DIVE: Developing a Virtual Environment to Teach Computational Thinking through Dance

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Abstract

The possibilities of what can be achieved with computers are nearly limitless, and, because of this, there has been an increase in the interest of the computer science fields. For instance, the 2011-2012 school year granted the most doctoral degrees ever in the area of computer science. Although the demand for personnel in the computer science field is increasing the CRA Taulbee Survey results show that there is a distinct lack of representation of women in the field [1]. The goal of the Dancing in Virtual Environments (DIVE) project is to introduce young girls to computational thinking, a skill valuable for computing careers. In DIVE, we will pioneer the design, development, and testing of a virtual environment for blending dance and programming as a novel and embodied way to engage 5th and 6th grade girls with computational thinking. We hypothesize that girls creating dance performances for their virtual characters and using their bodies to think through the actuation of the characters should bootstrap their intuitive knowledge in order to learn computational concepts, utilize computational practices, and develop computational perspectives. This paper presents the three iterations of a virtual environment that have been developed.

Project

The goal of this research is to develop a desktop-based virtual environment in which students must program a 3-dimensional character that they can later perform with. In the first iteration of this work, we built on top of the Carnegie Mellon University created Alice, a programming interface specifically designed to teach object-oriented programming in an accessible fashion. In the current version of Alice, in order for a character to move in a dance-like fashion such as lifting or turning an arm or other appendage, there are a lot of commands necessary. The necessity of multiple commands for a simple move is not ideal for creating a full dance. In order to simplify this process, we created basic methods within Alice to support basic dance moves (e.g., arm positions, foot positions, head positions) on an existing Alice character. These positions could be placed in commands together in order to create more complex movements, and then dances. However, the quality of the Alice avatar did not meet the requirements of DIVE goals. The avatar could only be rendered at low quality and did not have realistic joints and limbs when performing a dance.

In the next iteration, we created a minority female character in Maya. When building the character an individual piece of geometry had to be modeled at every joint that needed to move. Then, an alternate rigging through parenting created a hierarchy to control the limbs. Once this was accomplished, the character was textured (i.e, given a visual appearance) and exported to a format that Alice accepts. This platform was used in a pilot with nine middle school children. The limitations of the character prevented the students from creating realistic dance moves. For example, some students created motions that were not (typically) humanly possible (i.e., such as floating in the air, flipping upside down repeatedly), or moving the legs to such a degree that the limbs would detach from the body. Further, we noticed that students immediately wanted to

change the characteristics of the dancer to be male, to change her clothes, to change her ethnicity, and to change her body, often replicating their own identifying characteristics. This was not possible with the character we created. Finally, there was little fidelity to realistic dance movement since the character was only able to move limbs and nothing in between.

To improve upon these previous limitations, in the current iteration, we are using mixture of Unity3D development and motion capture animation to produce an environment that will be both intuitive and lifelike. By using top-notch animation quality, the students will be able to program believable dances and receive output that will reinforce computing knowledge. Thus far, the initial infrastructure of DIVE has been developed in three stages, pre-development, programming and modeling, and motion capture.

Technical Development

To begin with, the pre-development stage focused on planning and getting familiar with the methods used to build the application, Unity3D and Vicon Blade Motion Capture. The Vicon Blade motion capture system is a pairing of both software and hardware needed to capture human subjects in 3D virtual space. The motion capture setup includes 14 infrared cameras that send infrared light to markers placed on the subject. From there, a user can record the motions in capture sessions. The user must then post-process the captured data and build a skeleton that holds the animations. This skeleton can then be exported to a 3D Modeling and animation software and be rigged to create an avatar for use in Unity3D.

The development stage created the initial functionality of the DIVE including an animation queue control, limb-based clip selection, output feed, and camera controls. Each set of functionality had varying levels of frustration and difficulty in their creation. For example, the animation queue had to be developed using both normal scripting practices but also with Unity's own animation queue object. During the motion capture phase, the DIVE team captured a talented dancer doing both ballet poses and the "Cha Cha Slide." This data is captured, post-processed, and can be added to the application in the near future.

In order for the program to be successful, there needed to be high-quality and realistic dance movements involved. Therefore, we needed a talented dancer that could perform during a motion capture session as naturally as they would be dancing in a practice studio. The team planned motions and decided to use a popular dance the "Cha Cha Slide" for the summer demo. Also, more dances were desired so that there would be motion capture data around for later use. The dancer was also tasked with performing ballet positions first through fifth as naturally as she could. The motion capture sessions went very smoothly, and the data captured looked very realistic. After capturing the data, the team had to post-process that data which prepares it for being exported it to Autodesk Maya or Blender3D. However, obstacles were met after data was post-processed and future work needs to be done.

Future Work

In the near-future, the motion capture data needs to be applied to a more substantial model than the Iron Man test model. Due to time and travel constraints, the data was not applied

successfully. Also, functionality for saving the queue and previewing dance clips needs to be added to the DIVE application. Later on after a successful demo, DIVE will have functionality for user-created avatars, multiple high-fidelity virtual environments, and export features for viewing dances outside of the application.

Conclusion

By increasing exposure to computational thinking through dance, it is expected that there will be more interest in the computing fields in years to come, with a greater representation of women. The goal of DIVE is to develop an application that will allow young girls to program and perform dances while simultaneously exposing them to computational thinking. With newly acquired computing knowledge, they can be ready for positions in computing in the future.

References

[1] Zweben, Stuart, and Betsy Bizot. "2012 Taulbee Survey Strong Increases in Undergraduate CS enrollment and Degree Production; Record Degree Production at Doctorate Level." *Computing Research News*. 25.5 (2013): 11-13. Web. 5 Aug. 2013. <http://cra.org/resources/crn-online>.