Dynamic stimuli visualization for experimental studies of body language

Nesrine Fourati, Jing Huang, Catherine Pelachaud

Institut Mines-Telecom, Telecom ParisTech, CNRS LTCI
37/39 rue Dareau, 75014 Paris
nesrine.fourati@telecom-paristech.fr, jing.huang@telecom-paristech.fr, catherine.pelachaud@telecom-paristech.fr

Abstract

Understanding human body behavior have relied on perceptive studies. Lately, several experimental studies have been conducted with virtual avatars that reproduce human body movements. The visualization of human body behaviors stimuli, using avatars, may introduce bias for human perception comprehension. Indeed, the choice of the virtual camera trajectory and orientation affects the display of the stimuli. In this paper, we propose control functions for the virtual camera.

Keywords: virtual camera, camera motion, camera position, perception

1. Introduction

The studies of the human perception of body language and motion patterns received a wide range of interest since a long time for different fields of research like the recognition of affect in body movement (Kleinsmith et al., 2011) and the identification of body cues that contribute to the attribution of emotions and affects (Meijer, 1989; Dahl and Friberg, 2007).

The content of the stimuli that the observers are asked to judge depends on the research question that needed to be answered from the results of the perception study. One can use the raw videos (videotaped) that depict the real visual content of body movement of the “actors” (Meijer, 1989). Digital modifications can also be done on the original movies or pictures to abstract some bodily information (Dahl and Friberg, 2007; Atkinson et al., 2004). For many other purposes, it is required or preferable to use computer avatar as the content of the stimulus.

To visualize stimuli of an avatar wandering around an environment (walking, turning, etc) we can choose to have a static or a dynamic camera that follows the avatar in its displacement. However, when the camera is static the distance between the avatar and the camera varies and this may affect the perception of the avatar body movement. Similarly if the orientation of the camera and the avatar body varies, it may affect how body movement is perceived. To overcome such biases in perception studies, we propose tools to parameterize the camera movement and orientation. For example, we can control the trajectory of the camera and its orientation so that it maintains an equal distance and orientation with the avatar.

2. Related work

The use of computer avatars in perception studies of body movement has widely emerged recently (Coulson, 2004; Hicheur et al., 2013; Kleinsmith et al., 2011; Roether et al., 2009). Depending on the goal of the study, the movements reproduced with the avatar may be the result of motion capture data (Kleinsmith et al., 2011) or the results of a model that provides the synthesize of new body movements (Hicheur et al., 2013).

Previous discussions related to the perception studies of body movement were mostly around the body model of the computer avatar. Point-light display of body movements was primarily used for the studies related to the perception of biological motion (Johansson, 1973; Dekeyser et al., 2002). Other body models were used for the studies that rely on the perception of both body posture and the dynamics of movement. Those models are mostly based on body skeleton model through specific geometric shape primitives (Griffin et al., 2013; Kleinsmith et al., 2011; Kleinsmith et al., 2006; Roether et al., 2009) or a virtual animated character (Hicheur et al., 2013).

As body posture involves a three-dimentional presence, human perception of body postures and body movements reproduced on a three-dimentional avatar may depend on the viewing angle (Coulson, 2004; Daems and Verfaillie, 1999), especially for viewpoint that result in occlusion of some body parts by others. In the studies based on the perception of body movement, the viewpoint is defined according to the goal of the study. Kleinsmith et al. (Kleinsmith et al., 2011) reproduced expressive postures on computed avatar and simulate a frontal view for the perception of emotion from body posture. Hicheur et al (Hicheur et al., 2013) chose a side viewpoint to create the videos depicting walking behaviors reproduced on an animated character. Roether et al. (Roether et al., 2009) used movies of a animated virtual avatars turned 20 degrees from the frontal view. However, it could be interesting to study the effect of different viewpoint on the perception of body behavior (Coulson, 2004).

3. The description of the proposed approaches

Two different types of virtual camera must be distinguished: free camera and target camera. While the orientation of free camera requires the definition of the 3D rotation, target camera is, by default, facing its target. Most often, the target refers to the center of interest of the object to be followed (the avatar). We assign the target of the camera to the pelvis in order to perceive the whole body posture, but the choice of the joint associated with the target could change from one study to another.

3.1. The position and the orientation of the camera

The definition of the viewpoint of the avatar refers to the determination of the position of a virtual camera that looks toward the avatar.

The viewpoint determined by the virtual camera has to be defined based on the orientation of the object (here the avatar body). We define the orientation of the whole body based on the orientation of the pelvis.

3.1.1. The position of the camera

The desired viewpoint of the avatar may differ from one study to another. Our goal is to provide a solution that can be controlled through a set of parameters. The determination of the 3D camera position is based on three parameters: the distance between the camera and the target, the height of the camera, and the angle that defines the viewpoint of the avatar. By default, the height of the camera and the distance between the camera and the target could be proportional to the height of the pelvis. As a result, the attribution of the desired viewpoint relies on the determination of X and Y components of the camera position.

The determination of the camera position turn out to be a geometric problem that involves both the vector orthogonal to the direction of the whole body and the vector between the target and the camera position. When considering the pelvis posture as the indication of the body orientation, the geometric problem involves the vector defined with the Left Hip Position and the Right Hip Position and the vector defined with the Pelvis Position and the Camera Position. Knowing the positions of Right Hip and Pelvis, the distance between the pelvis and the camera, and the angle that defines the angle of viewpoint, we are able to determine the position of the camera.

3.1.2. The orientation of the camera

The target of the camera is used to define the orientation of the camera towards an object. Assigning the target to the pelvis position makes the camera point to the center of the body structure. However, defining the target as the pelvis itself could affect the perception of pelvis motion. In fact, a target camera will not only be oriented toward its target, but it will also follow (without changing the position) all the motions performed by its target, including the more subtle motions. For instance, if the avatar is jumping up and down, the camera motion will follow the same motion (up and down). As a result, in the related video, we will perceive the floor as a moving object and the pelvis as a static object, which is the opposite of the result that we are expecting. For this reason, we define the target as an approximation of the pelvis position. For body movements that involve small body displacement (where the avatar can be still visible to the camera), the target position can be set to the first position of the pelvis, and still static for the whole animation. However, for body movements that involve considerable body displacement in the space, the target has to move according to the pelvis motion. In the next section, we introduce some solutions for the motion of the camera as well the target following the avatar motion.

3.2. The control of virtual camera motion

Up to our knowledge, previous perception based studies that rely on the perception of body movements tend to use movies where the viewpoint as well as the position of the camera is static while the avatar is moving in the 3D space. While this approach could be a good solution when the whole body movement is relatively small, it has the limitation of loosing the details of body motion during the perception if the animation involves turning behavior or walking along long distance. In this section, we introduce some solutions for the control of the camera trajectory and the target motion when the animation involves a considerable displacement of the whole body in space.

One principal issue that could affect our perception of body movements is the desynchronisation of the camera motion with the avatar displacement, which creates an effect of zoom in and out. Another issue that can create the same effect is the change of the distance between the camera and the target. So the first motivation for the solutions that we propose to control the camera path is the non-uniform motion of the camera following as much as possible the same change of velocity and acceleration in the avatar displacement. And the first motivation for the solution proposed to control the path of the target is to keep as much as possible the same distance between the camera and the avatar.

3.2.1. The path of the target

As we explained previously, the target position has to follow the targeted joint. We project the pelvis positions along straight lines defined through the positions of the pelvis in two successive time steps. Figure 1 (4) depicts the path of the target.

3.2.2. The path of the camera

For perception based studies, there is a lack of discussions on the control of the path of virtual camera. Thus, we based our work on the assumption that the virtual camera motion can influence the perception of body movements. Our aim is to create camera with less potential influence on the perception of body movements.

A first intuitive solution is to update the camera position in each frame during the whole animation. The result of this solution can be visualized in Figure 1 (1). This method results in a perfect synchronisation between the motion of the avatar and the camera, while handling the same viewpoint during the whole animation (based on the angle between Left Hip - Right Hip vector and Pelvis-camera vector). The algorithm that controls the path of the camera is as follows; for each frame, we get the positions of Right Hip and Pelvis and update the position of the camera according to their current positions as described in section 3.1.1.. However, one should bear in mind that walking motion give rise to non linear pattern of body segments, including the pelvis (Fourati and Pelachaud, 2013; Olivier et al., 2009). Hence, this camera motion may affect the perception of body movements since the camera is shaking from the left to the right due to the non linear motion of the pelvis.

In the following, we propose some different solutions for the control of virtual camera path according to the avatar

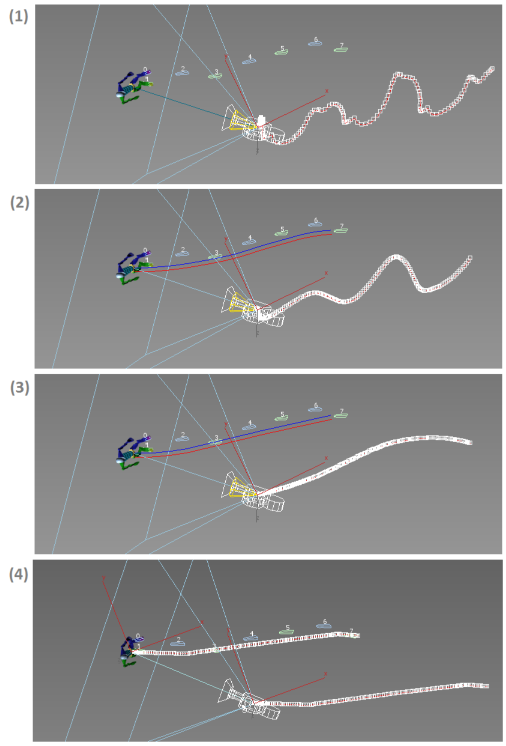

Figure 1: Camera trajectories when 1) Updating the camera position each frame based on pelvis and right hip positions, 2) Updating the camera position each frame based on the estimation of Pelvis and Right Hip motion through spline curve where the control points are the time steps, 3) Updating the camera position each frame based on the estimation of Pelvis and Right Hip motion through spline curve where the control points are the timing of all the right steps, 4) Defining the camera motion as the translation of its target trajectory.

movement.

- Synchronized non uniform non linear style: Update the camera position in each frame based on the approximation of pelvis motion

  One solution to control the motion of the camera is to approximate first the trajectory of pelvis and the right hip (or in more general way the joints that determine the position of the camera) and then to update the position of the camera (as explained in section 3.1.1.) at each frame. In this way, the viewpoint is updated at each frame according to the approximation of pelvis posture for straight walk and turning behavior (See Figure 2).

  The approximation of pelvis and right hip positions is set on a spline curve (the red and blue curves in Figure 1 (2) and (3)). However, this approximation is strongly based on the control points. Defining the control points along a fixed time window (for example each 30 frames) or along the time step results in a sinusodal form of the camera motion (See Figure 1 (2)). This is due to the opposite posture of the pelvis in two successive steps (left step and right step). This problem can be resolved by defining the control points on the steps of one side (all the right steps or all the left steps), which result in a more linear camera motion (see Figure 1 (3)). This solution provide a good trade-off between the smoothness of the camera motion and the conservation of the same viewpoint during the animation (as a result the synchronization between the avatar and the camera motion).

- Synchronized non uniform semi-linear style: Make the camera follow the avatar motion without keeping the same viewpoint.

  Another solution for the control of the camera motion is to maintain a perfect synchronization between the camera motion and the avatar displacement without updating the viewpoint (See Figure 1 (4) and Figure 2 (1)). Comparing to the results in Figure 2 (2), the camera position in Figure 2 (1) does not provide the same viewpoint during the whole animation, but this might be interesting for the studies based on the perception of turning behavior. The camera motion is obtained by the translation of its target trajectory. The latter is based on the projection of pelvis positions along straight lines. Each straight line is defined through the positions of the pelvis in two successive steps timing. In this way, the camera motion is defined as a succession of small straight lines according to the successive steps.

- Walking steps based style: Update the camera motion differently for straight walking steps and turning steps

  Finally another solution that aims to maintain the same viewpoint on the avatar and a good synchronization between the avatar and the camera motion is to combine the synchronized non uniform semi-linear style for straight walking steps and the update of the camera position in each frame for turning steps. This approach requires the annotation of walking steps into straight walking steps and turning steps. However, this solution needs smoothing the camera path during the transition between straight and turning steps.

4. Conclusion and future work

In this paper, we propose some solutions to control the position and the trajectory of the virtual camera used to visualize stimuli for experimental studies. Our solutions allow to automatically convert a database of body movement animation files into a database of movies for the use in a perception study. Furthermore, we propose automatic control of the virtual camera position and motion in perceptive studies.

For future work, we aim to compare the visualization of stimuli using moving virtual camera with those created using static virtual camera through a perception based study. We also aim to compare the stimuli displayed with the different solutions that we proposed through a perception based studies for different body movements (walking, turning, sitting down...).

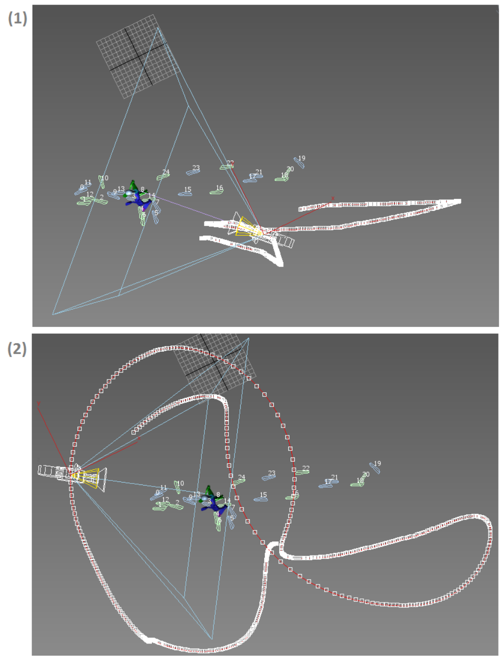

Figure 2: Camera trajectories in straight walking and (180 °) turning behaviors; 1) without keeping the same viewpoint (Synchronized non uniform semi-linear style), 2) while keeping the same viewpoint (Synchronized non uniform non linear style). The screen shot corresponds to the same frame in the animation.

5. References

Anthony P Atkinson, Winand H Dittrich, Andrew J Gemmell, and Andrew W Young. 2004. Emotion perception from dynamic and static body expressions in point-light and full-light displays. *Perception*, 33(6):717–746.

Mark Coulson. 2004. Attributing emotion to static body postures: recognition accuracy, confusions, and viewpoint dependence. *Journal of Nonverbal Behavior*, 28(2):117–139.

Anja Daems and Karl Verfaillie. 1999. Viewpoint-dependent Priming Effects in the Perception of Human Actions and Body Postures. *Visual Cognition*, 6(6):665–693.

Sofia Dahl and Anders Friberg. 2007. Visual Perception of Expressiveness in Musicians' Body Movements. *Music Perception*, 24(5):433–454.

Mathias Dekeyser, Karl Verfaillie, and Jan Vanrie. 2002. Creating stimuli for the study of biological-motion perception. *Behavior research methods, instruments, & computers : a journal of the Psychonomic Society, Inc*, 34(3):375–82, August.

Nesrine Fourati and Catherine Pelachaud. 2013. Head, shoulders and hips behaviors during turning. *4th international workshop on Human Behavior Understanding, In conjunction with ACM Multimedia 2013*, 8212:223–234.

Harry J. Griffin, Min S.H. Aung, Bernardino Romera-Paredes, Ciaran McLoughlin, Gary McKeown, William Curran, and Nadia Bianchi-Berthouze. 2013. Laughter Type Recognition from Whole Body Motion. *2013 Humaine Association Conference on Affective Computing and Intelligent Interaction*, pages 349–355, September.

Halim Hicheur, Hideki Kadone, Julie Grèzes, and Alain Berthoz. 2013. Perception of emotional gaits using avatar animation of real and artificially synthesized gaits. *Humaine Association Conference on Affective Computing and Intelligent Interaction*.

Gunnar Johansson. 1973. biological motion. *Perception & Psychophysics*, 14(2):201–211.

Andrea Kleinsmith, P. Ravindra De Silva, and Nadia Bianchi-Berthouze. 2006. Cross-cultural differences in recognizing affect from body posture. *Interacting with Computers*, 18(6):1371–1389, December.

Andrea Kleinsmith, Nadia Bianchi-Berthouze, and Anthony Steed. 2011. Automatic Recognition of Non-Acted Affective Postures. *IEEE Transactions on Systems Man and Cybernetics Part B Cybernetics*, 41(4):1027–1038.

Marco Meijer. 1989. The contribution of general features of body movement to the attribution of emotions. *Journal of Nonverbal Behavior*, 13(4):247–268.

Anne-Helene Olivier, Richard Kulpa, Julien Pettre, and Cretual Armel. 2009. A Velocity-Curvature Space Approach for Walking Motions Analysis. *MIG 2009*, pages 104–115.

Claire L Roether, Lars Omlor, Andrea Christensen, and Martin A Giese. 2009. Critical features for the perception of emotion from gait. *Journal of Vision*, 9(6):1–32.