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A Cloud-Based Pervasive Serious Game Framework to Support Obesity Treatment

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Abstract. Obesity has become an outstanding public health issue in most countries around the world. Many attempts have been made to address this issue that ranges from taking medication to doing exercise to following a diet plan to playing games. Few approaches combine exercise and game to engage the obese people in playing fun-based games or purposeful games, also known as serious games, while monitoring their bio-signals. However, existing work hardly provides a configurable, scalable and context-aware serious game framework that can be used as a support for obesity treatment. In this paper, we take an attempt to propose such a framework. The proposed framework facilitates bio-signal monitoring based on body sensor network, context-awareness based on pervasive sensors, and on-the-spot activity recommendation based on current game-playing context. It uses the cloud computing platform as infrastructural support that ensures the scalability of the framework. In order to demonstrate the suitability of the proposed framework, we developed a sample serious game; deploy it over a cloud platform; and experiment with it by capturing some psycho-physical data while the obese are engaged in game-play. We observed that the obese people were very much engaged in game-play and they had positive experience using the system.

Keywords: Obesity, serious game, body sensor network, cloud computing

1. Introduction

In recent years, obesity has become a major health problem in the world that affects people of all ages [4] [23]. The World Health Organization (WHO) defines obesity by a Body Mass Index (BMI) of an individual higher than 30 kg/m2 [23]. It can lead to problems including increased risk of cardiovascular disease,

diabetes, and cancer in addition to psycho-social problems, functional limitations, and disabilities. Therefore, it is important to work for the obese people to minimize the problems they face and find solutions.

Many attempts have been made to address the obesity issue that involves taking medication, doing exercise, dieting or playing games. Researchers and practitioners have also advocated for a combination of these approaches, such as to follow a diet plan and exercise [17] [4] [23] or more interestingly engage in exercise and gaming at the same time[16], which includes indoor or outdoor exerting activity in the game-play and teaching people regarding health issues. It can implicitly encourage people to increase physical activity levels while playing without inducing boredom. Most popular indoor exergames are Dance Dance Revolution [1], Wii Fit [3] and Gitter Hero [2]. Outdoor exergames include AR Quake [22], Pirates[11], Neat-0-Game[15], Move2Play [10], etc.

While the existence of the above works indicates the past and ongoing efforts to combat obesity, which shows limited success on weight loss and management, they are clearly not enough since obesity is still rising [17]. All of these works, at a general level, encourage increased physical activity to help prevent or treat obesity. In addition, the types of physical activities they consider are the same for all users. Thus, they generally fail to provide the full potential of pervasive serious gaming with real-time activity monitoring and recommendation that can be played anytime, anywhere and from any device. It is also critical that the games that combine exercise (also known as exergaming) provide a suitable bio-signal monitoring and context identification platform, which is configurable, cost-effective and scalable. However, existing works have yet to address such a framework. Moreover, few of them include social network or group-based treatment, which is important for mental well-being and dietary adjustment as well as physical activities.

Recent advancements in multidisciplinary research domains such as Body Sensor Networks (BSN) [18], pervasive wireless communications and Cloud computing [12] are enabling a new era of advanced mobile health-care services that can equally benefit both patients and health professionals. For example, various wireless body sensors can capture different vital signs such as heart rate, blood pressure, glucose level, and sweat condition. In addition, physical activities such as walking, sleeping, driving, running, talking, and a conversation with a friend could now be captured, as well as environmental parameters such as humidity, temperature, location, altitude, etc. can be recorded. Besides, cloud computing is being utilized to provide massive storage and high-performance computing in the form of Virtual Machines (VMs) at low cost for real-time processing of a huge amount of BSN data. It also facilitates the analysis of the processed information under context to extract knowledge of the health condition of patients.

Capturing and evaluating user context (i.e. temporal, spatial and bio-signal parameters) ubiquitously and then providing on-the-spot feedback and suggesting actions in terms of energy in-take and physical activity level can play a major role in combating obesity. This need and availability of the aforementioned

technologies have led us to design a cloud computing-based pervasive serious game framework that is capable of remote real-time collection, dissemination and analysis of BSN data while playing the game, thus providing recommendation regarding suitable exergaming, healthier nutrition and difficulty levels in the game under context. In addition, the framework supports a cost-effective and scalable collaborative exergaming service on the fly for aiding health-care professionals to better manage or treat obesity.

To the best of our knowledge, our proposal is one of the early attempts to introduce cloud-based pervasive serious game framework for supporting obesity treatment. The proposed platform can augment current obesity treatment methods and empower therapists and patients with the process of physical activity monitoring for continuous treatment and long-term management of obesity. In order to achieve this, we develop a cloud-based treasure hunting game as a prototype that can be connected with multiple sensors to obtain several physical activity-related data. In this paper, we concentrate more on the framework and game design as oppose to sensor integration and data collection. Nevertheless, we discuss the basics of sensor-based physical activity data collection from within the game playing context.

The rest of the paper is organized as follows: Section 2 describes related work regarding serious games, its applications for obesity treatment and cloud-based gaming. Section 3 presents the system architecture of the proposed platform. Section 4 depicts the design and creation of a cloud-based serious game called Treasure Hunting. Section 5 shows the implementation details of the game and Section 6 highlights several cloud-based game implementation issues. Section 7 reports the results of physical activity data collection while game-play and the outcome of subjective evaluation. Section 8 concludes the paper.

2. Related Work

2.1. Brief Background on Serious Game

Nowadays, serious games are widely used in many different areas [6] [13] [25]. The recent advancements of video games, computer graphics, and computer hardware gave a large support to the development of serious games. Clark Abt in [5] introduced and discussed this term in his book Serious Games. He defined a serious game as an activity between two or more independent decision-makers seeking to achieve their objectives in some limiting context. In Game Developers Conference (GDC) 2004 [6], Sawyer introduced Serious Games concept as solutions to solve problems. According to him, serious games' primary goal is not entertainment, but they can be entertainment games applied in a different manner. In 2005, Zyda in [25] updated some serious games concepts. He defined serious games as "mental entertaining context played in accordance with specific rules to serve certain objectives, including training, education, public policy, and health". Thus, serious games can be used in many areas (such as: health specially rehabilitation, education, governments, etc.) for

different purposes. Serious games can be of different types: Action, adventure, role-playing, strategy, puzzle and simulation games.

2.2. Serious Game Applications for Obesity

In order to support obese and overweight patients, some exergaming applications have been developed using serious games concept. Gobel et al. [16] developed three serious games for health purposes -1) ErgoActive, uses the physical activity of the user by riding a bicycle to control a film. 2) SunSports Go, a multiplayer game in which the player can run toward or shoots at target, and 3) Y-Move, a multi-player racing game which uses head-tracking technology as input where the player can control the game by moving his/her head. The same authors also propose a context-aware serious game framework for sports and health to select appropriate exergaming based on users' current context [19].

The Wit Fit from Nintendo [3] is probably the most well known commercial example of exergaming platform providing a series of games, such as golf, dance and football. Dance Dance Revolution [1], Guitar Hero [2], Feeding Yoshi [8] and RTChess [24] are other examples of exergames. Selmanovic et. al. in [14] produces a serious game for children who uses Wii Controller and Wii Balancing Board. Play Mate! [9] is a game which motivates users to perform physical activities that lead to change the game difficulty level depending on user's performance during the game. Exertion Interfaces [21] aims at increasing the physical activity of computer users stating that persuasive physical activity intervention will contribute to overall well being. NEAT-o-Game [15] collects user activity data from a wearable accelerometer which controls the animation of an avatar that represents the user in a virtual race game running on cell phone and playing with other players over the network. Similarly, MacLellan et al. [20] perform measurements of physical activity and the location of users to promote the utilization of walking as a form of transportation as a primary mechanism to encourage people to become more active.

While the existence of the above works, which are very recent, none of them would be used clinically by an obesity expert. They generally fail to provide activity recommendation, evaluation and in many cases even a suitable activity tracking mechanism. On the other hand, commercial systems such as RunKeeper and Endomondo provide activity evaluation and activity tracking. However, they target already physically active people, who often do not require recommendation or evaluation of their activity, nor any special motivation, as they can handle all these factors on their own. On the contrary, in this paper, our goal is to augment current obesity treatment methods and empower therapists and patients with a comprehensive process of physical activity management for continuous treatment and long-term management of obesity.

2.3. Cloud-based Gaming

In recent years, cloud computing [12] is becoming a promising technology to provide a flexible stack of massive computing, storage and software services in a scalable and virtualized manner at low cost. Because of its elasticity, scalability, pay-as-you-go model, Cloud computing is being utilized in various application areas such as health, education, and recently in gaming. Cloud Gaming is a new kind of emerging service, which combines the successful concepts of Cloud Computing and Online Gaming [7]. It provides the entire game experience to the users remotely from a data center. The player is no longer dependent on a specific type or quality of gaming hardware, but can use common devices. The end device only needs a broadband internet connection and the ability to display High Definition (HD) video. The benefits of cloud-based game implementation can be summarized as follows:

- No huge disk storage, memory and resources are needed during the game run, thus saving costs
- Can be played by many players from different locations using different devices
- Can support different platforms and operating systems
- Different versions of the game can be applied without upgrading the players machine or software
- Can use high definition video for rendering and processing without being concerned about the computation while the game is running
- Can save energy consumption while playing from mobile devices

Currently, OnLive [www.onlive.com] is one of the most popular cloud game provider. However, still now existing cloud gaming services are not being utilized for improving pervasive healthcare services. The exploration of such a method is timely and crucial to the development of a clinically effective system in combating obesity.

3. System Architecture

3.1. Overview

The high level architecture of the proposed cloud-based pervasive serious game framework is shown in Fig. 1. The cloud-based serious game framework enables users to play the game on any device like smart phone, pocket PC, laptop or a personal PC without having to download the game engine. The devices handle user's game input such as keystrokes, mouse coordinates and clicks, and send the data over the wired or wireless network to remote cloud servers hosting the game. In addition, they send user's bio-signal data, physical movement data as well as contextual data to the cloud servers while playing the game. The cloud servers carry out all the necessary processing for game physics, graphics as well as psycho-physical data while the users are engaged in game-play. During the execution of a game, the graphical output is used to show the user the current state of the game.

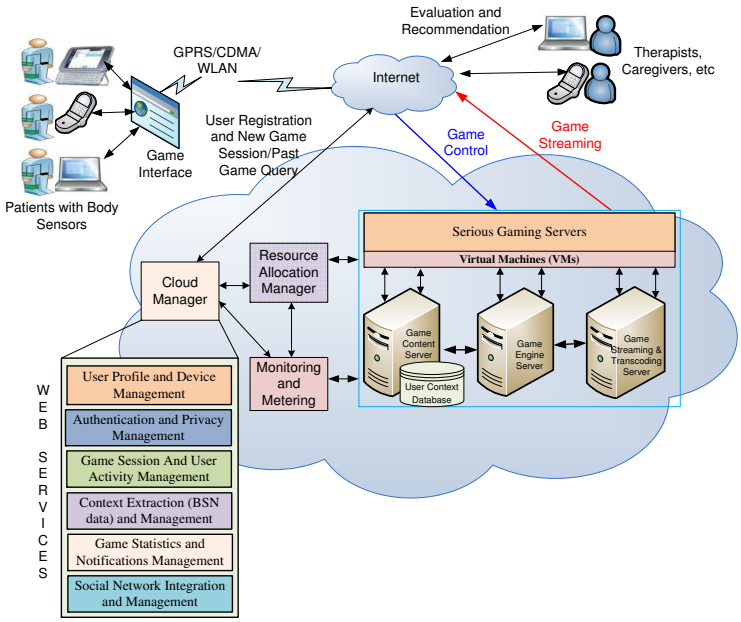

Fig. 1. A Cloud-based pervasive Serious Games Framework

3.2. Component Description

The major components of the proposed architecture as shown in Fig. 1 are briefly explained as follows:

- **Users:** The main users of the framework are obese patients and therapist /caregivers. Obese patients are equipped with various body sensors and play serious games in the cloud environment from different devices. Therapists/caregivers are responsible for monitoring the patients' performance within the game play and providing appropriate recommendations to improve the health condition.
- **Game Content Server:** Responsible for maintaining the serious games database and holds all the necessary information of the users/obese patients along with their context information (i.e. bio-signal parameters, physical movement and environment condition) during the game. Besides, it holds the connections for the users, delivers the interactive messages as well as updates the active users game data simultaneously.
- **Game Engine Server:** Responsible for synchronizing the player's game data with the game content server, and processes the game logic and data to render the raw game video.
- **Game Streaming and Transcoding Server:** Responsible for encoding the raw game video and sending it to the players.
- **Cloud Manager:** It is responsible for overall management of the proposed framework. It is the component that performs the first communication be-

tween the user device and serious game content server, allowing a new game to be initiated. It consists of several web services to manage the whole game infrastructure in the cloud. They are described as follows:

- *User Profile and Device Management*: This web service is responsible for managing the obese patients' profile and device information.
- *Authentication and Privacy Management*: It is responsible for authenticating the users in the system. In addition, it maintains the privacy of the users and provides secure access to the game database.
- *Game Session and User Activity Management*: To manage and control the game sessions. When a user/obese patient wants to play a serious game, the cloud manager generates a new game session through this web service for that user in the game content server and provides the address of the VM in the game content server to the user. After that all future communications will be done directly between the game content server and the user, without going through the cloud manager. At the end of the gaming session, the cloud manager is signaled by the user and the corresponding session is closed.
- *Context Identification and Management*: It is responsible to extract vital sign parameters, physical movement and environmental data of the patients and store them in the user context database of game content server.
- *Game Statistics and Notifications Management*: This web service produces the performance report and game statistics of the patients based on the data collected from body sensors while playing the serious game. It also notifies the therapists/caregivers about the obese patients' progress.
- *Social Network Integration and Management*: It enables the pervasive collaborative serious gaming in the cloud platform. The players can play the game with their friends in the social network from different locations.

– **Resource Allocation Manager:** Manages and allocates various VM resources for running the games and web services. Upon receiving a new game session to be serviced from the cloud manager, a new virtual machine to run the particular game session for a user is initiated by the resource allocation manager. This virtual machine will function as the game content server, communicating directly with the user/obese patients. It also configures VM capacities dynamically according to the current workload demands. It can facilitate migration of VMs between physical servers in order to: (i) pull out physical servers from an overloaded state when the sum of VMs capacities mapped to a physical server becomes higher than its capacity; (ii) turn off a physical server when the VMs mapped to it can be moved to other physical servers. When new service joins or VM migration is needed, it uses a VM allocation algorithm to find proper physical server.
– **Monitoring and Metering:** Responsible for performance monitoring and usage tracking of VM resources.

3.3. Functional Description

As we explained in the introduction, our architecture facilitates three major functions which are discussed as follows:

- **Bio-signal monitoring based on body sensor network**:
  Our proposed framework supports real-time monitoring of an obese patient's vital sign data such as heart rate, blood pressure, glucose level, sweat condition, body temperature, etc. from the body sensors attached to his/her body while playing the games. The collected monitored data are transmitted to the patient's device via Bluetooth and then to the cloud server via the Internet or 3G. Such integrated system provide various BSN services such as real-time pre-processing, storing, sharing, visualizing, and analyzing of monitored data to therapists/caregivers or even patients ubiquitously by a variety of interfaces such as personal computer, TV and mobile phones. It can also allow sharing of monitoring data related to obesity to authorized social networks or medical communities to search for personalized trends and group patterns, letting insights into obese disease evolution and the rehabilitation process.
- **Context-awareness based on pervasive sensors**:
  The proposed architecture enables capturing of current context of obese patients such as body movement and geographical location (and therefore, altitude) through 3D accelerometer body sensors and GPS capable mobile devices. Altitude is important since it affects the energy that the patient has to spend to move a certain distance at a certain speed. To validate that energy expenditure is measured accurately enough, the system validates the values reported by the BSN against gold standard measurements of energy expenditure relating to obesity monitoring. While energy expenditure can be measured from context-based motion activities, measuring energy intake is also a challenging task. So the proposed framework provides an intuitive interface for mobile as well as desktop to the user in order to manually enter the food intake and thereby obtaining the measure of energy intake. Based on this manual input, the system will calculate the energy intake by consulting the food-value database, which will be carefully built under the guidance of nutritionist and therapist.
- **On-the-spot activity recommendation based on current game-playing context**:
  Our architecture provides seamless access to therapists/caregivers to monitor the progress through the game online or offline as well as performance of the obese patients while playing the game. It allows the therapists/caregivers to provide on-the-spot feedback and suggesting actions in terms of energy in-take and physical activity by evaluating patient's current context (i.e. bio-signal parameters, body movement and environmental condition). Even the therapists/caregivers can provide recommendation regarding the game levels.

3.4. Game Playing Sequence

Now, the whole sequence of the steps executed during the serious game between the system components are summarized as follows:

1. Obese patient is equipped with wireless body sensors attached to his/her body.
2. Obese patient connects to the game, and a new game is initiated or past game will be resumed by the game session web service after the authentication by the authentication web service
3. Based on the data stored in user profile, and the data collected by context extraction web service using body sensors, the level of the game is chosen.
4. Game session web service registers session and resource allocation manager allocates a VM resource for the obese patient to play the game.
5. Obese patient sends the game controls to the game content server.
6. Game content server sends data to the game engine server to process.
7. Game engine server sends data to game streaming and transcoding server.
8. Game streaming and transcoding server sends the game output to the obese patient.
9. Context extraction and management web service collects the data from body sensors and stores them in the users' context database during the game-play.
10. Steps from 5 to 9 are repeated until the game is finished.
11. Cloud manager terminates the session when the game is finished.
12. Caregiver/therapist requests patients information, reports and statistics that are provided by game statistics and notification management.
13. Caregiver/therapist receives requested information, reports and statistics.
14. After that, changing the game level, customizing the exercises and others will be recommended by caregiver/therapist.

4. Game Design

In this paper, we design and develop a cloud-based serious game called *Treasure Hunting* to show the full promise of the platform. Although many Treasure Hunting games were developed in the past, our game augments previous approaches in a number of key dimensions, especially through the promotion of pervasive exergaming in a cloud environment to combat obesity.

Using cloud computing to run the game allows many players from different locations to play the game and get its benefits. The hidden aim of the game is to increase the physical activity of the obese patients in attractive manners. It is designed as a web-based indoor serious game and currently desktop users can play this game. However, multi-player functionality is not yet implemented. Characters and environments of the game are designed using 3D graphics and presented in different themes such as day, night, rain to increase the game attraction and reality. Fig. 2 and 3 show a screen shot of the game character and its initial interface, respectively.

Fig. 2. The main character of the Treasure Hunting game

In order to use the idea of engaging physical activity, the game inputs and interactions are received by a player's movement. When the game starts, the screen displays the mission and the suggested strategies based on the measured BMI, age, gender and caregiver/therapist mission. The long-term goal is to achieve a better lifestyle, i.e. healthier nutrition and physical activity behavior. The game has different levels which the player can achieve. The player is represented by a graphical character or avatar. According to the player's physical fitness or BMI, the level of the game will be chosen. If the caregiver/therapist decides to upgrade or downgrade the game level for any reason, he/she can do that from his/her own account.

Fig. 3. The initial interface of the game

In order to achieve the next level, the player needs to gain certain scores during the game. These scores are represented by diamonds and to get these

Fig. 4. The character is near to a clue in the game

diamonds some exercises such as running, stepping, jumping, cycling, etc. are to be done by the players. Figure 4 shows a screen shot of this game scene. After getting the diamonds, some instructions to find the treasure will be shown to guide the player. During the game, information about healthy food and health problems caused by obesity are pop-up in the game and are shown also on the buildings to increase the awareness. The game environment is an everyday environment. Therefore, the player walks, runs, steps, in the streets, between the buildings, in the parks and in the shopping centers.

The Treasure Hunting game is developed to satisfy several essential requirements:

- *Bio-Signal Monitoring and Context Tracking*: The physical activity of the player is tracked and monitored by the system and automatically measured from time to time and level to level. Thus, the caregiver/therapist can accurately get the measurement of energy intake and expenditure (energy balance) of each player.
- *On the Spot Activity Recommendation*: The game recommends the appropriate level and exercises during the game and the targeted BMI. These recommendations can be taken based on the player's age, gender, bio signals and BMI. Fig. 5 shows a snapshot of this event.
- *Evaluation*: When a player creates his/her profile in the first time of playing the game, BMI is measured and stored in the player's profile. Every time a player plays the game; the BMI would be measured, calculated and compared to the first stored BMI value. Then performance percentage is calculated as below:
  Performance % = ((First BMI $-$ Current BMI) $/$ (First BMI $-$ Normal BMI)) * 100 where, Normal BMI $=$ the targeted BMI provided by caregiver/therapist. The performance of the player is also provided in reports and statistics, and these can be viewed in the player's profile. Only eligible people can view this information. Thus, the system gives useful information to care-

Fig. 5. Activity recommendation during the game-play

giver/therapist who helps them to monitor and treat the obese patients. Different reports are generated for monitoring the player's performance. The caregiver/therapist can change the game level and customize the exercises which are requested during the game based on the health status and physical fitness.

5. Game Implementation

The Treasure Hunting game was developed using Flash Develop 4.0 with Adobe Stage 3D library and Flex SDK 4.6 [http://www.flashdevelop.org/] and we deployed it on the Amazon Cloud. The user only should have access to the internet and type the address of the game on the browser and enjoy. Flash Develop is an open source source-code editor and it is specifically gear to Adobe flash. So developers can add their ActionScript code inside the Flash Develop and compile that code using Flex SDK to write ActionScript code and make their apps, games, and websites for free. With Adobe Stage 3D, developers can create games with full access to the computer or mobile devices GPU for great performance.

Our game supports different operating systems and can be played in any device which supports Flash. The game inputs and interactions are received by the obese players' movement. The used devices to capture a player's motion are Wii Controller, Wii Balancing Board and other Wii accessories. These devices help to measure step count, weight, and movement of the users. To control the user inputs from the Wii devices, we use Wii Flash 4.0 library. In addition, Autodesk 3D Max 2012 software has been utilized to create the assets and game's character. We export the game component from 3D Max using Flare3D plugin v 1.3. The user needs to install Wii Flash Server 4.5 to connect their PC with Wii Balance Board via Bluetooth.

Table 1. List of sensor devices used for the game

Device Name	Company	Function
Wii Balance Board	Nintendo Wii	Controls users movement Measures users weight and step count
Push Up Bar	Nintendo Wii	Measures number of push ups
PAMSys Sensor	BioSensics	Measures body movement data such as sitting, standing, walking, speed, number of steps etc.
PAMSys-ECG Sensor and T-Shirt	BioSensics	Measures mainly heart rate and heart rate variability as a function of physical activity

In order to monitor bio-signal data such as heart-rate and body movement (e.g. sitting, standing, walking, speed etc.) of obese people while playing the game, various body sensors were used such as PAMSys sensors and PAMSys-ECG sensors from BioSensics company [http://www.biosensics.com/]. Table 1 shows the list of devices used for the game.

6. Cloud-based Game Implementation Issues

There are some challenging issues that need to be considered while making a cloud-based serious game. One important issue is how good will the user experience be, considering the user control data has to be transmitted uplink from the mobile devices, and streaming video data transmitted downlink from the cloud server. This issue is related to the subjective factors: response time and received video quality. The game response time refers to the total delay from the user control command occurring to the corresponding video frame displaying on the mobile device, while the received game video quality is influenced by the image quality in each frame and the smoothness of all the frames. The subjective factors are affected by a number of objective factors, which can be categorized into two groups: video settings and network parameters. All these objective factors affect the game response time and game video quality in a complex manner.

Another important issue in this environment is to find an efficient VM resource (i.e. CPU, memory, storage, network bandwidth, etc.) allocation in the cloud to guarantee real-time QoS requirements (e.g., response time, video quality, etc.) for seamless game experience as well as supporting various BSN services such as pre-processing, storing, sharing, prioritizing, visualizing, and analysis of monitored BSN data while playing games. Other issues include providing security as well as privacy for the patients' sensitive data.

7. Evaluation

7.1. Physical Activity Monitoring During Game-Play

We conducted experiments with the developed prototype by inviting different obese people of different ages - three children aged 8 to 15; four men aged 16 to 24; three men aged 25 to 34, and two men aged 35 to 44. We let them play the game wearing various sensors in different sessions. While they played the game, our developed system recorded their various health and exercise-related data such as weight, step counts, body movement, heart rate, calorie burn etc. Fig. 6 presents a graphical view of some of these data recorded in a 15 minutes game session.

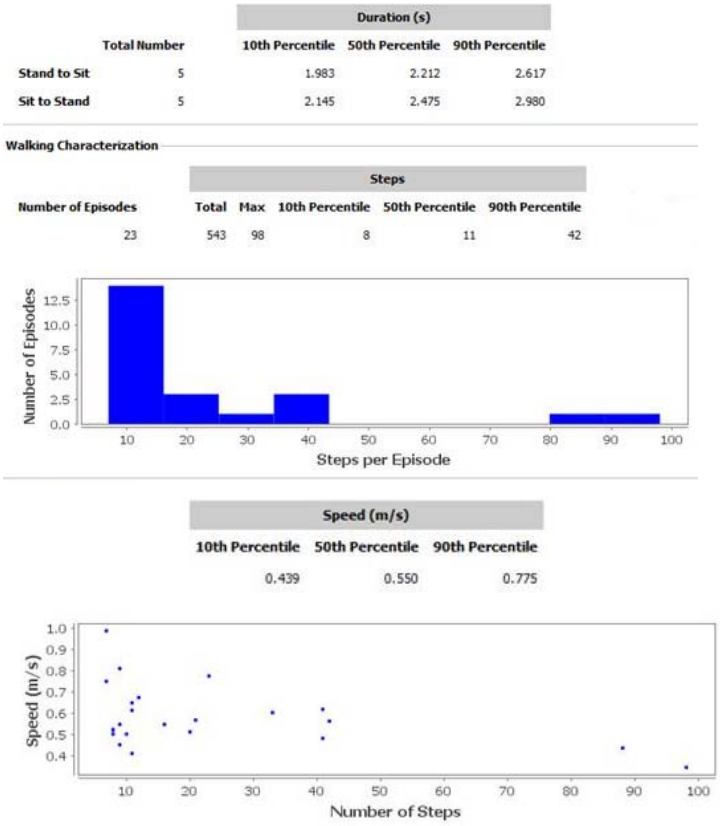

Fig. 6. Body posture data captured in a game playing session

7.2. Subjective Evaluation Test of the Game

After playing the Treasure Hunting serious game on the cloud, the participants showed good impressions about the game attraction, 3D graphics and its idea of combating obesity. Then, questionnaire forms were filled by the participants. This questionnaire includes some demographic information in addition to evaluation questions about the game's graphics, reality, control accuracy, used devices, and the information about healthy food and health problems caused by obesity during the game to increase the players awareness. There are also some questions related to networking issues such as performance of sending control and receiving outputs and is there any loss of services during the game. The results from the questionnaire are shown in Table 2. The evaluation rate is between 0 and 5 (0 is poor and 5 is outstanding).

Table 2. Questionnaire Results

Game Performance	Age: 8-15	Age: 16-24	Age: 25-34	Age: 35-44
Graphic	4	3	3	4
Reality	3	3	2	2
Attraction	5	5	4	5
Food	5	4	4	4
Network	5	4	3	4

Caregivers/therapists also participated in this experiments. They tested the reports and statistics which are shown in each players profile, and they gave a very good impression about the reports and statistics that help them to monitor and treat their obese patients. In addition to that, they tested the way to change the game level and to choose and customize the exercises during the game based on the players health state, physical fitness and statistics provided by the system. At the end, caregivers/therapists found the system very helpful and supportive to enhance their job and to achieve their target. Some suggestions were brought by the participants such as:

- To have a collaborative game that allows different players from different locations to play with each other
- To use haptic technology
- To include more game levels

8. Conclusion

In this paper, a cloud-based pervasive serious game framework in combating obesity is introduced. The design of the framework upon which multiple serious gaming applications can be deployed is described with the implementation of a proof-of-concept game. The proposed framework can enable the development

of new generation of pervasive serious games that augment current exergaming methods in a number of key dimensions like measuring user context data while playing the game, providing recommendation regarding suitable exergaming, healthier nutrition and collaborative exergaming service anywhere, anytime and from any device for the purpose of aiding health-care professionals better manage or treat obesity. Our future work will incorporate extensive integration of body sensors and other devices with the game framework to capture various psycho-physical data while the players are playing the game.

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