Real Time Trainer with Kinect

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Abstract—The present paper is related to a Real Time Trainer which trains in dance exercise by using Kinect. The paper comprises a trainer system and a user. The trainer system is trained in advance and keep the recorded data, by a good dance person, which help the user to lean dance steps correctly. In this paper, we design a Kinect-based training. The system consists of an analysation tool which compare the recorded or reference data with the user data and generates a report accordingly. Any mismatch will be displayed to the user, therefore he/she can correct the step or start the exercise from initial step. The assessment method enables the evaluation of resemblance check of dancing postures and also identifies the time difference or lag/lead between the movement of tutor and the time of action of the user.

Index Terms—Trainer; exercise; posture; assessment; Kinect.

I. INTRODUCTION

The extremely essential thing for staying healthy is exercise in human life. In this paper the motivation of present work and focus is on dance as a type of exercise. One can get 3 profits by doing this dance exercise are:

(1) It improves health of human being that is associated with day to day life of a person;

(2) Secondly, improvement in body and refreshing of mind in, short it would help in improving physical health;

(3) Thirdly, it would help in improving social environment by improving social relations with people.

The training can be taken by a Virtual tutor now a days, it has become a great application for real life as a home-based training system for getting some knowledge about exercise or training. By this exercise can be done at home without any other person requirement for guiding exercises can be done on repetitive mode as much as we want, without disturbing any person when dance step is not correctly performed. Presently, the work is done to improve 2 areas i.e health promotion (e.g. rehabilitation training) and dance exercise. The trainer assessment using Microsoft Kinect is employed for discussing designing of trainer. The trainer as an assessment system would give a notification to users related to results based on the performance by displaying ratings. The main aim of the paper is to achieve the results of matching by comparing 2-action data, and to find similar ground in between 2-actions. The data is fetched for evaluating the action by of the user by comparing with static data of the virtual tutor.

In paper [1] an application for real-time movement for human to fetch the information by a video present in database and motion is performed by assessment with Kinect, for receiving the difference between 2-postures. The evaluation of 2-poses in the paper is done by fetching statistical data a video posture executed and then saved in the database, following the similarities between 2-poses and then identifying the correct pose based on time. With the help of a virtual trainer one is capable of learning dance exercise. A 3-D unit displays the dancing actions and the person just required to track the action performed in training of virtual dance, and OpenNI – Open CV would show a video of dance at that time, and the appearance of user takes place on another screen. The paper has some similarities with the reference paper whose chief parameter is time. Different parameters that have been taken into consideration are the path length for determining the each data point distance, the time required for action, co-ordinates of data point coordinates of 2-actions, and the action flow error which will arise while performing.

Initially, the posture of the person is captured by the present system by using Kinect and then for identifying each and every joint, the skeletal information is acquired depending on system parameters. Secondly, the data of action would be generated by the system with the help of the trainer's data which is taken as a reference data. Fetching of data and then processing it is managed in the system to compare different data and then accordingly gives results. Next, is to calculate the distance related to the period of time, an average extent at each and every data point consistent to the frames/second generated by the system. The default value is 30 frames/second (fps) data has been used and caught with the help of Kinect.

The association of present paper is as follows: part II is the system systematic framework, part III describes the methodology, part IV displays the different results got by the methodology, and part V concludes the work done.

II. SYSTEM FRAMEWORK

There are two users that have been taken for the system implementation one is a trainer and another is a student; for recording the data action combined in the three dimensional model-trainer a real dance trainer generates a trainer. The dance is performed by the second user which is student that learns from virtual trainer. In this part of the project, the tools which have been used for the advancement in the work are also introduced.

A. Tools

The tootls that have been used are: an input device *'Microsoft Kinect'* in combination with some of the softwares, such as *'Miku-Miku'* Dance, *'OpenNI2'*, *'Unity3D'*, *'NiTE'*, *OpenCV3*, and system compiler that is Visual Studio. In paper [2] it is discloses the beginning of Kinect with various advantages which have applications in various fields, for example in tutoring, industries, individual, etc., these all use the Kinect to achieve the aim in different fields. Prospectively, the system has been implemented to achieve the goal. This device is used in the system for improvement here,

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it generates data out of fifteen joints present in skeleton of a human body. Kinects captures the video and it is shown with the help of associated 'OpenNI2' and 'OpenCV' with 'NiTE' library that provides a precise skeleton of the user joints tracing, gesture identification, and many more. A Three-Dimensional model has been developed that acts as a virtual trainer with the help of a Unity3D data is input in the model, and then model would perform accordingly. The positioning is done as shown in Fig. 1, to record real trainer's the data action and data related to action of the second real time user (when the system is in process). The generation of data is done at a ground position, whether in Kinect position or in real coach/user real-time. The distance between user and the trainer is adjusted manually.

Where d = 2.5 m, distance between trainer and second user; and

'h' is the height of the device from the ground, where h = 1.0 m, to reflect the ordinary coordinates of the three dimensional level with corresponding Kinect device.

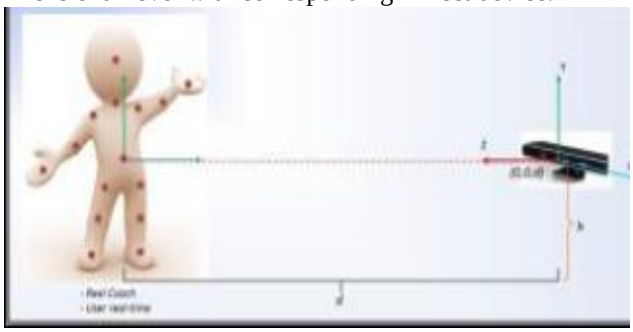

Figure 1.Positiong of recorded Data (Trainer) and Captured Data (Real-time User)

B. *User's Real-time System*

The exercise in dance form is accomplished by the real-time by following the steps performed by the trainer which is the first user of the system, thus by doing the action real-time data is generated by the student (second user). Firstly, the performance of the student is captured using a Kinect device, and corresponding video has been displayed by an 'OpenNI – OpenCV'. By doing this the student is able to see the action performed by himself and easily can find an accurate location for starting the dance exercise, Various instruction are displayed by the system for the student and the only thing that the second user or the student has to follow those instructions.

C. System Architecture

From Figure 2 illustration of various tools and the software that generate the data to get the result after the evaluation. There are two phases involved in the system are online and offline phases, correspondingly, illustrated in Figure 3. In case of online phase, a video will be displayed that comprises of multiple actions and that would be seen to the student, and the user is just required to track the way of different commands. When the track of movements is displayed then user is capable of following the track in the online part in addition with tracking the actions of the trainer related to the virtual model.

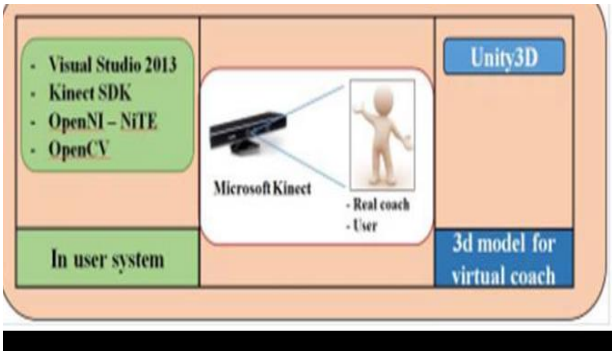

Figure 2. The System Architecture

The evaluation process present in system is only to train the student for doing accurate steps by generating a report based on the performance which ids compared to the data fetched from the system trainer. For initiating the action of exercise, the accurate position should be initialized by the user. Later, remains the actions continuous and identify the error in action when student is performing. More particularly, the system notifies error part and the student selects for the procedure of training in the definite part (unmatched part) or he/she will start the performance from the initial position.

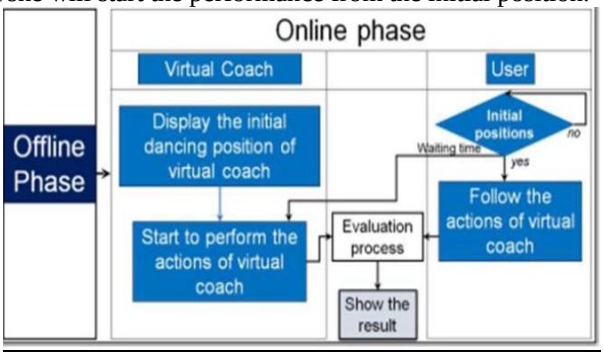

Figure 3. The System Model of Online Phase

Figure 4 is the flow process for online phase model. The process of comparing, matching and the accordingly scoring is shown in the figure.

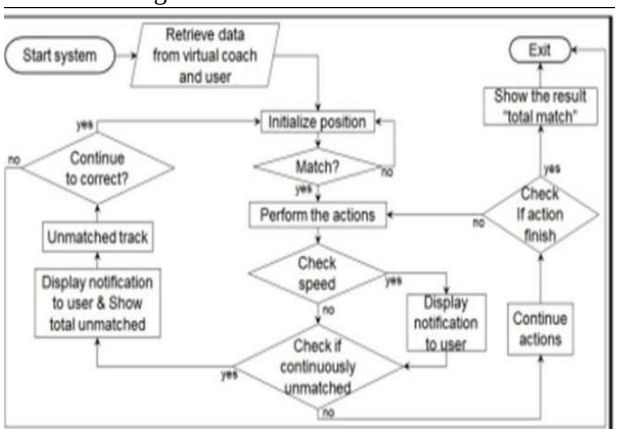

Figure 4. Flowchart of Online Phase

III. METHODOLOGY

In the present part of the paper this that will be discussed are estimating the action by the contrasting algorithms, and some considered parameters such as time period, co-ordination points for each joint, error detection parameter, and distance.

A. Movement Estimation

There exists multiple methods to estimate the similarities between movements are, a general similarity method which works on sequence alignment, signal and vector encoding, and time twisting etc. Paper [1] Beforehand refers to a method of resemblance measurement between 2 postures by using improved '*DTW'* method.

The present method finds the similarities between two movements by comparing the movements and parameters are considered:

1. Time period:

For providing synchronization between the trainer and user, a start has to be chosen as a (after initial position) for the student however trainer can be controlled by coming up the user by pushing a button present in the system called start button for the trainer. It is assumed parallel total time action, and regulate in recording procedure by using the previous way.

2. Points:

There are some points created by the first user that is trainer of the system and to get synchronized with the trainer user has to match those created points, known as point synchronization.

3. Distance:

The error coming between student's moving positions and trainer's moving position is called as distance. The value for the distance can be less or more depending on the action or movement which can be slow or fast. This can be evaluated by equating the points of trainer and the user. The universal equation to calculate distance is as follow:

$$d = \sum_{i=1}^{n} \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})} \quad (1)$$

4. Error in Actions

It is calculated when there is a mismatch between actions and there are 2 parts, first one is 5 times constantly matchless; and second state is situation of extremely fast and extremely slow motion, to train the user. F calculating the first type of error situation that is inspection if constantly mismatched for five times (e.g. t3 to t8), then it will be shown to the user. After this user is capable to stop the mismatching or will start the movements from initial position. For identifying the contrast point (match point) in a time interval 0-t, the method which is used in the present paper takes the half (50%) part out of total frame (30 frames/second have been used). There are 15 fps arbitrarily matched from 30 frames, therefore tN is reckoned as matched, else tN is an mismatch and continues for the following time t until n>5.

B. Matching Actions and Scoring Result:

Initially, define the matched and mismatched points between trainer data denoted as 'x' as a 1st record of data and user data denoted by x'. The1st data record has a range of $-10 \leq x \leq 10$. Then, the ratio of trainer point and user point i.e (x': x) is calculated to recognize the identical points. For a time interval t=0 to t = 1 sec, thirty frames are generated (30 frames = 30 points). For each and every point, true situation is represented by 1, else it is 0.when total numbers of true situations are greater than 5 times in a time interval 0 to t then it is considered as matched action otherwise mismatched action. For the calculation of similarities between matched and unmatched data, the formula is given by:

$$\text{Matching action} = \frac{\sum_{t=1}^{n} \text{matched data}}{\text{all data}} * 100\% \quad (2)$$

$$\text{Unmatching action} = \frac{\sum_{t=1}^{n} \text{unmatched data}}{\text{all data}} * 100\% \quad (3)$$

IV. EXPERIMENT AND RESULT

The experiment id performed in various steps wherein first step is recoding the different action done by a good dancer. For this case a *'Slow Tap Dance'* is employed that emphases on timing period and various beats. Subsequently, the data of real trainer is saved with some input which is processed into the system model and it is treated as a reference data (fix data) for comparing, the calculations of similarity and then scoring of output results. Some of the figures are shown below as a result of experiment.

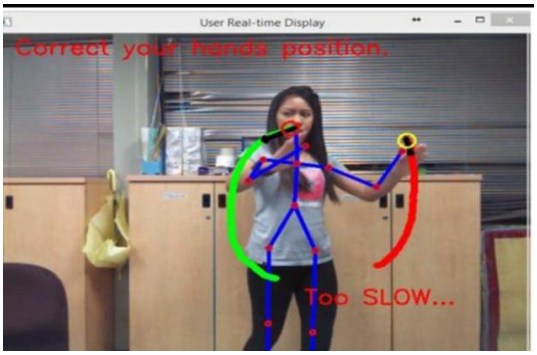

Figure 5. The Action Performed by User.

Figure 6. The Action Performed by Trainer

From equation 2 and 3 the comparison is done which is shown in following table I.

TABLE I. SCORING RESULT

Compare Data	t					Result	Scoring (%)
	t_1	t_2	t_3	t_4	t_5		
Trainerdata(x)	1	0	1	1	1	matched	66.67%
and	1	0	0	1	1	matched	60.46%
userdata(x')	0	0	0	0	0	unmatched	97.33%

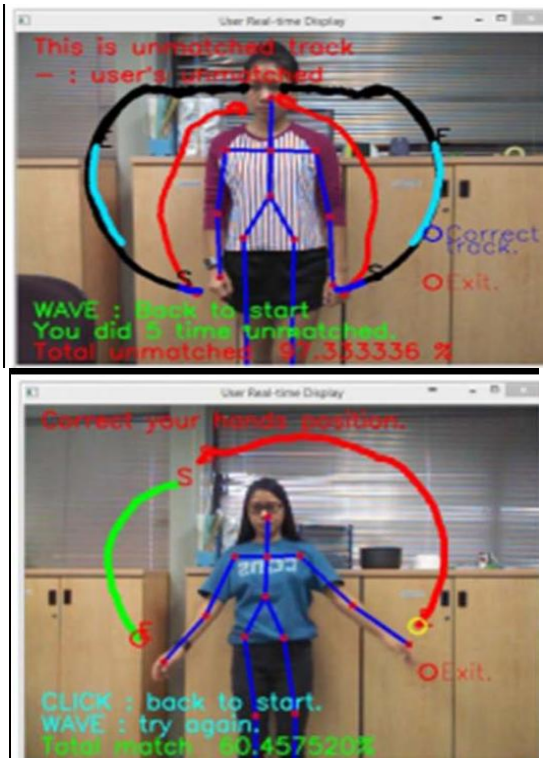

Figure 7. Scoring result in percentages

V. CONCLUSION

A trainer system to train the user in dance exercise has been implemented which uses Kinect. The user would get the alert notification according to the performance. The system successfully shows the scoring by determining mismatching between the data of user and trainer. The system provides various profits like enhancement in efficiency and cost efficiency, dance exercise performance of the user can be improved by the system. The system is used for but not limited to dance exercise, rehabilitation's action can be seen from simulations.

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