An Adaptive Framework for the Creation of Body-Motion-Based Games

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An Adaptive Framework for the Creation of Body-Motion-Based Games

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***Abstract*— As of the early 20th century, a significant body of research has been published that shows how effective game-based learning and gamification techniques can be compared to other methods. However, creating games can be time consuming and usually demands a significant effort. Therefore, this paper focuses on the design and development of a novel framework for the rapid design of body-motion-based customizable game-like applications. This framework consists of two components: i) an interface that allows the user to design the game and capture the motion data, and ii) a customizable game for learning and training using off-the-shelf motion capture sensors like the Microsoft Kinect. The game is automatically configured based on the output of the game design interface. In order to evaluate the proposed system, a pilot use case for the Latin dance Salsa has been selected. Preliminary small-scaled experiments with latin dance students have shown the great potential of the proposed application.**

Keywords— adaptive; framework; motion-based games; Kinect V2;

I. INTRODUCTION

Serious gaming or applied gaming refers to games designed for a primary purpose other than pure entertainment [1]. By combining gaming and learning, serious games, that exploit the latest simulation and visualization technologies and target populations, ranging from children to adults [2], are gaining an ever increasing interest in various educational domains, such as education, defense, healthcare, aviation, etc. Such games can achieve many types of educational outcomes supporting aspects that modern theories of education consider as central for effective learning. Specifically, studies have shown that modern digital games can promote extrinsic and intrinsic motivation [3], engage learners in order to invest effort and commitment in learning tasks [4] and support constructive, experiential, situated [5], procedural [6, 7] and self-regulated learning [8]. Furthermore, it is also argued that serious games can achieve many types of educational outcomes, since, besides teaching effectively mere educational content, games provide the possibility of a variety of additional types of learning, such as: strategic thinking, a variety of cognitive skills and kinesthetic learning [9].

A special category of digital games employed in education are motion gaming systems or motion-controlled gaming systems that allow players to interact with the game through body movements. Studies have shown that body-motion-based games can have a variety of benefits for the players and are increasingly applied in physical therapy, motor skills teaching, rehabilitation and prevention for older adults [9]. During the last decade, the availability of affordable motion capture sensors (Kinect, Wii, leap motion, etc.) have contributed in the growing interest in designing and developing such games for different disciplines.

For example, Deng *et al.* [10] implemented an interactive dancing game based on Kinect's tracking technology. They proposed a novel approach to handle real-time recognition of the user's dance motion based on human body partition indexing. Experiments showed that their proposed method had good performance on both isolated and continuous motion recognition and positive feedback from the subjects was obtained from the user study. Similarly, Chan *et al.* [11] implemented a dance training system that enables learners to learn dance by themselves. Using their system, a student can imitate the motion demonstrated by a virtual teacher projected on the wall screen, while, the student's motion is recorded and analyzed by the system, in order to provide them feedback about their performance.

Furthermore, within the i-Treasures (Intangible Treasures - Capturing the Intangible Cultural Heritage and Learning the Rare Know-How of Living Human Treasures FP7-ICT-2011-9-600676-i-Treasures) [12] project, a number of game-like applications for sensorimotor learning of specific dance types and other activities involving full body gestures were designed and developed to support the learning and transmission of a number of ICH expressions. Specifically, a serious game application for transmitting ICH knowledge concerning the Greek traditional dance "Tsamiko" was designed and implemented [13, 14]. The game is structured as a set of activities, each consisting of several exercises, aiming to teach different variations of the dance. One of the most important elements of the proposed game-like application is the evaluation of the performance of the learner [15], in order to provide meaningful feedback. To this end, the learner's movements are captured using a markerless motion capture approach (Kinect v1 or v2 sensor), which aims to fuse skeletal data from multiple sensors into a single, more robust skeletal representation. Subsequently, the motion similarity between the learner's movements and an expert recording is performed through a set of appropriate performance metrics and a DTW/

FIS-based approach [15]. Preliminary small-scale user studies in Thessaloniki, Greece, have shown the positive educational potential of the proposed framework. Respectively, more such educational game-like applications were developed for other types of traditional dances (Walloon, Callus, etc.).

However, although most of the studies presented above have shown positive educational outcomes, they are also characterized by some significant limitations. Most cases don't include any adaptive features and can only support a limited number of movements. In addition, in some cases the feedback provided to the users is quite limited and others use high cost motion capture systems that limit their wide use. On the other hand, there are also a few recent works that allow users to both record and learn physical movement sequences. Most notably, Anderson et al. [16] proposed YouMove, a novel Kinect-based system that enables users to record and playback body movement sequences allowing them to create and share training content. The corresponding training system, that uses a large-scale AR mirror, trains the user through a series of phases that gradually reduce the user's reliance on guidance and feedback. The authors also presented a user study showing that YouMove improved the learning effect compared to a traditional video demonstration. However, although users can record and share training exercises, the proposed system doesn't provide any choices to the users to adapt the training system to their needs.

Taking into consideration all the above studies, it is understandable that serious games can effectively support sensorimotor learning. However, while the process of designing and developing serious educational games can be a creative and positive experience, on the other hand, creating games can also be a time consuming, skill demanding and frustrating experience. Specifically, Kanode and Haddad [17] present a number of challenges a game development team is more than likely to confront, such as: a poorly established project scope (estimation of the time and resources needed to bring the project to a successful conclusion), the growing need of diverse assets and resources, the over-arching phases of game development (preproduction, production, and testing) and issues to deal with when selecting third party technologies.

Therefore, in order to facilitate the game design and creation process of sensorimotor learning games, in this paper we propose the development of a framework based on Unity 3D engine [18], which will provide an easy and rapid way to design and develop simple serious game-like applications for any kind of disciplines that include body gesture movements (martial art, dance, medical rehabilitation, arts and kinesiotherapy) and will offer users many choices to customize and adapt the generated game to their needs. Our work offers several contributions. First, we provide a novel design framework for customizable full-body movement training games, providing design and implementation details, and interaction guidelines for an educational body-motion-based interactive game. We also perform a detailed evaluation based on questionnaire results that demonstrates the learning effectiveness of our proposed framework. Last but not least, we analyze the educational effects of the proposed framework and provide plans for future work.

II. System Architecture

We developed a generic framework, which provides an easy way to design and develop simple serious game-like applications for dance learning or other kind of activities involving full body gestures (e.g., martial arts or kinesiotherapy). This framework consists of two components: i) a game design module that allows the user to capture the required motion data and to select the desired game parameters (environment, evaluation algorithm, etc.) and ii) a customizable game-like application for motor skills learning, which is automatically configured based on the output of the game design module (Fig. 1). The target users of the game design module are mainly experts who would like to teach a sequence of movements to their students and need to have moderate ICT skills. Accordingly, the target users of the game-like application are learners with only basic ICT skills who are interested in practicing or learning new sequences of kinesiology.

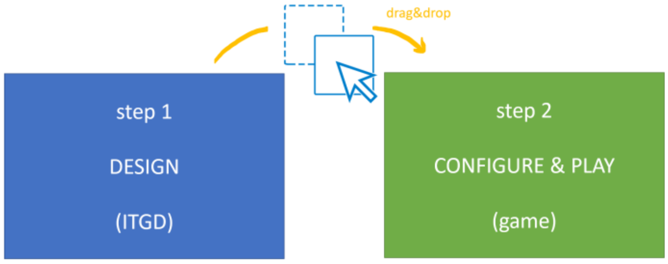

Fig. 1. The architecture of the proposed framework.

A. *Game Design module*

In order to design and develop the serious game-like applications for activities involving full-body motion, the ITGD (i-Treasures Game Design)Game Design module has been developed. ITGD provides the user with a simple interface to a) record and annotate motion capture data (3D skeleton movement data and video) and b) customize various game parameters. It is written in C++, based on the open source MotionMachine framework [19], and can support different motion capture data formats, or records in real time data from the Kinect sensor [20].

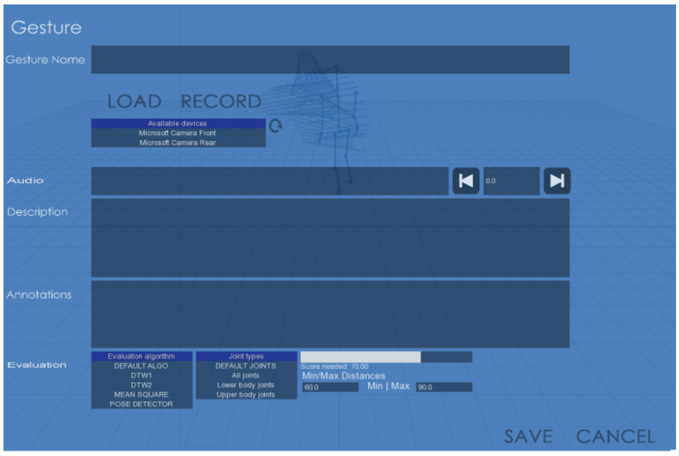

Fig. 2. Screenshot of the gesture creation/edition within the ITGD module.

Specifically, after launching the ITGD tool, the users can specify the name and the description of the project and also the number of activities (levels) and exercises in each activity. Each exercise represents a body movement sequence to be learned. The interface allows adding new exercises or editing existing exercises. In both cases, a new window appears (Fig. 2) that allows a) editing the name and the description of the exercise and b) recording or loading mocap data and annotation of this data. The interface also allows users to adapt the game according to their needs. Specifically, they can select the evaluation algorithm to be used in the game out of a list of provided choices including DTW (Dynamic Time Wrapping) [21], HMM [22](Hidden Markov Model) and Poser Detector (an algorithm that detects the degree of difference between the selected joints of the expert and the learner once every ten frames and calculates the average error percentage at the end of each exercise) and the group of joints to be evaluated (upper body, lower body or all joints) for each exercise. The motion editing and annotation interface (Fig. 3) allows authors to crop the recorded data to eliminate any unwanted parts.

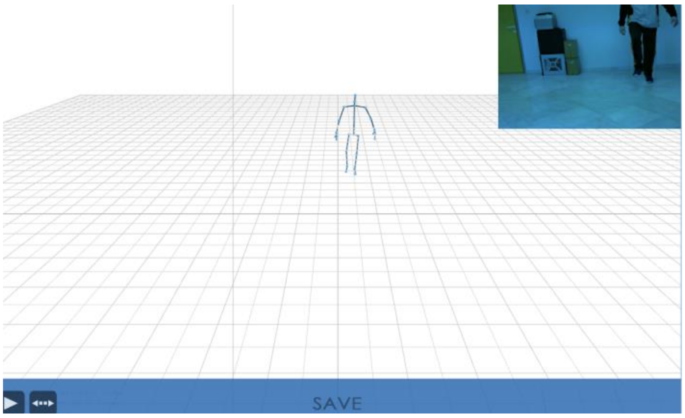

Fig. 3. Motion editing and annotation interface.

In addition, the users can further customize their game by uploading audio files and synchronizing them with the exercises, selecting the avatar models and the 3D environment of the game (Fig. 4) and adjusting the difficulty level of each exercise by setting the minimum score threshold needed to pass to the next level (exercise).

Fig. 4. Selection of avatar and game environment

B. *Game-like application*

Once the game design procedure has been completed, the selected configuration parameters are saved in an XML file, along with all associated data (mocap data, annotations and video). By simply copying these data files to the game folder, the game-like application is ready to be used for learning the recorded activities/exercises.

In the rest of this paper, we will evaluate the efficacy of learning using this game-like application in a specific pilot case: learning the basic steps of Salsa dance. Towards this end, four learning activities were designed and implemented, in close cooperation with dance experts, each consisting of a number of specific exercises of increasing difficulty. The learner has to perform all of the exercises successfully to achieve the activity objective. Each exercise consists of several dance steps, which are presented to the learner one by one. In order to proceed to the next exercise, the learner must perform the current exercise correctly. In each exercise, a 3D animation of the virtual avatar of the expert performing the specific moves is shown to the learner and the learner is expected to imitate the same moves synchronously. If the evaluation score achieved is larger than the set during the design phase, the game progresses to the next exercise. Otherwise, the learner is expected to repeat the same exercise until his/her performance is sufficiently improved.

Fig. 5. Menu interface of the Salsa game-like application.

The game allows users to learn Salsa by either observing expert's movements in the Observe mode or by starting practicing the dance routines respectively in the Practice mode (Fig. 6 and Fig. 7). There is also a tutorial aiming at explaining to the learner the basics of how to play the game. In order to teach how to use each user interface element, a 2D virtual tutor presents both the sensors and the GUI to the learner. More specifically, the virtual tutor explains a) the sensing technology used in this game, b) the Observe screen components and c) the Practice screen components. When the tutorial is completed, the learner is expected to continue with the observe phase of the first activity, followed by the practice phase.

The practice starts with an introduction from the virtual tutor. After providing some basic instructions, the virtual tutor asks the learner to get ready and a counter starts counting down. Then, the learner is expected to imitate the moves of the expert avatar displayed on the screen. A video of an expert performing the target move is also shown on the left of the game screen to show the learner the real-life Salsa dancer. The learner's motion gestures are captured by the Kinect sensor and then transferred to the game and used to animate the learner's avatar. Then, they are further analyzed by the game evaluation system selected in order the similarity between the learner's and the expert's movements to be estimated. In this case, we selected the DTW (Dynamic Time Wrapping) [21] evaluation algorithm, a well-known technique for measuring the similarity between two temporal sequences that may vary in time or speed. We used various feature sets which are used as input to DTW separately in order to obtain distinct distance measures. Taking into account that in Salsa dance both the leg and hand movements constitute key elements of the choreography, the choice to use all joint positions (head, shoulders, elbows, knees, ankles) was selected.

After the user performance is completed, evaluation is performed and the virtual tutor presents the evaluation score along with an appropriate message, e.g. "Outstanding performance! You are ready for the next exercise/activity!". If the learner goes beyond a pre-defined success threshold, the virtual tutor asks him/her to get ready for the next exercise. If the performance was not as good as expected, the learner is asked to repeat the same exercise. This tutor has different mood expressions (happy, explanatory, unsatisfied, confused etc.), so as to provide the learner with the proper feedback depending on their performance. Although the exercises progress sequentially, in some cases the learner has to repeat not only the previous exercise but also some of the previous ones.

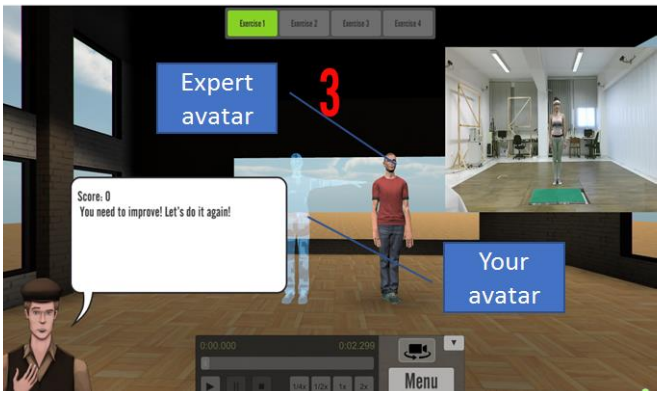

Fig. 6. Front view of the game's practice mode.

Furthermore, during the runtime phase, performance and other analytics data from each play session are collected and stored, as an XML file, by the analytics system of the game-like application. These data allow extracting statistics about the learning curve and performing a post-evaluation of the learning process. They can also be transmitted and stored to a remote server.

As shown (Fig. 8), game analytics include the time spent and the number of clicks in menus and in the game (observe and practice modes). These are quite important to understand if there any part of the game which impacts the learners in any negative way. For example, a specific feature of the game may discourage users to try advanced practice. On the other hand, if in some games certain features are enjoyable and encourage users to play and learn more, these best practices may be replicated in other games, if possible. Analytics data may also provide information about the language and guidance preferences of the users to be used in further development of the games. For instance, the game analytics may suggest implementing more detailed user guidance methods that will improve the learning curve and the educators' ability to understand students' learning performance.

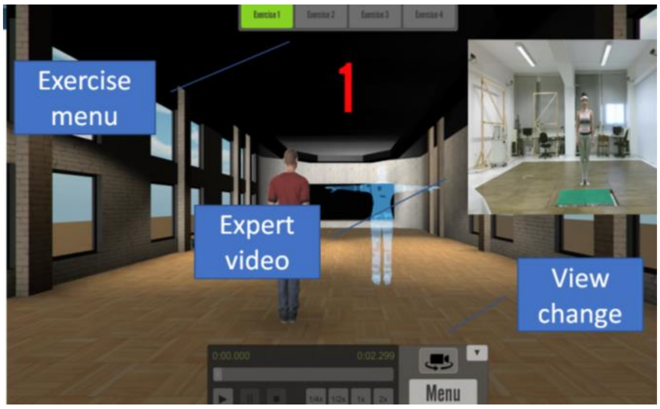

Fig. 7. Back view of the game's practice mode.

```
<Analytics>
        <GameAnalytics />
        <MenuAnalytics StayedInGame="0.0165671221911907" />
        <SalsaGameAnalytics TotalPlayTime="65.2626195922494"
         PracticeTime="65.2626195922494"StayedInMenus="63.8341214582324"
        StayedInGame="65.2460524700582" GameTotalClicks="6" />
</Analytics>
```

Fig. 8. An example of a generated XML file containing analytics data about the learners' use of the game.

Furthermore, detailed analytics are provided for every exercise performed by users in practice mode in an additional XML analytics file (Fig. 9). This type of analytics can be useful to educators, e.g. to assess the level of difficulty and learning curve of each exercise.

```
<statistics>
  <idstep>4972</idstep>
  <userid>132</userid>
  <kindofgame>SALSADANCE</kindofgame>
  <gameid>8</gameid>
  <whichactivity>1</whichactivity>
  <whichexercise>3</whichexercise>
  <totalclick>27</totalclick>
  <stayedonexercise>6.704953</stayedonexercise>
  <errorsexercise>0</errorsexercise>
  <scoreexercise>-1</scoreexercise>
  <helpuse>0</helpuse>
  <iscompleted>not completed</iscompleted>
</statistics>
```

Fig. 9. An example of a generated XML concerning a particular exercise.

III. Evaluation Methodology and Experimental Results

The adaptive framework for the creation of body-motion-based games, which led to the creation of the pilot Salsa game, was evaluated by Latin dance students in order to assess their attitude towards the use of such a game-like application for Salsa learning. The evaluation was performed by 11 persons aged between 25-43 years old (5 females – 6 males). Eight of them were Latin dance students (4 females- 4 males), who are novice in the Salsa dancing (assigned to Group A) and three of them were dance teachers (one male Greek folk dance teacher, one female classical ballet teacher and one male Salsa dance teacher) and they can be considered experienced dancers (assigned to Group B).

In order to evaluate the efficacy of such a game-like application in Salsa dance education, all subjects practiced the four activities of the Salsa dance exercises for about half an hour and most of them completed the entire game. Subsequently, a questionnaire was used for evaluating cognitive, emotional and behavioral elements of the students' attitudes towards the use of the Salsa game-like application for learning the Latin dance Salsa. The subjects were asked to answer seven groups of questions that concerned the game scenario, the visualization elements of the game, the accuracy of the user performance evaluation, the sensor set-up, the usability, the learning experience and the perceived performance of the game. The subjects used the following scale (from 1 to 5) to rate each question: 1. Strongly agree, 2. Agree, 3. Neither agree nor disagree, 4. Disagree and 5. Strongly disagree. The results for each group of questions for both Group A and Group B are presented below.

Game scenario: This section presents the key outcomes derived from the analysis of the questionnaires regarding the game scenario of the salsa game-like application. This group consisted of six questions, depicted in TABLE I. The average ratings obtained from the answers related to the satisfaction of the users regarding the game scenario of the game are shown in Figure 10. The average value for the 1st Group of questions is 4.61 (SD 0.13) for Group A and 4.56 (SD 0.4) for Group B. Therefore, it is clear that both Groups A and B made a positive assessment and stated that the game scenario was satisfactory, the objectives of the game were clear, the instructions offered were helpful and the order of the offered activities helped them learn Salsa in a progressive way.

TABLE I. 1ST SET OF QUESTIONS REGARDING THE GAME SCENARIO

Q#	Questions
Q1	I have clearly understood the objectives of the game.
Q2	I found the game scenario clear and satisfactory.
Q3	I have easily understood what I have to do in each activity of the game.
Q4	I think that the sequence of offered activities helped me to learn how to dance Salsa in a progressive and smooth way.
Q5	The "Getting started" section was informative.
Q6	I found helpful the instructions offered by the virtual tutor.

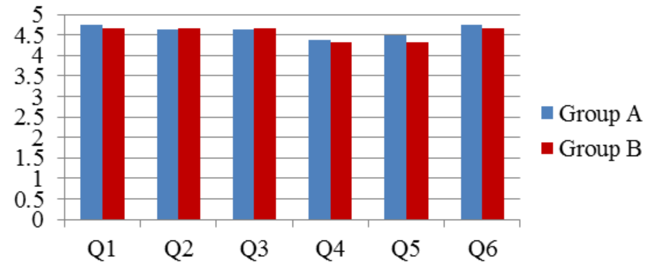

Fig. 10. Average ratings for the 1st set of questions regarding the game scenario

Visualization: The 2nd set of questions consisted of six questions presented in TABLE II. regarding the evaluation of the visual elements and graphics of the game-like application. The average ratings obtained are displayed in Fig. 11. The average values were 4.52 (SD 0.29) for Group A was and 4.62 (SD 0.12) for Group B. The results show that both groups found the animation system of the game accurate and the visual elements of the game satisfactory, pleasant and helpful.

TABLE II. 2ND SET OF QUESTIONS CONCERNING THE VISUALISATION ELEMENTS OF THE GAME

Q#	Questions
Q1	I found the 3D game environment pleasant in terms of design and aesthetics.
Q2	I found the appearance of the expert and learner dancer avatars satisfactory.
Q3	I found the visualization of the dance movements by the avatars accurate.
Q4	I found the animations performed by the virtual avatar of the expert helpful in order to learn the basic movements of Salsa.
Q5	I found the video of the expert helpful in order to learn the basic movements of Salsa.
Q6	I found the practice of the dance movements and the watching of the virtual avatar at the same time comfortable.

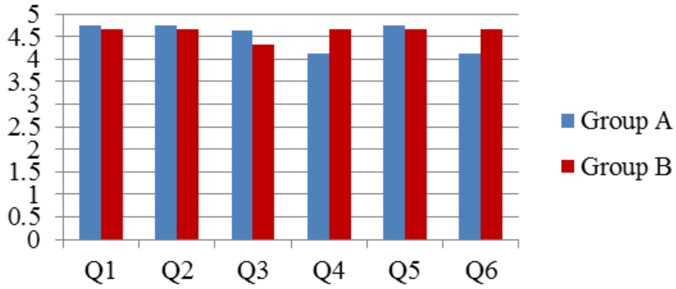

Fig. 11. Average ratings for the 2nd Group of questions concerning the visualization elements of the game

User Performance Evaluation: The 3rd set of questions (TABLE III.) included four questions about the evaluation of the user performance and to what extend the subjects thought that the score they received after completing an exercise was accurate. The average ratings are displayed in Fig. 12 for both Group A and Group B. The average values were 3.75 (SD

0.78) for Group A and 3.58 (SD 0.64) for Group B, which reveals a mixed attitude regarding the accuracy of the evaluation system of the game. Both Groups A and B stated that sometimes they had to perform an exercise many times because they hadn't understood what they had to do (Q3), a remark that reveals that the feedback and guidelines provided to users before and during each exercise could be improved. However, both groups agreed that the evaluation system was accurate and the feedback they were receiving during the practice mode helped them improve (Q1 and Q2).

TABLE III. 3RD SET OF QUESTIONS CONCERNING THE USER PERFORMANCE EVALUATION.

Q#	Questions
Q1	The evaluation score displayed in the screen at the end of each exercise helped me to understand when my movements were not correct and, thus, I improved/corrected my dancing performance.
Q2	I found the evaluation algorithm used by the game accurate.
Q3	I didn't have to perform some exercise many times because I could not understand what to do.
Q4	I didn't have to perform some activity many times because the evaluation of my performance was not accurate.

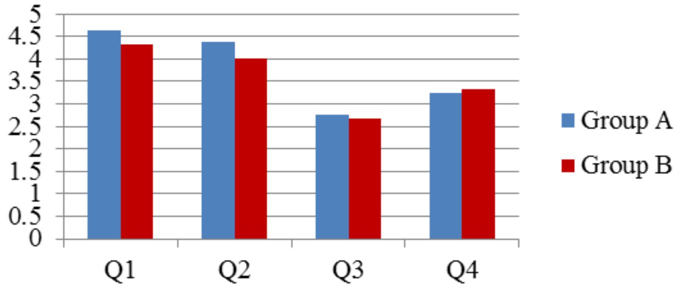

Fig. 12. Average ratings for the 3rd set of questions regarding the evaluation system.

Sensor Setup: The 4th set of questions concerned the attitude of the subjects towards the setup and use of the Kinect. This group consisted of four questions, shown in TABLE IV. . The average ratings are displayed in 0 and average values are 4.19 (SD 0.76) for Group A and 4.25 (SD 0.43) for Group B. Therefore, it can be assumed that both Group A and B have a positive attitude towards the use and set-up of the sensor and believe that it would not be a challenge for them to use it on their own in the future (Q4). However, especially Group A (beginners) and less Group B (experts) admitted that the presence of the Kinect sensor caused a degree of annoyance to them (Q3).

TABLE IV. 4TH SET OF QUESTIONS CONCERNING SENSOR SETUP.

Q#	Questions
Q1	I easily understood where I should stand (in which area) when practicing the dance movements.
Q2	It was comfortable to dance within a specific area so as to be captured by the sensors.
Q3	The placement of sensors did not cause any disturbance to me and did not affect my performance.
Q4	It will be easy for me to handle the sensor(s) by my own.

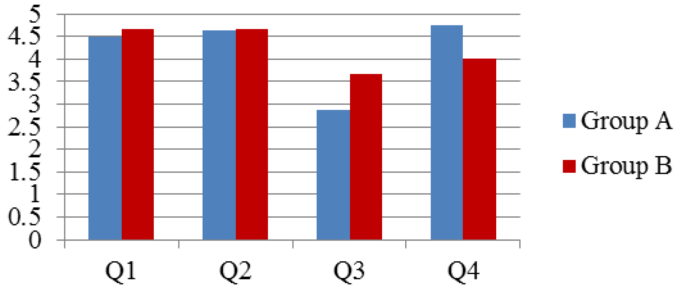

Fig. 13. Average rating for the 4th set of questions regarding the system setup.

Usability: The 5th set of questions (TABLE V.) included six questions regarding the usability of the game. The average ratings are displayed in Fig. 14 and the average values were 4.17 (SD 0.29) for Group A and 4.17 (SD 0.42) for Group B. Although results show that both groups found it easy to learn to play the game and use the visual elements of the UI, the Group A (beginners) stated that the existence of several windows in the screen sometimes caused them confusion (Q5).

TABLE V. 5TH SET OF QUESTIONS CONCERNING THE USABILITY OF THE GAME.

Q#	Questions
Q1	It was easy to learn how to play the game.
Q2	I would be able to learn how to play the game alone (without any external guidance).
Q3	It was easy to perform the different activities.
Q4	It was easy to follow the avatars' movements and practice them myself.
Q5	I found the existence of several windows in the screen not to be confusing and annoying.
Q6	I found the general feedback provided by the game satisfactory.

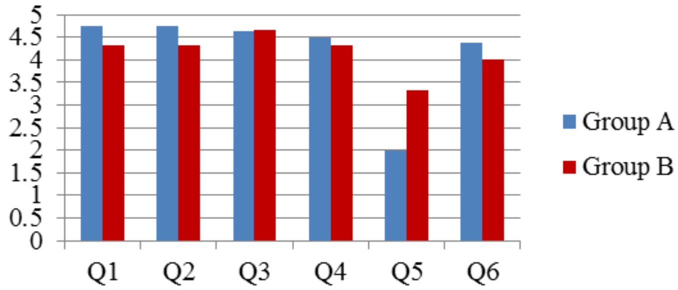

Fig. 14. Average rating for the 5th set of questions regarding usability.

The Learning Experience: The 6th set of questions concerned the educational effectiveness of the Salsa game-like application. This group consisted of fourteen questions, presented in TABLE VI. The average ratings are displayed in Fig. 15 and the average values are 4.07 (SD 0.7) for Group A and 3.93 (SD 0.93) for Group B. Taking into account the key outcomes, it can be assumed that both Group A and B evaluated in a positive way the educational character of the game. However, although the Group A (beginners) found the game more enjoyable and easier compared to traditional methods of dance teaching, they were not convinced that their short time period of using the game helped them learn the basic steps of salsa (Q5). On the contrary, Group B (experts) expressed a very positive attitude towards this question. Moreover, both Groups A and B stated that it would be useful for the learners to be able to contest against each other and to be able to view the instant score of their performance during the practice of the exercises. Such additional features would be considered as positive improvements for the game.

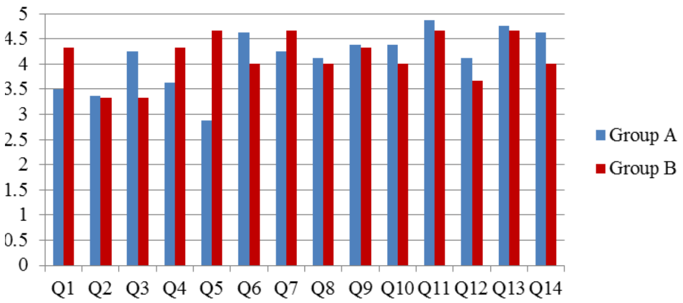

Fig. 15. Average ratings for the 6th set of questions concerning the learning experience.

TABLE VI. 6TH SET OF QUESTIONS CONCERNING THE USERS' LEARNING EXPERIENCE.

Q#	Questions
Q1	I found the activities satisfactory.
Q2	I think that this game makes the dance learning experience easier compared to traditional techniques (e.g., observing a teacher live).
Q3	I think that this game makes the dance learning experience more enjoyable compared to traditional techniques (e.g., observing a teacher live).
Q4	I would use a similar game to learn how to perform some other dance by myself.
Q5	The game helped me to learn how to dance Salsa.
Q6	I did not find the game stressful in any way.
Q7	I had fun playing the game.
Q8	I think that the game respects the tradition of Salsa dance.
Q9	I would like to see such a game or similar technologies included in the educational process of my school/organization.
Q10	I would find it interesting to be able to contest against other individuals for the best dance performance using this game (i.e., support of multi-player scenario).
Q11	It would be helpful to be able to watch a video focusing on the virtual avatar's legs in order to learn the basic movements of Salsa.
Q12	The addition of the overlay of the virtual avatar and the user ghost image helped me would help me to improve/correct my own dancing performance.
Q13	It was useful to be able to navigate through the 3D virtual environments and change the position of the virtual camera (zoom in/out, rotate virtual avatar).
Q14	It would be helpful to be able to watch the evaluation score displayed on the screen during the activities.

Perceived Performance: The last set of questions (TABLE VII.) consisted of four questions regarding the general perceived performance of the game by the subjects, i.e. to what extent users found the game to be effective, efficient, satisfactory and innovative. The average ratings are shown in Fig. 16 for both Group A and Group B. The average outcome of the questions was 4.63 (SD 0.36) for Group A and 4.5 (SD 0.17) for Group B, showing that both groups shaped a very positive attitude towards the game in general.

TABLE VII. 7TH SET OF QUESTIONS CONCERNING THE PERCEIVED PERFORMANCE OF THE GAME.

Q#	Questions
Q1	The Salsa game is effective (if the game meets its objectives).
Q2	The Salsa game is efficient (if the game responses satisfactorily and in a short time).
Q3	The Salsa game provides satisfaction (if the game provides satisfaction to the user).
Q4	The Salsa game is innovative (if the game offers novel tools/ techniques in ICH transmission).

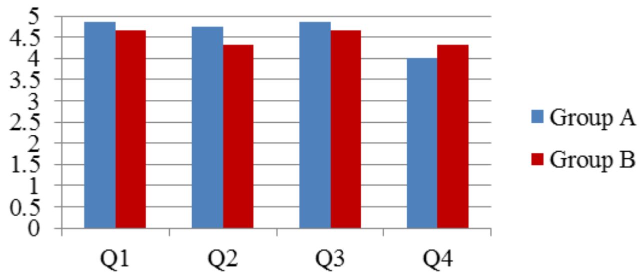

Fig. 16. Average ratings for the 7th set of questions concerning the perceived performance.

IV. CONCLUSIONS AND FUTURE WORK

This paper presented a novel adaptive framework for the easy and rapid design and creation of serious game-like applications for learning full-body gestures (e.g. dance steps) by imitating the pre-recorded performance of an expert. We proposed a novel game design system which supports motion capture data based on an inexpensive Kinect sensor and we briefly presented the architecture and main features of an educational body-motion-based interactive game. Experiments with different users, both beginners and experts that evaluated a game-like application for Salsa learning showed that the use of such a game-like application can be very efficient, as positive feedback was obtained.

As future work, we will consider introducing more meaningful feedback to the users, such as the display of an instant score in the practice mode, which will readily indicate to the users how well they are performing during the different phases of an exercise. Moreover, we will work towards adding more adaptation mechanisms, so that the games become more personalized according to needs of the users and each use case. Last but not least, we may also examine the addition of more game scenarios (i.e. a multiplayer game), which could significantly improve the users' engagement.

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