screen based on [12]

Anthropological measures of children						
	Women			Men		
Measure	Percentile			Percentile		
	5	50	95	5	50	95
Height (m)	1,22	1,32	1,44	1,22	1,33	1,47
Weight (lb)	45,00	65,00	110,00	49,00	67,00	116,80
Popliteal height	31,50	34,63	37,92	30,46	34,90	38,30
Knee height	39,27	42,45	47,10	38,44	43,05	46,96
Thigh height	10,44	12,70	15,52	9,90	11,60	14,32
Scapula height	32,49	36,75	40,31	30,95	35,70	41,61
Elbow height	15,98	20,00	23,73	15,31	19,90	24,35
Long armrests	31,40	34,95	38,66	31,27	35,00	39,58
Distance buttock-popliteal	32,99	36,23	40,62	31,14	35,50	39,45
Wide hips	21,93	26,15	34,14	22,99	26,90	36,74
Shoulder Width	26,81	30,95	37,87	27,94	30,90	38,57
Buttock-knee distance	39,84	43,73	49,56	39,20	43,70	49,81

Table 2. Anthropological measures of children aged 9 based on [11]

Based on the information shown in the Table 2, a multitouch screen was designed and constructed. The resulting screen (shown in Figure 2) met the average measurements of infants (aged 7 to 11 years) that are the test subject for the project described in this document.

Fig. 2. Final design

2.2 Dance Dance Revolution

We made an adaptation for Dance Dance Revolution mat, thus so it was necessary to make sleeve that covered the original design of the table (Figure 3 shows a diagram of the sleeve adaptation). This wrapper was designed according to the theme of the environment, and it was later attached to the frame's base that is assembled with the multitouch screen.

Fig. 3. Diagram of the sleeve adaptation

The game was developed with Visual Studio 2010 (with C #) and XNA Game Studio 4.0. The application is composed of two main layers [13] (see Figure 4). The first layer has two libraries, the first and most important is AdventuresInTheJungle.Framework.dll, it contains a set of classes that form the skeleton of the game. The second library, that is in the same layer as the one described above, is responsible for managing access to the database (AdventuresInTheJungle.DataBase.dll). Finally, in the upper layer is the executable that contains the logic of the game.

Fig. 4. Sleeve coupling Video Game

2.3 Economy indicator level

This level is responsible for obtaining the number of moves that the child performs. It assesses the energy cost required to complete the test, which consists of finding a route from the place of departure (which is represented by a giraffe or a chimpanzee) to an end point (represented by a bush or a banana). The child can choose between different paths (See Figure 5), each of them are valid as long as next more is vertical or horizontal. Once the first part is completed, the scenarios are reversed, so that children is shown the scenario that the opponent has just completed. After the two activities are finished, the two children that were tested, should have completed the same tests.

When the level is completed, the information obtained is stored in a database for later analysis.

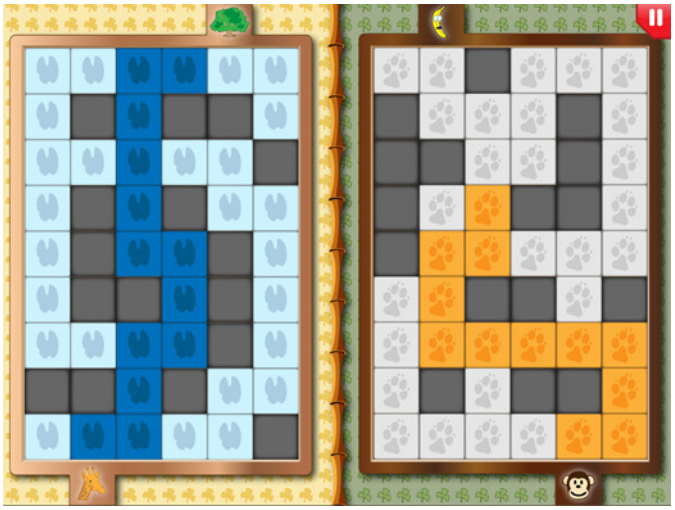

Fig. 5. Economy indicator level

3 Preliminary results and Conclusions

The environment was tested by a final run that evaluated a group of school children at Universidad Panamericana, campus Bonaterra in December 2010. In this version, it was observed that overall performance of the game, with the following results:

1. The setting met the required spatial dimensions to suit the physical characteristics of children.

2. Psychomotor coordination were encouraged

3. The content of the game scored measuring psychomotor coordination, specifically the area of the economy.

Children assessed, implemented correctly the level of economy, consisting of two panels that were made, each by different routes. The exercise involved traveling these roads, at the lowest possible energy cost. After completing the exercises, the system yielded information on the database environment. The results for this psychomotor coordination indicator are:

Name	Age	Test #1 (number of movements)	Test #2 (number of movements)	Test #1 (category)	Test #2 (category)
Carlos	9	15	16	High	Middle
Rowan	7	16	16	Middle	Low
Daniel	8	15	15	High	Middle

Table 3. Results obtained in the level of economy

These results are only preliminary. Later tests will be carried out with a significant group of children, those results are expected to be similar to the preliminary ones.

4 Future work

Future work will be focused on the development of standards covering the nine indicators of psychomotor coordination. This research can be used as an aid for interactive projects that integrate novel devices to help measure and encourage psychomotor coordination, one such device is Kinect, that can interpret an individual's body movements, without physically interacting with a device. These types of devices can help measure more sophisticated and complex movements.

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