

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/220878822>

Automatic adjustment of a virtual teacher's model in a learning support system

Conference Paper · January 2011

DOI: 10.1145/1958824.1958947 · Source: DBLP

CITATIONS

0

READS

24

2 authors, including:



Mamoun Nawahdah

Birzeit University

22 PUBLICATIONS 13 CITATIONS

SEE PROFILE

Automatic Adjustment of a Virtual Teacher's Model in a Learning Support System

Mamoun Nawahdah

Graduate School of
Library, Information
and Media Studies
University of Tsukuba
Tsukuba, **Japan**
nawahdah@slis.tsukuba.
ac.jp

Tomoo Inoue

Graduate School of
Library, Information
and Media Studies
University of Tsukuba
Tsukuba, **Japan**
inoue@slis.tsukuba.ac.jp

Abstract

It is known that a virtual teacher-model's position and orientation influence (a) the number of errors, and (b) the accomplishment time, in physical-task learning using mixed reality (MR) environments [1]. This paper proposes an automatic method to adjust the virtual teacher's orientation according to a given task motion. Through always showing the physical task's critical features regardless of changes in position, mimicking errors regarding the respective task are expected to be minimized. Thus, this research is considered to advance transferring skills of physical tasks. It can also be applied to remote collaborative work.

Keywords: Mixed Reality, Physical Task Learning, Remote Gesturing, View Control.

ACM Classification Keywords: H.1.2 [Models and Principles]: User/Machine Systems-Human factors. H.5.2 [Information Interfaces and Presentation (e.g., HCI)]: User Interfaces-Evaluation/ methodology; Training, help, and documentation.

General Terms: Experimentation, Human Factors.

Introduction

Using actual equipment in a real environment is known to be very effective in the case of physical task learning. MR technology supports this feature and allows exciting learning, in which learners can actively explore new tasks without the help of experienced instructors. Learners become actively involved in the learning process, and thus memorize more than without using MR [2]. The use of MR also enhances users' perception, and improves learners' intuitive interaction with the real world [3]. Systems have been developed which employ a virtual teacher to perform the physical tasks in front of the learner [4]. In the CSCW context, collaborative physical tasks have been investigated, and the use of deictic gestures is known to enhance task performance [5][6].

In light of these considerations, a physical-task learning support system was developed. This system shows a 3D virtual-teacher model in the real world, using mixed reality. The virtual teacher performs physical motions

that instruct the learner in the performance of the same motions in the real world.

In typical remote-mentoring tasks, the viewing angle of the worker to the helper -or the helper to the worker- has not been a significant issue [5][6], because the helper's hand gestures are typically displayed in the correct position for the worker to determine the proper task. However, in our research, we deal with physical tasks that need full body motion, and here there are many tasks demanding information regarding not only the manipulation of objects but how the helper's body itself is moved.

It has been shown in previous research [1] that a virtual teacher-model's position and orientation have significant effects on learning. The results show that the virtual teacher's close side-view is the optimal view for physical task learning that involves one hand motion. However, when the virtual teacher uses both his/her hands, or moves around, orientation adjustment becomes necessary.

In this paper, we introduce a novel method of automatically adjusting the virtual teacher-model's

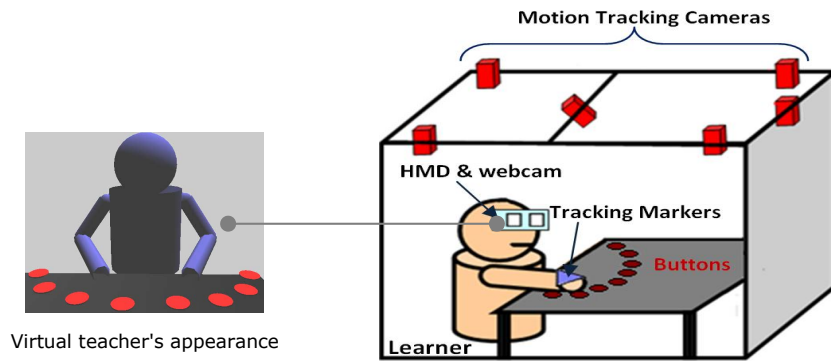


Fig 1. The MR learning support system's physical workspace.

orientation during run time. The automatic adjustment method is based on the virtual teacher's behavior, and more specifically on his/her body movements. The purpose of this method is to ensure that the virtual teacher's most moved body part is visible to the learner. This will enhance the learning outcome, and the learner will feel more comfortable and assured during learning.

The Experimental System Design

An MR learning support system has been built to test our automatic adjustment method (**Fig 1**). Six motion tracking cameras are placed above a table. Eight buttons are placed on the table. Button pushing is selected as a model task because it is a generic physical task. A 3D virtual teacher model is presented to the learner by a head mounted display (HMD). A program has been developed to render the learner's MR scene, which is a combination of the real scene and the generated 3D virtual teacher model. The real scene is captured by a small camera clipped on the HMD.

System Implementation

The automatic adjustment processing flow is shown in **Fig 2**. The system is divided into two main processes: initialization process and run-time process. During the system initialization, the virtual teacher's motion data is retrieved from a specific motion data file. Next, the motion data is split into small fixed-duration segments. For each motion segment, the teacher's optimum rotation angle is calculated. During system run time, the teacher's motion data is split into segments and displayed. Before displaying each segment, the teacher's orientation is automatically adjusted, according to a pre-calculated optimum rotation angle, so the main teacher's movement is facing the viewer.

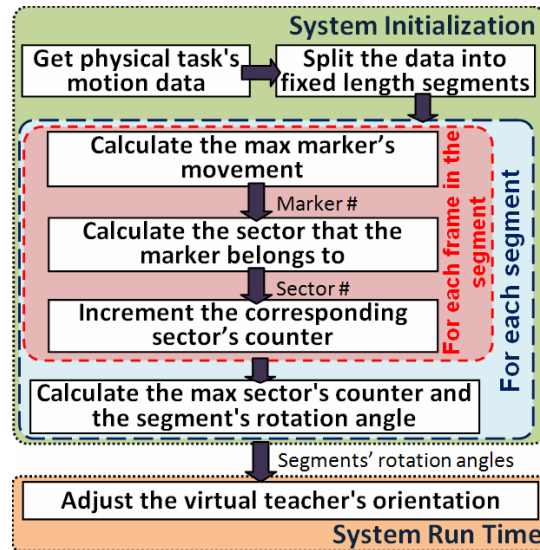


Fig 2. Automatic adjustment processing flow.

Preparing the Physical Task's Motion Data

The virtual teacher's motion data, which shows button pushing by the virtual teacher's hands, is prepared in advance by tracking and recording a real person's motion. To do so, 8 unique markers are placed on the main joints of the teacher's upper-body. The markers' 3-dimensional coordinate data (**X**, **Y**, and **Z**) are recorded at a 100 frame-per-second rate. Each line in the motion data file represents one frame of motion data, and each frame contains the 8 markers' position data.

Calculating Adjustment Angle

This process starts by reading the segment's motion data frame by frame. For each marker's coordinate data in the frame, the absolute marker's movement amount M_j is calculated based on the previous frame's data:

$$M_j = \sqrt{(X_c - X_p)^2 + (Y_c - Y_p)^2 + (Z_c - Z_p)^2}$$

Where j is the marker number ranged from 1 to 8. X_c , Y_c , and Z_c are the current frame marker's position. X_p , Y_p , and Z_p are the previous frame marker's position. Next, the maximum marker's movement MM_i is determined:

$$MM_i = \text{Max}(M_1, M_2, \dots, M_8)$$

Where i is the current frame number.

For this marker, which has the maximum movement, we calculate the angle O_i :

$$O_i = \text{Arctan}(Y_i/X_i)$$

The teacher's surrounding area is divided into eight equal sectors as shown in **Fig 3**. Each sector has an associated counter (C_1 - C_8). Based on the calculated O_i , the associated sector's counter will be increased by 1. Once all the segment's frames are processed the same way, the max sectors' counter value C_{max} is determined

$$C_{max} = \text{Max}(C_1, C_2, \dots, C_8)$$

This sector is assumed to be that wherein the most important motion has occurred. Accordingly, the segment's rotation angle (**SO**) will be set according to this sector's predefined angle (θ). The sector's predefined angle (θ) is calculated so that the sector's close side-view faces the learner when selected.

Resulting Views of the Virtual Teacher

A preliminary test was conducted to verify the actual performance of the proposed method. **Fig 4** shows the resulting views during the first two segments. During the first segment, the virtual teacher used mostly his/her right hand, and the teacher's orientation was automatically adjusted to **247°**. In the second segment, the teacher used mostly his/her left hand, and here the orientation was adjusted to **112°**. In each case, the learner was able to see the critical elements of the virtual teacher's motion.

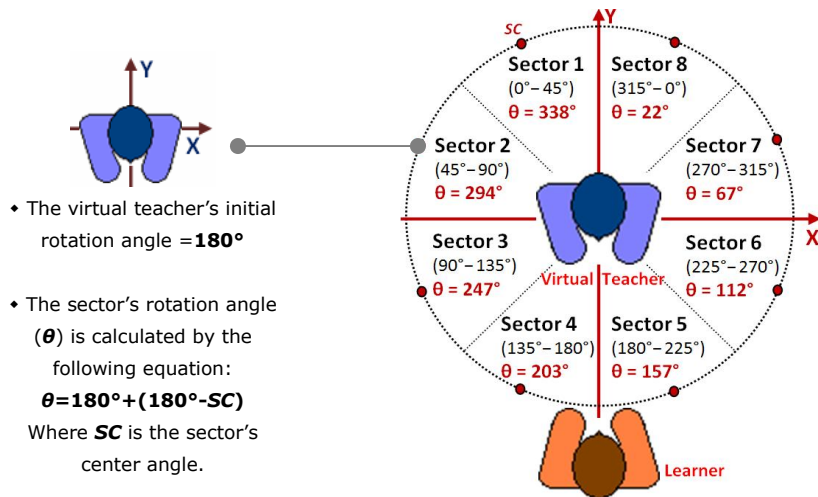


Fig 3. Teacher's surrounding area divided into eight sectors.

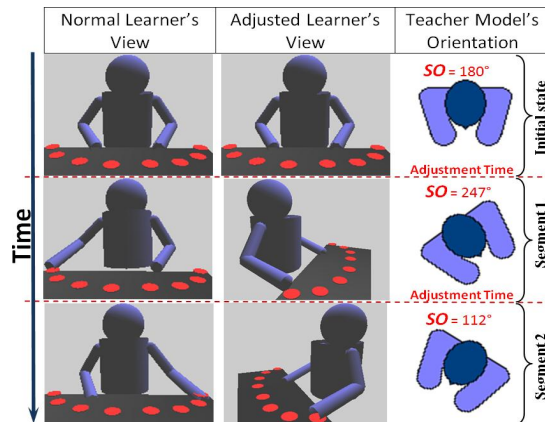


Fig 4. The normal learner's view compared to the adjusted view.

Conclusion

In this paper, we propose a method for the automatic adjustment of a virtual teacher's orientation, when the virtual teacher is demonstrating physical task motion. This method will ensure that the learner sees the

teacher's motion from an optimal viewing angle. Such a method is significant for physical task learning because such learning is mainly done by observation. The method is also useful for remote collaborative physical tasks involving full body motion. Moreover, when the learner has his/her own physical objects in hand, it might be difficult for him/her to control the viewing angle at the same time, even if the system provides an angle-control function to the learner. The proposed method helps the learner in this situation; and is, again, valuable for similar situations involving collaborative physical tasks.

Acknowledgments

This research was partially supported by the 2010 Research Grant of Graduate School of Library, Information and Media Studies of the University of Tsukuba, and the JSPS Grant-in-Aid for scientific research 22500104, 2010.

References

- [1] Inoue, T., and Nakanishi, M. *Physical task learning support system visualizing a virtual teacher by mixed reality*. Proceedings of the 2nd International Conference on Computer Supported Education (2010), 276-281.
- [2] Haller, M. *Mixed Reality @ Education, Multimedia Applications in Education Conference*, MApEC (2004).
- [3] Azuma, R. *A Survey of Augmented Reality*, In Presence: Teleoperators & Virtual Environments (1997), 355-385.
- [4] Chan, J., Leung, H., Tang, J., and Komura, T. *A virtual reality dance training system using motion capture technology*. IEEE Transactions on Learning Technologies (2010).
- [5] Kirk, D., Rodden, T., and Fraser, D. *Turn it this way: Grounding collaborative action with remote gestures*. CHI '07 Proceedings of the SIGCHI conference on Human factors in computing systems (2007), 1039-1048.
- [6] Fussell, S.R., Kraut, R.E., and Siegel, J. *Coordination of communication: effects of shared visual context on collaborative work*, In Proc. of CSCW 2000, ACM Press (2000), 21-30.