Poster: RealDance: An Exploration of 3D Spatial Interfaces for Dancing Games

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Abstract

We present RealDance, a prototype video game for exploring spatial 3D interaction for dance-based gaming and instruction. Our interface uses four Nintendo Wii remotes and is independent of buttons, floor position, cameras, or sensor bars so the user is untethered, allowing for natural, full-body motion. Our range of detectable movements includes stationary poses, punches, kicks, claps and stomps, which are scored in the context of the dance routine. We describe our initial experiments in interface design, gesture evaluation and scoring, and user experience, which reveals interesting new areas for 3D spatial interaction research related to creating an 'ideal' dance game.

Index Terms:
I.6.3 [Computing Methodologies]: Methodologies and Techniques—Interaction Techniques;
K.8 [Computing Milieux]: Personal Computing—Games

1 Introduction

One of the main reasons behind the popularity of the Nintendo Wii has been the higher degree of physical motion it supports compared with other video game systems of the past and present. Having motion-based tracking controllers broadens the appeal to casual gamers, who may feel uncomfortable with most traditional gamepads and the keyboard and mouse. However, software developers often struggle to find new domains well-suited to this hardware, delving into sports, music, and even cooking. One genre with a lot of potential is dancing games. The success of previous console software titles has proved that dancing is a fun activity most people are willing to try in video game format [1, 2]. In addition, dance games can be used for fitness purposes or even as a training tool for dance moves.

However, current dance related games have several limitations. First, the input devices are too simplistic to reflect the range of motions used in dancing. For example, Dance Dance Revolution, one of the most influential and pioneering games in the genre, only requires carefully timed stepping on a pressure-sensitive mat. Second, with motion detecting devices, such as Wii Remote controllers (Wiimotes), players can often 'cheat' the game by using the motion detection ambiguities inherent in accelerometer-based input devices. Also, real-time dance instruction often requires interpreting icons at high speeds, a skill that has little to do with dancing and can be difficult for new gamers that do not have previous experience reading and reacting to fast moving graphics.

With RealDance, we have been working toward an 'ideal' dance game experience: one where the user feels like they are dancing naturally through a 3D spatial interface, and that their feedback is directly tied to how well they complete each movement.

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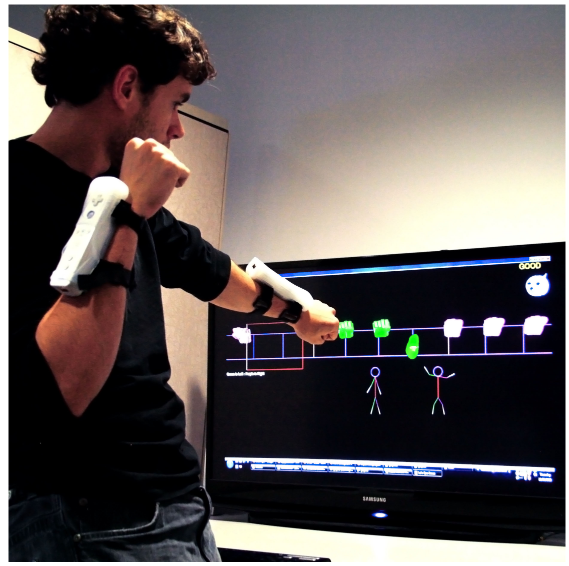

Figure 1: RealDance in action.

2 Related Work

Analyzing the capabilities of the Wiimote is a relevant and important area of research. Early video games on the Nintendo Wii console led to disappointing results for users that expected a more full-body experience. This led researchers such as Lee to explore how Wiimotes could be used to cheaply approximate hardware that is too expensive for the average consumer [7]. Other papers focus on trying out many different tasks that the hardware might be suited for [9]. We chose to investigate the Wiimote's usefulness in full body interfaces because it is commercially affordable and easy for the consumer to access.

In contrast to the relatively new study of Wiimotes, analyzing full body motion has been around much longer. A variety of hardware solutions have attempted to capture the motion of dance as digital data [8]. For the most part the input devices are inertial devices, giving the ability to record and assess the qualities of a dance adequately [5, 6]. However, much of this equipment is complicated to use and install and not accessible to the public.

3 RealDance System Description

RealDance incorporates a visual interface to tell the user what dancing moves to perform, a hardware setup to capture the moves and a gesture recognition system to score them. We have explored each of these concepts by implementing a prototype using XNA, C#, and the Bespoke [3] game framework in a Windows environment.

Interaction with our system occurs as follows: A user attaches four Nintendo Wiimotes to their body, one on each wrist and one on each ankle. Once in place, they can choose from a selection of songs. Each song is represented by a timeline of dance moves and an avatar that visually shows what they are expected to do. Users are graded on their performance by the timing of their movements as well as the correctness of their actions. When the song ends, they are given a percentage based score and may play another song if desired.

3.1 Visual Interface

Communicating the dance sequence to the user in an intuitive and efficient manner is critical in dancing games. As previously mentioned, the typical means of conveying this information is through a scrolling series of icons that are interpreted by the user. We implemented such a system, where the shape and color of the icon indicate the action. The stream of icons moves so that each icon passes over a marked line at the instant that the move should be completed.

We have also provided an animated avatar that performs the dance in time with the music. During the dance, the user can follow along with the avatar's movements, duplicating the actions taken. In this approach, the user does not need to interpret the icons, reducing the experiential barrier to playing the game. Mimicking the avatar's observed motions is also a more natural approach, closer to how dancing is traditionally learned.

Feedback to the user is provided by the final score as well as real-time visual cues. In our prototype, an additional stick figure avatar mirrors the user's actual motion, allowing the user to understand how their movement compares to the desired action. The user's timing score for each move is displayed in colored text on the screen and performance quality is indicated by the facial expressions of a cartoon character. In addition, since RealDance contains several popular songs with recognizable dances, we play the music videos in the background to increase motivation.

3.2 Gesture Scoring

Our system is different from traditional gesture recognition configurations. In most machine learning algorithms involving the Wimote, gestures are defined by the duration of a button press. Since one of the key design components of our interface is that the user is not required to push buttons, we had to define a different metric to determine the start and stop of the gesture. Music can be defined in terms of signals over time, so determining gesture duration by the measures in the song was a logical direction to head in. Since the choreography is pre-determined, and we know what action we expect at any given time, we can cut up the song into segments which are a beat or a measure in length. Then these timed segments can be evaluated separately.

However, this introduced a whole new way of approaching the gesture recognition problem. Rather than having a system which 'listens' to the controller input and classifies it by the most likely gesture from the collected features, we know what gestures we expect and when, even before runtime. This focus necessitates a different approach to the project that traditional machine learning algorithms aren't suited for.

We used several categories of motion to give diversity to our performance evaluation. An impulse motion, like a punch, is characterized by a rapid deceleration occurring on the peak of the move. An impact motion, such as a stomp or a clap, is distinguished from an impulse motion by the presence of a sudden shock when two surfaces collide. For a freeze pose, the user stands still in a specific posture for a certain number of beats. We detect these types separately using functions based on timing and acceleration.

4 Discussion and Future Work

Through the development of RealDance we have addressed a number of issues unique to dance gameplay. Our goal from inception was to solve existing problems in the genre, but other interesting details surfaced as well. Using data from both arms and legs forces the user to involve all four limbs and not cheat. A player only achieves an exceptional score for acting within a certain time or data window; simpler movements will not score as well. There is no absolute positioning required, allowing for a greater range of free movement. These aspects of interface brought us closer to an ideal dance game experience.

One of the focuses of our current design was to get as much information about the user's movements as possible within the limitations of four accelerometers. With more knowledge about the user's body we can detect more specific movements. In early 2008, Nintendo revealed their latest inertial hardware, the Wii Motion Plus [4], a device which will incorporate gyroscopes into the Wiimote controller. Our lab has developed an equivalent prototype which could be included in future gesture scoring methods.

In our experimentation, we also discovered an unexpected problem: how to convey information to the user via a visual language. As the icons stream across the timeline, the user has only a limited amount of time to interpret and react to each intended action. A more cohesive icon language is needed to keep the visual display readable and enjoyable when the complexity increases.

Finally we were able to identify different teaching methods by varying the simplicity of the icons and the timed movements of the instructor avatar. Since almost all commercial dance games feature only an icon stream as instruction, we have not seen a direct usability comparison involving several ways of conveying information to the user. We want to present several choreography visualizations in a formal user study to determine which method is most effective.

5 Conclusion

We have presented RealDance, a game prototype we believe is moving toward the next generation in 3D spatial user interfaces for dancing entertainment. We offer a new perspective on how to better communicate dance-related information and to provide a sensation of actually dancing. By incorporating visual feedback, an on-screen instructor, and a timeline coupled with wearable motion-based controllers, we hypothesize the game play is easier to understand and more usable as a game as well as a teaching device.

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