Chapter 26
Gesture Recognition Sensor: Development of a Tool with Playful Applications to Evaluate the Physical and Cognitive Skills of Children Through the Use of Bootstrap Algorithm

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26.1 Introduction

The gesture recognition sensor (GRS) works with concentration points, where different actions and positions of the object can be determined. They contribute to the development of ludic games, based on technology that promote, conserve and strengthen innate physical activity that children possess from birth [1].

There are currently a high level attention deficient in children, because in their homes there are factors that do not allow you to focus on their activities, due to these problems is to develop a tool on the basis of educational games which help both to learning as to combat with the concentration and a deficit of early attention.

Camera is an important subject at the time of work with the device Kinect, a performance important to create the 3D geometry [2] is to get the proper resolution, as mentioned Dal Mutto, Carlo Zanuttigh in his book Time-of-Flight Cameras and Microsoft Kinect [3]. The hardware allows you to work with a camera at 30 fps with VGA (640×480) and obtain data of length, width and depth to create a scenario in three dimensions.

Zeng [4] mentions in his article, the importance of the 3D cameras and how they are creating new opportunities for revolutionizing multimedia information. He also

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expresses the form in which corporal language is used for video games, saying the sensor that recognizes gestures allows the computer to directly sense the third dimension (depth) of the players and the surroundings, which makes the job much easier.

The use of a hardware as Kinect also requires knowledge of their respective software which allows you to handle all your libraries and functions to program the device, thus giving the importance manipulate the most important factor after the cameras, working with the data obtained, in fact the points of concentration of Kinect call skeleton-programmer, which creates the most basic of the program, this skeleton virtual perform actions and events necessary for the implementation of the applications [5].

The 2012 investigation of Garrido [6] demonstrates the great importance that this gesture recognition technology that Microsoft uses for the development of games for Neuro-rehabilitation for children who have problems with slow learning. Also in this investigation is been mentioned the use of libraries for the development of applications as well as the XNA platform for the programming and the potential this language has. The results demonstrated allow us to have a wide idea of the aspects in which this helps a specific handicap, in which we recognize the importance of these games. Patetsianakis et al. [7] also speaks about another type of technology. The GRS have a group of microphones that allow the recognition of instructions using voice. The monitoring of the sensor of the person, who is utilizing it, requires standards for optimal use, the minimum distance that varies from 6.5 to 7.8 feets allow the GRS to capture the entire body of the player and the information from the persons voice.

The Kinect sensor is a multi-purpose device because of its wide scope, it could be different uses according to the need of the user, Wenbing et al. [8] performs a monitoring for results in the progress of rehabilitation with the use of Kinect, showing a broad overview to allow results verify and quantify the aid in children attention deficit and concentration in their daily activities.

Kinect technology is a device that allows you to develop high-impact therapeutic games in children's fashion that is achieved to stimulate physical and mentally, allows a cognitive development by the game and learning, two activities that apply jointly.

26.2 Influence Area

26.2.1 Factors that Influence the Evolutionary Development of the Child

In the present technological advances and research in the different fields of formation have put the gaze on social needs and have said that the integral attention since the first years of life determines the later stages and the construction of a true personality as the basis of a productive society. Therefore, the timely attention to children at an

early age responds to the wide social conscience, to develop their skills and physical skills, motor and cognitive impairment.

The early development of the child and the initial education refers to the process of change through which children are enabled to handle levels increasingly complex movement, coordination and reasoning, of feeling and expressing emotions and relationships and interact with other people and with the natural environment.

26.2.2 Attention Deficit in Ecuadorian Children

The attention-deficit hyperactivity disorder (ADHD) is a growing problem in Ecuador due to the factors involved since their first years of life, this disorder is characterized by a pattern high of motor activity, impulsivity and difficulties in the performance in the attention. The article by Ramos et al. [9] presented an investigation which had as objective to describe the prevalence of ADHD in a sample of students of Quito-Ecuador, with a methodology epidemiological to establish the prevalence of the disorder in question.

26.2.3 The Education with Games

The education in children been based on the curriculum of early and basic education [10] because they are developed according to the childrens necessity. The use of tools helps in the study fields that the children develop while they are growing up.

Learning in children through the visual-motor development focuses principally on the following study fields:

* The relation between the natural and cultural means.
* Logic-mathematic relations.
* Discovering the characteristics of the elements of the natural world explored through the senses.
* Understanding the basic notions of quantity facilitating the development of thinking skills.

This type of learning allows the identification of the animals characteristics, colors, shapes, outlines and in this way learn to recognize these elements in the atmosphere in a graphic and visual way.

Children respond to visual and ludic methodologies of learning in a better way. This work hopes to provide an innovative didactic tool that contributes to the development of the skills and visual-motor abilities in children between 6–8 years old, through activities and games that involve the total physical movement. In this way, knowledge been obtained and retained through the world that surrounds us. Using new technology that efficiently contributes a decrease in a sedentary lifestyle and an improvement in childrens health.

26.3 Evaluation Techniques

Palou Pere research [11] compares the quality of life between physical activity and sedentary lifestyle that modern children live; we clearly observe how the lack of dynamic games affect the cardiorespiratory health of children.

He mentions that exploring the relation between Quality of Life relating to Health (CVRS), they are important resources for the adaptation of society and healthy development of the child, physically as well as psychological. Due to these reasons, it is of paramount importance the contribution of these ludic games and technologies that will help reduce sedentary lifestyles from an early age.

Presented in this way an algorithm that allows to quantify the development of the activities of the children, as well as the methodology of PC gaming for the development of their skills.

26.3.1 Bootstrap Algorithm

Is an algorithm that allows for the treatment of samples of a versatile by removing a number of the total population for its analysis. Allows for the construction of confidence intervals at the time of approximating the distribution of a statistical process, provides estimates of the statistical error, impose few restrictions on the random variables analyzed and establishing itself as a procedure of a general nature, regardless the statistical considered [12].

The fundamental affirmation bootstrap is that a frequency distribution of statistics calculated on the basis of samples is an estimate of the distribution of sampling of the population [13].

26.3.2 Methodology Using Gesture Recognition Sensor

SDK (Software Development Kit) allows the creation of applications using native methods, and in this way work with physical gesture recognition, allowing for an improvement in the interaction of the program and user [14].

The SDK controls the recognition of the skeletons through the SkeletonFrame Ready, and the recognition of articulations through the points of focus joints. If the sensor does not detect any body, it simply sends the image of depth to the host device, like an Xbox or computer. The software that executes the host device contains the logic to decode the information and recognize the elements in the image with human shape characteristics. To accomplish this objective, the software has been programmed with a wide variety of body shapes, it uses the aligning of diverse parts and movements to identify and monitor them (Fig. 26.1).

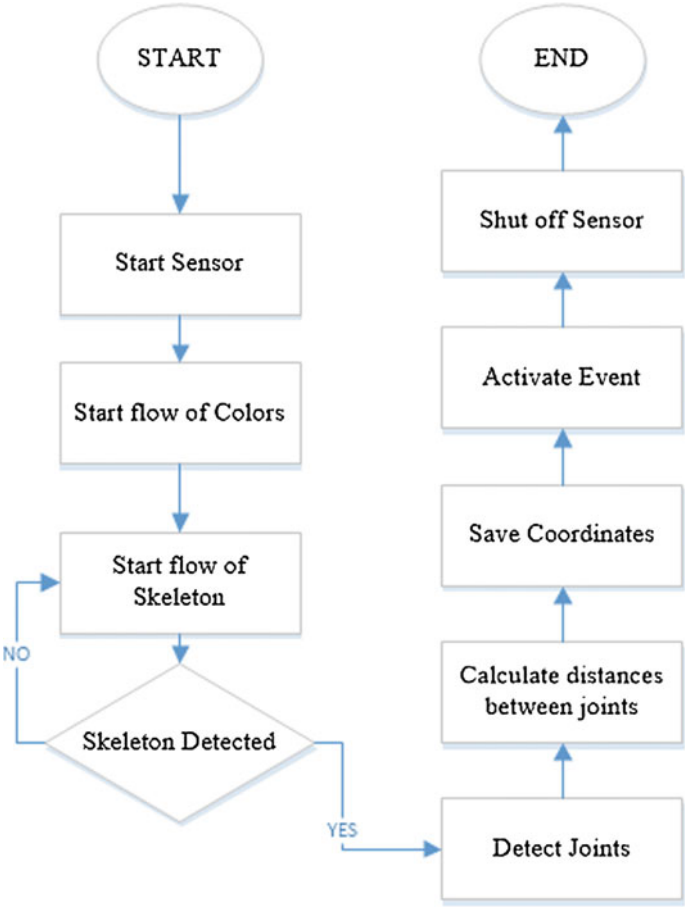

Fig. 26.1 Principal Programing Algorithm. When starting, the sensor immediately activates the control of color flow and the flow of skeleton information. With the last, it is been hoped that the user will position himself in front of the sensor to recognize the joints and calculate the distances between the points of focus. Afterwards, the coordinates are been registered with each of the points, principally the *left* and *right* hand, to execute the predefined event of the action that is being made

26.3.3 Detection of Skeleton

With the use of the SkeletonFrameReady method, a detection of the skeletons can been captured through the sensor on the camera for gesture recognition. The skeletons will been detected, but only those that provide the sufficient information and data, such as hand and head positions, and will be established as the principal or closest to the sensor, maintaining at a margin any other skeleton that may be detected.

26.3.4 Position of Points of Interest

After having the skeleton on screen, the coordinates of point of interest are been shown (hands, feet, head, arms, etc.) to achieve this; we turn to the JointID, which uses the Joints vector to obtain the elements that we want and to be recognized in a precise way (Fig. 26.2).

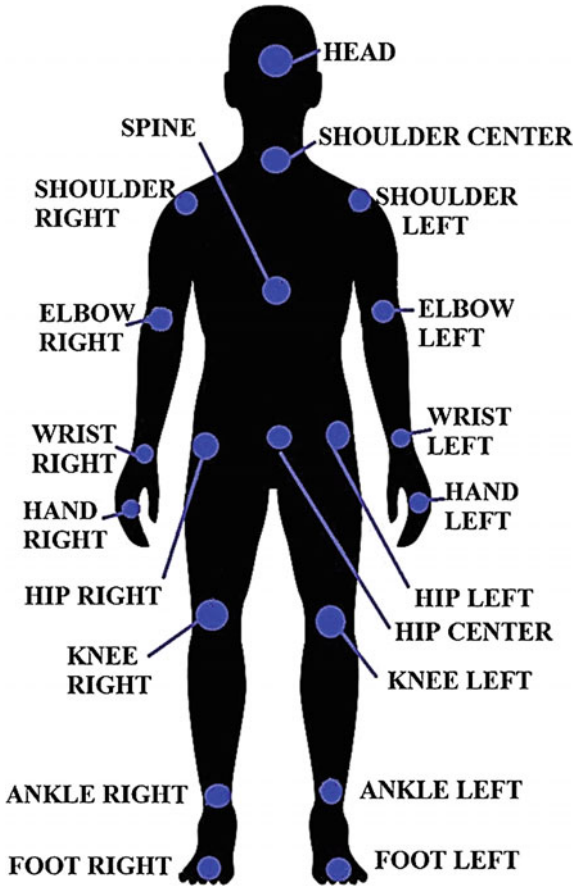

Fig. 26.2 Concentration points in human body. Following the distances and coordinates in (X, Y) of the concentration points of the human body, the recognition of gestures that the body is making is been made for example, lifting a hand. In this case we can measure the distances that exist between the hands be it the *left* or *right*, and the head; and in this way detect if the hand is lifting

26.3.5 Gesture Recognition

26.3.6 Remote Communications Network to Store in the Database

It implements a local network between various computers with its respective Kinect connected to a personal computer that fulfils the function of a remote server, with the ease of which shall not be taken different databases for the monitoring activity of children, this will send the data to the remote server and the data is stored in a single database to have a better control of all the children who are playing at that time.

The database has been implemented in the engine of MySQL databases in the same way only as server without cost, the data for each of the users are filled in an event that ran next to finish each of the games, where the tutors are responsible to qualify those errors had children and will be stored in the database remotely on the computer intended to be server on the LAN.

26.4 Applications Running

This section presents all applications created in gesture recognition sensor (GRS) and clear operation exercises developed and recreational games.

26.4.1 Learning the Colors

26.4.1.1 Description

This option hopes to teach the user about colors, through object selection. In the interface, we see three different color cups as shown in Fig. 26.3, each cup must be placed on the plate according to its corresponding color, after each hand movement over the cup we can select the desired cup and allow to move it and take it to its correct position. You can change hands (between the left and right) to play the game, the cup lands on the corresponding plate, and if placed correctly, a confirmation will appear demonstrating its correct place. Besides appearing on the right hand side, the cups change position randomly with each start of the game.

26.4.1.2 Obtained Results

The result obtained with children from 6–8 years, is that correct interaction with gestures had children, the children were able to correctly select the cup, besides being able to take her proper course, teachers and instructors they were satisfied with the

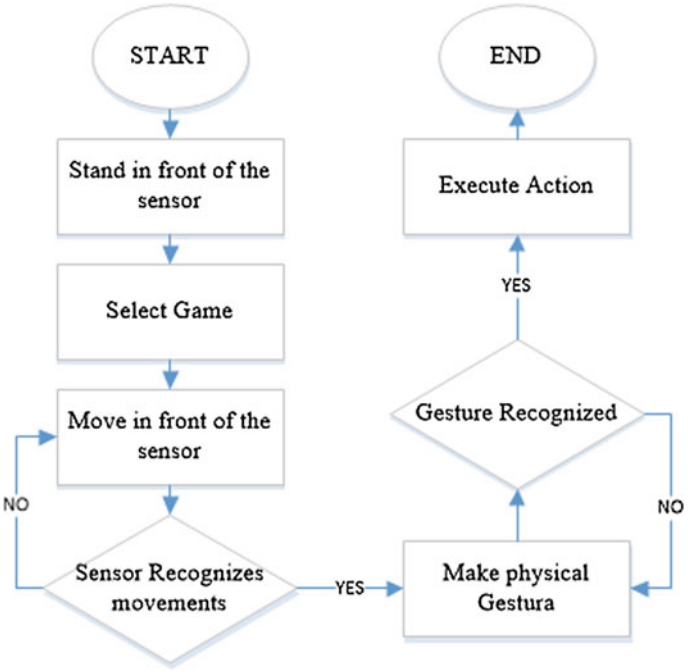

Fig. 26.3 Principal functionality Algorithm. The algorithm that is presented is the basic operation of all applications developed, in which the user is presented in front of the sensor, followed selects the appropriate game and it begins with the movement to be recognized until the program identifies you and finally you perform the corresponding action

game, because it is innovative to have an interface that allows interaction between the child and the objects found on the screen; proper operation of the program was against the rapid movement of children. The children saw fully interactive gambling, they amused themselves by using the game, the children stood, crouched moved, the game improves movement of children and allows them to improve their laterality and learning colors by special methods and teaching that are perfect for the age in which they find themselves (Fig. 26.4).

26.4.2 Learning the Numbers

26.4.2.1 Description

In the demonstrated interface, we can see numbers 1 through 5, which change positions randomly each time the game is started; the user selects the number, whether it be with the right or left hand, if the hand disappears from the screen, the number

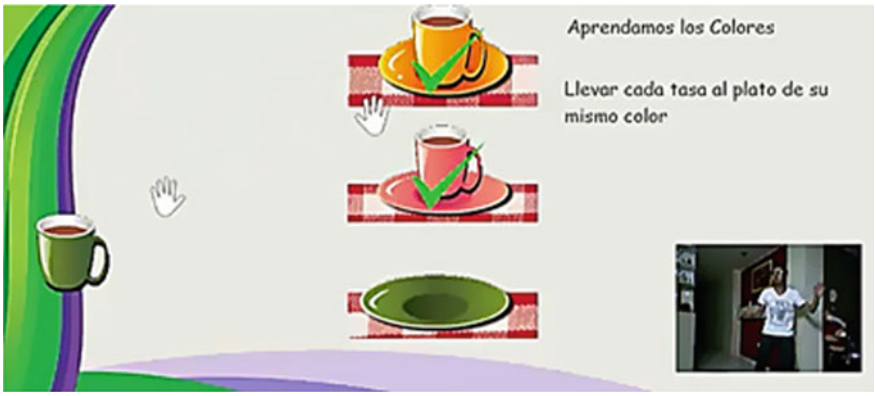

Fig. 26.4 Learning the colors interface

disappears from the list as well. The numbers must be selected in numerological order. Each time the hand passes by a certain number, there will be a number that appears on the right side that represents the number of objects where the hand is currently positioned.

26.4.2.2 Obtained Results

As in any game at first practice it is needed to understand the dynamics and controls in addition to the commands needed to run the game as effectively. The game improvement in children's ability to recognize numbers within images that can hide them, making it difficult to recognize them and at the same time improving the ability of children to recognize hidden objects and expediting their mental and brain capacity; counting the number of objects displayed on the right side of the image improves the ability to count and recognize the number of objects to be present in an image (Fig. 26.5).

26.4.3 Learning the Figures

26.4.3.1 Description

For this game you must find the object that appears only as an outline, within a variety of other objects. With the left or right hand, you must select an image that is similar to the outline on the right and separate the left hand with the band, so we can determine if the chosen object is correct, if the object is correct, the outline will be indicated as correct, otherwise an X is shown. After pressing the continue button, a new outline will be randomly shown so that the game will be more dynamic and

Fig. 26.5 Learning the numbers interface

interactive for the child. The application improves visual-motor abilities as it allows free interaction with the interface without the necessity of a control or device.

26.4.3.2 Obtained Results

Children select the figure that create similar to the shape shown, with this can improve the ability to recognize shapes and to classify or filter within a group of objects, although if you do not have a similarity between them, encourage the child the ability to discern between one object and another, increasing their intellectual capacity as well as their dynamics, laterality through movements made by children to select the object you want. The generated every time a new image allows the child not only based on his memory, but exercise your brain t his intellect against the evidence raised (Fig. 26.6).

26.4.4 Learning Animals

26.4.4.1 Description

Another important feature of the sensor is its phrase and word recognition, with this we can develop an application that allows identification of animals shown on screen. This improves the visual capturing ability of children, as well as contributing to the development of word pronunciation.

Fig. 26.6 Learning the figures interface

Fig. 26.7 Learning the animals interface

26.4.4.2 Obtained Results

The children had great interaction with the Kinect and recognition of sounds, the child is pronounced in syllables, so we decided to take another kind of sentence recognition (Fig. 26.7).

26.4.5 Avatar

26.4.5.1 Description

With the gesture recognition sensor, there is communication between the game development platform and the user. An avatar is implemented to recognize the movements of gestures from the user. With the aim being to call the attention of the child and make it easy to get up and simulate the movements of a super hero, controlling its movements (Fig. 26.8).

Fig. 26.8 Avatar

26.5 Results Analysis Through the Use of the Algorithm Bootstrap

It is considered a population of 30 children from the age of 6 to 8 years through 2 techniques different, the first is the use of techniques conventional and the written tests in order to check the knowledge of children and the second is the use of the tool ludic that allows you to get the number of errors of children from the games raised, in this section use the matlab code with the bootstrap algorithm [15].

26.5.1 Learning the Colors

As you can see in figure, for the game, it is estimated that the average of the population with respect to the percentage of learning with the use of games entertainment, increase in their frequency and therefore represents a percentage of learning the 90.03 % with respect to the use of techniques conventional, as written test that only has a result of learning of 11.12 % (Fig. 26.9).

26.5.2 Learning the Numbers

In the same way, it gets the outcome of the game of the numbers taking into account that increases the frequencies to obtain the highest result of learning from 9 % to 90 %, considering a improvement for the learning of children (Fig. 26.10).

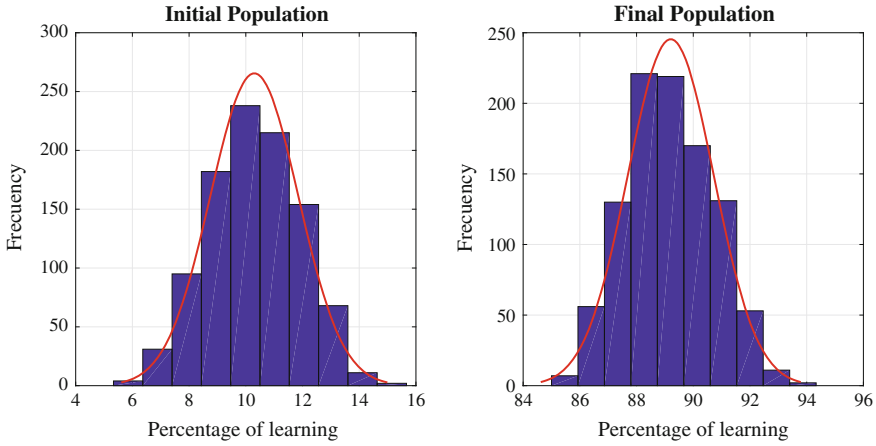

Fig. 26.9 Percentage of learning about the colors game

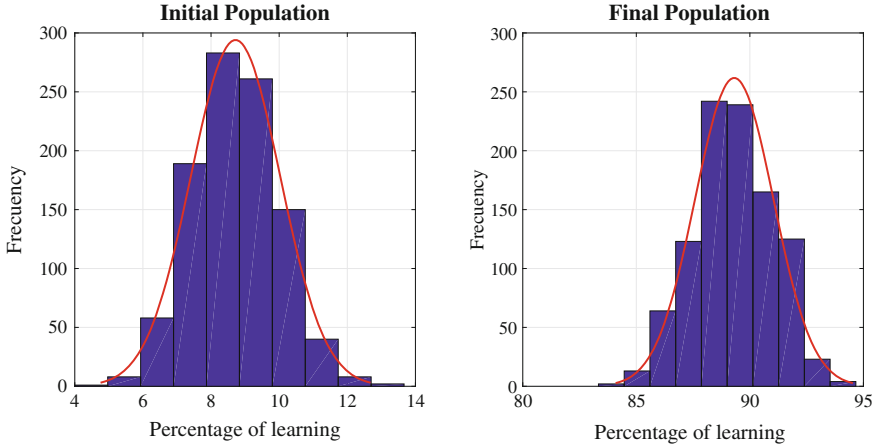

Fig. 26.10 Percentage of learning about the numbers game

26.5.3 Learning the Figures

The game is striking in the sense of handle different figures only standing in front of the sensor, for this game it was considered that the minute game will take measure of the successes that had the child with the interface, although it was a short time, was obtained an increase in the percentage of learning with regard to the use of conventional techniques of 11 % to 80 %, showing the importance of the games for learning (Fig. 26.11).

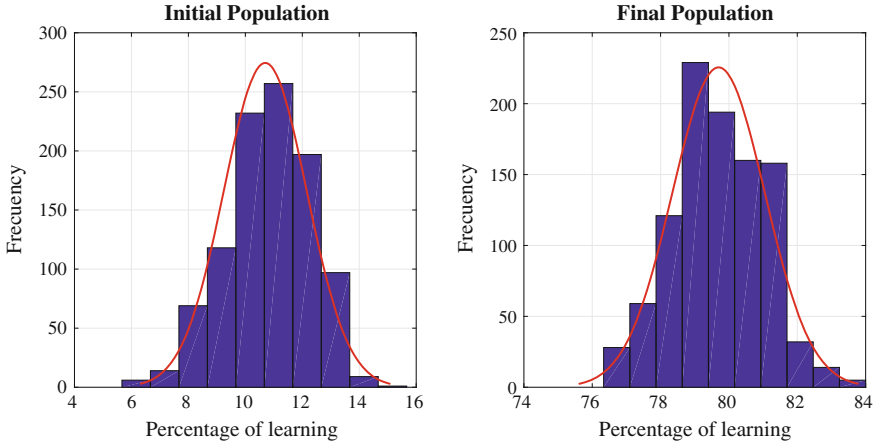

Fig. 26.11 Percentage of learning about the figures game

26.6 Conclusions

- The gesture recognition sensor is an excellent option when involving didactic games due to the fact that it s a strong technological tool not only in hardware and software, thanks to its great versatility to develop applications and programs dedicated to the necessities of the user.
- As has been observed in all the figures that represent the percentage of learning, the use of games to teach different topics such as numbers or colors, exceeds in approximately 70 % to the use of conventional techniques in order to teach these topics, it is recommended to use the technology, as has been demonstrated in the research, help in a large percentage to learning and therefore to the intellectual development of the child in the stage that you need it most.
- Due to the movement detector and gesture recognition being relatively new on market, there can be an implementation of games that are being dedicated to these types of activities, in the case of this Project, ludic games that are oriented towards the development of the physical and emotional abilities of the child.
- The mode of play is dynamic, unlike other ludic games currently available, there is diminished sedentary lifestyle and accessibility for the child at the moment of learning to play.
- Through these games, the form of learning of a child is much more advantageous, as in ages 6 to 8; the activities that involve any movement will help them relating sociably to others as well.
- The use of a LAN for you to deploy a remote database for each one of the players, implies that the teachers have a control over all the data that are coming from each of them, allowing the monitoring and the correct classification of data, considering a more effective solution to implement individual databases in each one of the computers with the games.

References

1. Freire AB, Pazmiño VD, de la Cruz DR, Tobar JB, Mejía PH (2015) Ludic tool that contributes to the physical and motor development based on sensor technology for gesture recognition. In: Lecture notes in engineering and computer science: proceedings of the world congress on engineering and computer science 2015. San Francisco, USA, pp 338–342, 21–23 Oct 2015
2. Khoshelham K (2012) Accuracy and resolution of kinect depth data for indoor mapping applications. Faculty of geo-information science and earth observation, University of Twente. ISSN: 1424-8220
3. Dal Mutto C, Zanuttigh Cortelazzo GM (2012) Time-of-flight cameras and microsoft kinect, springer briefs in electrical and computer engineering. Springer, New York
4. Zeng W (2011) Microsoft kinect sensor and its effect. University of Missouri. Published by the IEEE Computer Society
5. Tao G, Archambault PS, Levin MF (2013) Evaluation of skeletal tracking in a virtual reality rehabilitation system for upper limb hemiparesis. Interdisciplinary Research Center in Rehabilitation, Laval, Canada
6. de la Garrido FD (2012) (6 june of, 2012) Kinect applications for neurorehabilitation. Polytechnic University of Catalonia, Thesis work
7. Patetsianakis E, Ksylakis E, Triantafyllidis G (2014) A kinect-based framework for better user experience in real-time audiovisual content manipulation 2014 international conference on telecomunications and multimedia. Telecom ParisTech, Technological Educational Institute of Crete, Aalborg University
8. Wenbing Z, Espy DD, Reinthal AM, Feng H (2014) A Feasibility study of using a single kinect sensor for rehabilitation exercises monitoring: a rule based approach. Departament of electrical and computer engineering, Cleveland State University
9. Ramos C, Bolaños M, Ramos D (2015) Prevalencia del trastorno por déficit de atención con hiperactividad en estudiantes ecuatorianos. Revista científica y tecnológica UPSE, vol III, N 1, pp 13–19 (Dic. 2015)
10. Mara Cristina Espinoza Salas (2014) Stefanie naranjo oro santacruz. Early Education Curriculum. Ministry of Education
11. Palou P, Vidal J, Ponseti X, Cantallops J, Borrs PA (2012) Relations between quality of life, physical activity and cardiorespiratory fitness in sedentary children
12. Solanas A, Sierra V (1995) Boostrap: fundamentos e introducción a sus aplicaciones. Universidad de Barcelona, n 55, pp 143–154
13. Mooney CZ, Duval RD, Duval R (1993) Bootstrapping: a nonparametric approach to statistical inference. Sage, no 94–95
14. Hacking the Kinect. Autores: Kramer J, Burrus N, Echtler F, Herrera DC, Y M Parker. Editorial: Technology in Action. Chapter 2: Hardware. Page 13
15. Andrea C, Edison S, de la Danni C, Mejía P, Paredes (2016) CLEI Electronic J, 19(1), Paper 4, April 2016. http://www.clei.org/cleiej/papers/v19i1p4.pdf