Physical Activity Based Interactive Exercise:

Punch Punch Diet

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Abstract: The rate of obese children has been increasing and obesity has emerged as a highly significant threat not only to the health but also in society. Obesity in childhood has adverse effects such as physical appearance, psycho-social consequences, orthopedic complications and metabolic disturbances. As one of reasons causing these phenomena, some games targeted on children have static and stationary interfaces as input devices. This kind of devices hold game users at their computers and it causes not only decreases of the strength of their health, but also blocks communications with their family members as on of the side effects. In this paper, we propose physical activity based interactive diet exercise for obese children called “Punch Punch Diet”, which is played with a body-pointing user interface on a large screen. The motivations and goals of this study are giving physical exercises and group interactions to the obese that involve children while they are playing games.

Introduction

Obesity is defined as a condition where a pathological excess of body fat is present in an individual (Wabitsch 2000). In fact, in the past obesity in children was uncommon and there were no compelling evidence that childhood obesity tracked into adulthood or had implications for long-term health and longevity. However, recent scientific literature reveals a tremendous change in the health status of children and adolescents caused by malnutrition and changes in general life style (Wagner 2005). For example, TV viewing, an inactivity and food intake promoter, can be one of the risk factors for obesity in childhood (Maffeis 2000). As many studies show, obesity in childhood is associated with several health hazards and functional disabilities (Sarlio-Lähteenkorva 2001). Hence, obese children and adolescents frequently suffer from not only disease but also personal quality of life in terms of unhappiness with their own body. Besides, many obese children will become obese adults with possible societal implications. Therefore, medical and social pressures to lose weight seem to be substantial and many methods to lose weight have been introduced for recent years with the result of studies suggesting that quality of life is improved among reduced-obese. Even though almost all the methods introduced are designed in terms of adults exercise training has been shown to play a crucial role in the treatment of obesity (Hare 2000). Some companies and researchers are trying to give more physical activities while people are playing games and doing exercises, but most games for pursuing interactive exercise are lacking inducement of full mobility of human body due to its working range (Pesce 2004). In this paper we suggest a physical activity based interactive exercise for diet, played in a real environment rather than on a monitor on a desk. As a solution to obesity in childhood, we implemented the body-pointing based interactive exercise game called Punch Punch Diet, mainly using computer vision system applied physical activity based interface to help obese children when they are doing exercises with fun and efficiency.
Motivations

The motivation which leads to this research is to implement an enjoyable physical activity based exercise game for obese children and to enable obese children to enjoy games with physical activities while playing the game. Children spend most of their time with computers. As they are playing exercise games they can learn things easier and faster, because electronic games are formed with the conception of game provided various stories, graphic shapes and multimedia materials, such as sounds and animation (Gee 2003). This is one of the main reasons why children spend most of their time with computers, and this is a phenomenon that will not go away. However, while they are spending their time playing computer games on local site or on-line sites, they are gradually losing chances to do physical exercises such as playing basketball, volleyball, soccer, and running. As one of the side effects of computer games, they are lacking in human-human or social communications. It will be harmful for children not to talk with their family members or friends while they are playing games. As they are playing games with other players on the Internet or local sites, they are using a mouse, a joystick or a keyboard, without physical activities and real social interactions. This means new interactive devices are needed for playing games which will enable them to do exercise with fun and efficiency as well as interact with their family members while they are playing games.

Exercise Game Design

We suggest physical activity based outdoor style exercise game concept for exercise as shown in figure 1, based on interactive and collaborated system with new pointing devices in playing games controlled by computer vision system with CCD Camera. This exercise game can be played on real environment such as on a floor or on a wall. The body-pointing concept based exercise game is simply played by detecting user’s gestures and locations with other users who are playing at different sites. This means the exercise game is played by children’s position, where they are located in a playful space, providing input data with their movements, instead of using devices such as a mouse or joystick. Using user’s gesture and position in an exercise game, user can enjoy games as well as doing physical exercises with other users. Consequently, by replacing stationary input methods with gesture based dynamic input methods in games, we can not only help their physical exercises but also improve social relationships. Input location data with body is the conception of our exercise game in order to let game-users lose weight while playing games. It makes the users to lose weight not being fed up with exercise.

Exercise Scenario

We have given the title as Punch Punch Diet Together, and the main content of the exercise game is to hit virtual food characters displayed on a large screen by their bodies. The exercise game provides three stages in order to consume calories by hitting some instant foods. The basic idea of this interactive exercise game is showed in figure 2. In brief, a diet exercise game user needs to work out with this game to clear each stage, so that they can meet a successful ending and consequently become their weight lose. If players fail to clear each stage, then a failure
ending scene will be appeared on the screen like (d) in figure 2. In this game, we used well known fast-food images to children such as hamburgers, cokes and french-fries as shown in figure 2 (c) to let game users learn an association between fast-food and obesity. Additionally, we give dynamic animations of the characters while playing game in order to prevent playing Punch Punch Diet from monotonous.

![Exercise game sketches](image)

**Figure 2. Exercise game sketches**

**Interaction Interfaces**

A body pointing concept is applied to the diet game. Most current conventional interfaces such as a mouse and a joystick make a user stationary in front of their computers, and those input interfaces have few degrees of freedoms (DOF) in controlling motions. Those interfaces make children inactive while they are playing games. Instead of those traditional devices we used non-touchable and invisible interface as an input interface using computer vision system. As a prototype input system in the game, user needs to put on red colored gloves on their hands to give their position to the computer. A beam project is used as an output device to display game scenes to real environment.

**System Functions**

There are several configuration methods such as front, rear, bottom and top type in combining hardware parts to display virtual scenes. In this paper, front type configuration which enables camera and beam projector to set up easily was used (Kim 2004). The Punch Punch Diet are composed of mainly five modules: Image processing module to get images, Location detection module to recognize user’s position, Event processing module to check events, Game Database which have game objects and Output module to show game scenes. Figure 3 as shown below presents the whole block diagram of the Punch Punch Diet exercise game.

![Block diagram of Punch Punch Diet exercise game](image)

**Figure 3. Block diagram of Punch Punch Diet exercise game**

**Implementation**

The physical activity based exercise game called Punch Punch Diet, currently still on-going project, was implemented under the Microsoft Windows XP and IBM related Pentium 4 hardware PC. The physical activity based diet exercise game built with a gesture input interface and a large screen is tested by several juniors in middle school and university students. Some snapshots of playing the game are showed in Figure 4.
Exercise Space

A wall style game space was created using a beam projector with a 100 inch large screen under the front way hardware configuration (Kim 2004). The virtual space displayed on the screen enable users to interact with virtual objects by hitting them using user’s bodies as shown in figure 5.

Interaction Engine

The exercise game mainly composed of four parts: the first part is the setting game space part to measure x and y coordinates between real and virtual space; the second part is getting data part to get images in every 30 seconds; the third part is recognizing input part to detect user’s; the forth part is motion and animating of virtual objects part to make move virtual objects in every stage. We represented the whole structure of the game engine in figure 6. More specifically, image grab board of Microrobot called my vision was used to capture user’s movement and kcc_277 camera of Kocom was used in order to detect user’s actions. The Sharp beam projector and 120 inch large screen were used to display scenes and to create virtual spaces on the wall. To render 2D and 3D objects Microsoft’s DirectX and Direct Draw were used in Animating objects module. Figure 6 shows the relationships among four major functions in the signal flow point of view.

Interaction area measuring
Ratio Information
Mapping actual and virtual space
Saving ratio between two spaces
Getting image data
Time Interval
Capturing and saving images
Recognizing inputs
Virtual object type & User Location
Comparing mages
Calculating average values
Animating objects
Virtual object
Frequency and Steps

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Figure 5. Mixed exercise space

Figure 7. Game characters
Exercise Rules

In the first version of Punch Punch Diet exercise game as shown in figure 4 above, it consists of mainly three stages. Player needs to use “red gloves” to give their positions to the game engine. Game users get scores by hitting virtual objects such as a coke, a pizza, french-fries and a hamburger on the screen as shown in figure 7. The objects have randomly own movement trajectories which appear from right to left or left to right to display. We controlled difficulty of each stage by emergence frequency of virtual objects and allocated different scores from one point to eight points on each object to let game users more fun.

Evaluations

Physical activity based interactive exercise game called punch punch using a computer vision system showed up in practice to give physical activity to children to build better body, although the game is quite simple and still on going. We invited the dozens of children to experiment the game and they gave me valuable feedbacks for further research. While the children did play the game, we observed them by notes and analyze their behaviors. During the game, first, we discovered that participants’ physical behaviors changed depending on the moving trajectories of characters such as moving motion of hamburgers and cokes. They used most of physical human body, especially hands and arms, to hit the virtual objects on the screen. Compare to motions in computer games or console games, the physical activities in this game is much active than general convention games. Second thing that we found is that most children talk or shout while there are playing the game. When they are hit the objects they said “i-ya”, “hi-hi” or “pu-pu” something like this. From this observation we guess that they are enjoying the game and feeling fun. The last one that we observed is sweat. After finishing the three stage of the punch punch game, some children get sweated a little bit and some children are gasping. From the point we realized that the game much more made them exercised than other convention games such as computer based on-line game and console games. However, there were some technical problems in user interfaces and a computer vision system. For example, since we only used one camera and projector installed in front of the screen to capture the images and display the scenes, children are disappointed when they could not see virtual objects on the screen and hit them, because of their shadow. About the overall game quality in the sense of giving better interactive to children while they are playing a game, we think it is a lot funny to play with their physical body instead of electrical artifacts.

Conclusion and Future Works

We suggested and implemented physical activity based diet exercise game for obese children called Punch Punch Diet, which is a large screen based interactive exercise in order to be a solution for obesity in childhood. Punch Punch game enables children group interactions in large screen based setup. Compare the game to current similar computer supported exercises such as Eye Toy of Sony and programs managed on the Internet for diet. According to informal study by several participants such as middle school students and university students, the Punch Punch game have more physical activities and give more mobility than effects of current games and programs. The reason is the Punch Punch Diet game is used specific virtual target for actions such as punching and relatively space is not restricted than other computer vision based activities such as Eye Toy. We hope that the game, Punch Punch Diet will enables us to lead healthier lives and be an appropriate solution for obese children who desperately need efficient and fun exercise while playing games. We will strive to find conceptual background and develop other exercise game areas which can make more physical activity while playing games. In a technical sense, we are going to improve the accuracy of gesture based inputting interfaces to give better affordance and fidelity of use. For our next step of this study is to take formal user study in order to find children’s mental model for their computer assisted exercise games.

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References


