Serious Game to Combat Childhood Obesity Using Kinect

Rosa Rodríguez-Dzib[1], José López-Martínez[1], Victor Chi-Pech[1] and Erika Llanes-Castro[1]

[1] Universidad Autónoma de Yucatán, Facultad de Matemáticas
Tizimín, Yucatán 97700, México

Abstract

Obesity and overweight can lead to serious health problems, and when it occurs in childhood it is likely to prevail in the following stages of life unless something is done about it. Serious games are specially designed with an educational purpose, and videogames are included. This paper describes a videogame based on the traditional game of Jump Rope, developed with the purpose to fight childhood obesity, and implemented with the technology Kinect of Microsoft. Tests were performed with children from the East of the State of Yucatan, showing that the game promotes physical activity and teaches healthy foods.

Keywords: Obesity, Serious Games, Videogames, Kinect

1. Introduction

In order to classify a person as obese is not enough to know his or her weight, since for example, there are people with high weight and yet are not obese, such as athletes. Obesity is defined as a physical state of persons that is characterized by "having an excessive amount of body fat in relation to the rest of his or her body, excess that is associated with physical, psychological and social problems" [1].

In Mexico, nearly eight of every ten adults suffer overweight or obesity. In the 2012 National Health and Nutrition Survey (ENSANUT 2012), as a result is visualized a combined prevalence of those conditions in 34.4% of school-age children.

Currently more food is consumed, which provides an excess of energy, and the majority of modern recreational activities require very little physical effort, as for example many videogames. This, known as a sedentary lifestyle, contributes to the increase of body fat, and the most worrying are the chronic diseases that comes with it [2].

Modern lifestyle has made obesity a global problem [3] due to the serious consequences that entails, especially those related with health, by what the Government has proposed programs to reduce obesity. In 2014 the Government of the State of Yucatan developed an integral program to help to combat childhood obesity, which includes diagnostic and modification of the food provided to students by the cooperatives of their schools [4].

Childhood obesity predicts obesity in adulthood [5], many overweight or obese adults began to suffer it since the school stage. In adulthood is much more difficult to treat due to the habit of very little physical activity, therefore childhood is the ideal stage in life to prevent or eradicate it [3][6].

Regarding videogames, it is a polemic topic, because has been said that they incite to violence, to isolation, and that cause psychological problems. However, studies show that some of these problems have their origin in the family, and that videogames have positive effects such as a better cognitive performance, especially in the visual ability of players. Due to this positive results is that their application in education began to be exploited [7].

Currently videogames are used in physiotherapy, area where exergames emerged, which force the user to perform physical activity to allow him or her to play [8].

In the educational area, exergames are used as serious games, which are defined as games that besides the entertaining function has the goal of teaching something specific to players [9]. Constant practice in the use of a serious game allows the player to improve his or her execution abilities, which is one of the pedagogical objectives of serious games, and can be applied to unlimited learning contexts [10].

In this paper is described the development of a serious game based on the traditional game of Jump Rope. The game's purpose is that players perform physical activity during the videogame (using the movements sensor of Kinect) and at the same time educate them to prefer the consumption of healthy food.

2. Technology used

The hardware of Kinect consists of an array of microphones for speech recognition, a depth sensor, and a color video camera with resolution up to 640x480 pixels at 30 FPS that works in conjunction with the depth sensor to generate a color image with depth [11].

The Kinect sensor (the hardware) can be connected to an Xbox 360 for playing, or to a PC for videogames development using the SDK of Microsoft [12][13].

Furthermore, it allows the skeletal tracking of the human body in a specific range providing the information of 20 points in normal mode and 10 points in seated mode [13].

The programming was carried out using the IDE of Visual C# 2010 Express, and the framework XNA 4.0, which is specialized in videogame development.

3. Videogame description

First, it is necessary for the player to register in the system by providing his or her name, nickname or pseudonym, as well as age, weight, phone number (optional), and school grade (Fig. 1).

Subsequently, the welcome screen is displayed. Then, the player must stand in front of the sensor, in a proper position and distance that allow to observe illuminated joints as Fig. 2. If not in the correct position and distance, joints will be shown blue.
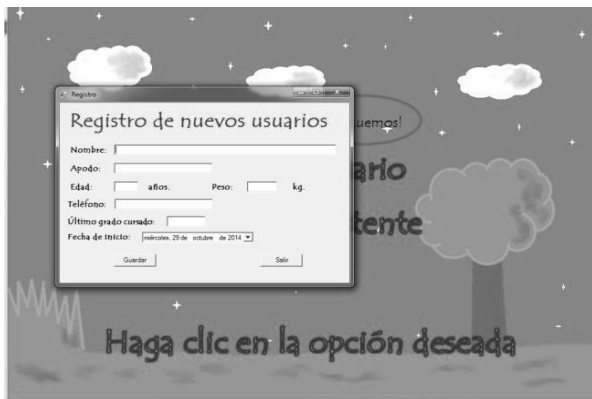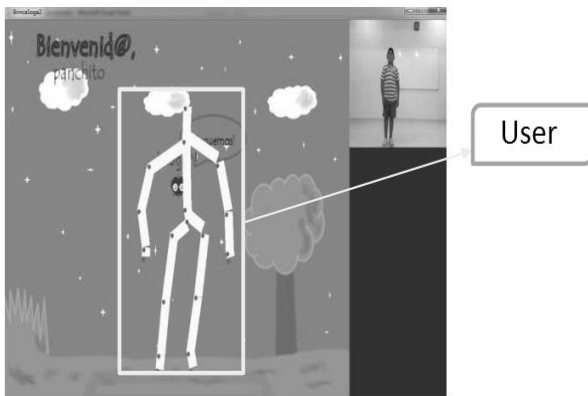

Fig. 1 Registration screen for new users.

Fig. 2 Start of the game

To start the game, the player must bring both hands to the Play button located at the center of the screen.

Subsequently an animation starts and the player must jump the rope at a moderate speed (Fig. 3).
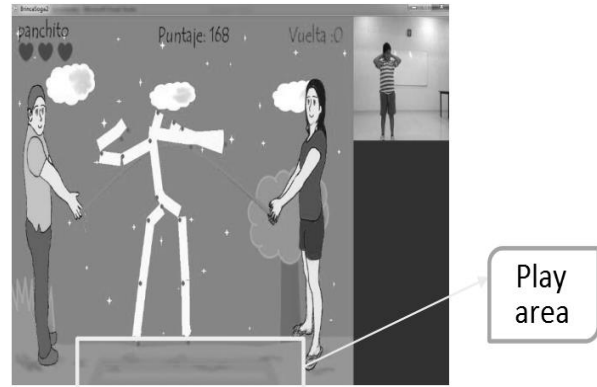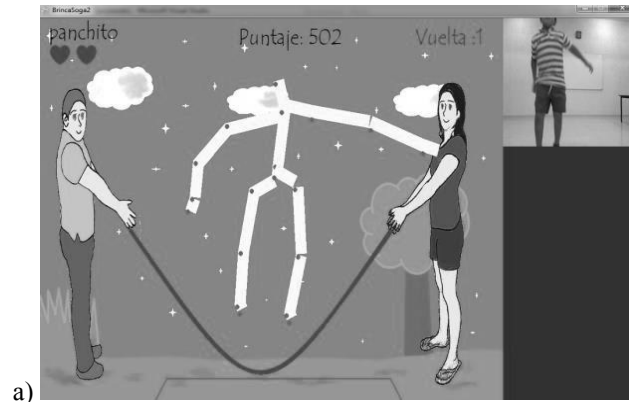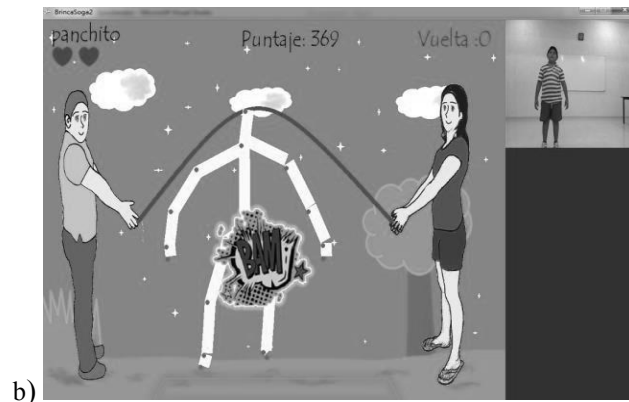

Fig. 3 Started game

The videogame was divided in 6 parts of 15 seconds each one, making a total of 1 minute 30 seconds. Fig. 4a shows the animation in which the player successfully jumps the rope.

a)

b)

Fig.4 a) User successfully jumping the rope; b) User failing and colliding with the rope.

Each part has three lives, but one is lost whenever the player does not opportunely jump the rope (Fig. 4b). If all lives are lost, then the game ends and the option to play again or to exit of the videogame is displayed.

Each time a player overcomes a part, is presented a pop-up message providing information related with heathy foods (Fig. 5a), displayed during enough time to allow its reading. The amount of time was determined based on reading statistics established in [15]. Subsequently is presented a screen showing two foods: one healthy and the other not (Fig. 5b); if the player chooses the healthy one has the option to increase or decrease the speed of the game. On the contrary the speed to jump the rope in the next part will be increased.

a)

b)

Fig. 5 a) Advice displayed; b) User choosing an unhealthy food.

As a feature the videogame keeps a record of the global highest score, as well as the highest score for each player. Likewise, in order to make this videogame motivational, the player is congratulated every time that the personal score is improved

4. Test

For testing, a classroom divided in two spaces was required, installing in each space a computer equipment with a Kinect sensor. Participated: two observers, two operators of the computer equipment and Kinect sensors, one coach to perform warm-up exercises with the players before starting the videogame, one person to explain how to play the same, and ten kids to use the videogame. The tests were conducted with children of a primary school of the South of the State of Yucatán.

In each space the operator requested to the child in turn his/her personal data to register him/her in the system, and administrated a questionnaire of six questions (of type true/false) of knowledge about healthy foods, with the purpose to know his/her previous knowledge on the subject so that later can be determined how much he/she learned during the videogame. Next the coach gave children a warm-up session to avoid any physical injury. After that, an explanation about the operation of the videogame and instructions necessary to play it were provided to each child.

Each child had 10 minutes to interact with the videogame. Once finished they were provided with water and the questionnaire about healthy foods was administered again, together with a new questionnaire about the videogame usability.

5. Results

The results of the questionnaires administered to the children before and after the videogame are shown in Fig. 6. It is observed that after playing the videogame there was an increase in the number of right answers with regard to the topic of heathy food in all questions except in the number five. This situation is understandable due to the knowledge required to correctly answer this question is provided in the last part of the videogame, and most of kids were not able to get to that part.
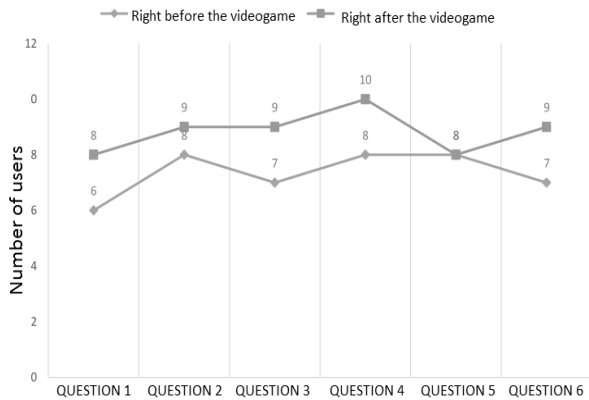
Fig. 6 Amount of children that had the right answer before and after the videogame.

Likewise, the average of right answers of each child before and after playing was compared, results are shown in Fig. 7.

Fig. 7 also shows that in most cases the average of each child improved, with exceptions of children 3, 7, 8 and 9. Child 9 stated to prefer listening (audio) instead of reading; child 7 said to prefer an animation instead of a text; children 8 and 3 do not expressed a preference, but the observers noticed them distracted at the moment in which the messages with the healthy eating topics were displayed. The observers believe that those children associated these messages with advertising and therefore ignored them.

The results of the usability questionnaire regarding the displayed messages in the videogame are shown in Fig. 8.
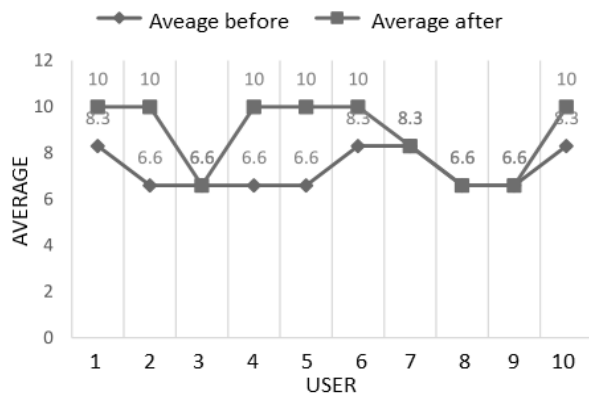

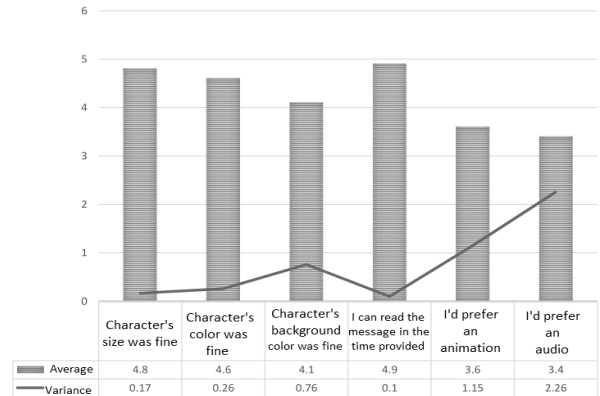Fig. 7 Average of each child before and after using the videogame.

Fig. 8 Average and variance of the usability of the messages that are displayed on the screen.

According to the results shown in Fig. 8, we can infer that the assigned time to read the deployed messages is enough and therefore correct. Regarding the background color assigned to messages, seems to be not suitable, and the variance in the last two questions is high because some children agreed that the messages were of text but stated that they would prefer other kind of didactical tool.

Fig. 9 shows the results of the usability questionnaire regarding the videogame. In a general way can be concluded that to majority of children the videogame seemed fun and entertaining, to a degree that in the future they would continue using it. To advance quickly in the videogame seems to be a little difficult for children, by what perhaps as in a future there will be work on improving the collision procedures in the videogame. For some children the videogame was not what they expected because they never had contact with Kinect before. The majority managed to learn good eating habits, without getting exhausted physically, which indicates that the duration of each part of the videogame could be increased in the future.

The usability questionnaire also included two open questions, from which as answer was obtained that the majority of children liked the activity of jumping the rope and felt good playing.
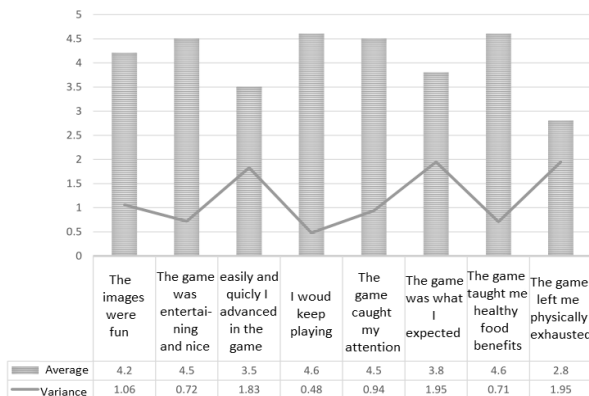
Fig. 9 Average and variance of the usability of the videogame.

6. Conclusions and future work

To prevent obesity, it is necessary to perform physical activity combined with a good diet, being childhood the ideal stage to teach good eating habits. For this reason, this work is focused on developing an exergame for children.

The best way of learning is by playing, and according to the current time in which we live, the interaction with technology allows to have the attention of children, which is very important to ensure that they learn quickly and remember easily the acquired knowledge.

The serious videogame exposed in this paper was able to teach good eating habits to children, moreover, it was observed that they liked the game of Jump Rope, which helps to promote traditional games in our State as well as to promote physical activity.

During the tests problems were noticed in the collisions detection between the rope and the avatar of the player, by what is aimed to improve this function of the game. Moreover, to allow a faster advance in the videogame, it is intended to complement the messages with other kind of didactical tools, like audios and animations, offering to users a more enjoyable experience. It is also intended to allow the adjustment of durations for the parts with physical activities to adapt them to the different users' resistance, as well as to display the messages randomly, because it is noted that not all users finished the videogame.

Results show that videogames, when implemented correctly and not used only for entertaining, are very favorable to players. In this work favorable results were obtained by combining the areas of education and health; which encourages to work with other traditional games of the region, such as Chacara and Kimbomba.

7. Acknowledgments

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Rosa Rodríguez-Dzib obtained his Bachelor's degree in Computer Science in 2014, from the Universidad Autónoma de Yucatán (UADY), México .His research interests include serious game, Mobile development and Human Computer Interaction.

José Luis López-Martínez obtained his Bachelor's degree in Computer Science in 2002, from the Universidad Autónoma de Yucatán (UADY), México and PhD in Computer Science in 2011 from Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), México. He is currently a Professor at Mathematics School, UADY ,México. His research interests include serious game, image processing and pattern recognition.

Victor Manuel Chi-Pech. Obtained his degree in Computer Science from the Autonomous University of Yucatan (UADY) in 1996 and his M. Sc. degree in Wireless Network from Monterrey Technological Institute (ITESM), Campus Cuernavaca, in 2007. Victor Chi has worked since 2000 at the Autonomous University of Yucatan, as a full time professor. He has participated in software engineering development projects. He is currently giving courses on wireless networks and software engineering in the professional programs in the UADY.

Erika Rossana Llanes-Castro. Received a degree in Computer Science from the Autonomous University of Yucatan (UADY) in 2002. She is about to receive a Computer Science degree from Monterrey Technological Institute (ITESM), Campus Estado de Mexico. Currently, she is a full time academic technician at the Autonomous University of Yucatan since 2002 in the department of computer in Tizimín México. She has participated in software engineering development projects. Currently is giving courses on programming mobile devices in the professional programs in the UADY.