ANIMATION RÉALISTE D’ÊTRES VIRTUELS À PARTIR DE DONNÉES SCANNÉES
REALISTIC HUMAN ANIMATION USING SCANNED DATA

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Abstract

Realistic human animation has to take account of the deformations of bodies, hands and face as well as the articulate motion. Various synthetic human models have been applied to simulating deformations but give approximations only. We proposed to make best utility of high quality scanned human body data to investigate mechanisms for body surface deformation, that can be used to guide the human animation using synthetic models. Here we present preliminary results of an animated whole body scan data that demonstrates the advantages of combining the scanned data and the human animation models.

Keywords: scanned data, human body animation, surface deformation.

1. Introduction

There is an increasing demand for realistic human animation in numerous applications; for example, film post-production, interactive computer games, interactive education, simulation, medical training and surgery. So far it has been difficult, if not impossible, to produce highly realistic 3D human animations. Realism depends on a believable appearance and realistic movements. The availability of 3D digitising technology means that real-life human bodies can be transferred into the virtual world (Petrov et al. 1998). Scanned data have accurate shapes associated with photographic textures. Highly realistic human animation could be achieved by animating the scanned human body with realistic motions and surface deformations. However, there is a gap between the static scanned data and animation models. We aim to fill the gap by converting the scanned data into a form compatible with human animation models. Later, we are going to investigate deformation mechanisms by analysing the shape changes of humans in different postures. In this paper we presented preliminary human animation results in which a whole body scanned data provided by Cyberware® has been animated in a commercial animation package Poser4®. The results show a believable appearance and realistic movements. This demonstrates the advantages of combining the scanned data and the human animation models.
Various synthetic human body models are available to represent and deform the human body shape, which broadly divide into surface model, multi-layer model and anatomically based model. In the surface model, the surface can be a polygonal mesh or a parametric surface. Thalmann and Thalmann (1987) used a polygonal surface model to animate Marilyn Monroe, also introduced the concept of Joint-dependent Local Deformation (JLD) operators (Thalmann et al. 1988, Thalmann and Thalmann 1990) to deform the skin surface. Those operators were specific local deformations that depend on the nature of joints. Forsey (1991) extended the hierarchical B-spline technique to 3-D character animation. A hierarchical surface was attached to an underlying skeleton in such a way that the figure designer had control over the location and scope of the surface deformation. Douros et al. (1999) used B-spline patches for reconstructing the surface of the scanned human body.

The multi-layered models contained the skeleton layer, intermediate layers to simulate the body volume (muscles, fat, bones and so on) and skin layer. Chadwick et al. (1989) proposed a layered technique based on Free-Form Deformation to apply muscle efforts to a skeleton. Thalmann et al. (1996) proposed an effective multi-layered approach for constructing and animating realistic human bodies.

Recently, multi-layered techniques were applied to anatomically-based models of humans and animals. Wilhelms (1997) proposed a multi-layered anatomically based model to simulate animals. She applied anatomical and physiological principles to model and animate animals. In her model, an animal was defined as a structure of individual bones, muscles, and other generic tissue covered by a flexible skin. Nedel and Thalmann (1998a) proposed a method to simulate human beings based on anatomy concepts believing that the closer the model is to reality, the better will be the results. A mass-spring system was used to simulate the muscle deformation (Nedel and Thalmann 1998b).

Human animation models provide useful tools to control the articulated motion and deform the body surface according to body postures; but the models have difficulties to build a model that closely resembles a specific person. Fua et al. (1998) and D’Apuzzo et al. (1999) fitted animation models to the surface data derived from multi-image video sequences and extracted motion sequences for modelling. Hilton and Gentils (1998) introduced a model-based approach for reconstruction from a set of low-cost colour images of a person taken from orthogonal views. A generic 3D human model represented both the human shape and articulation structure. Mapping 2D-silhouette information from the orthogonal view colour images onto the generic 3D model captured the shape of a specific person. Colour texture mapping was achieved by projecting the set of images onto the deformed 3D model. Non of these attempts have produced a highly realistic body shape for a specific person. In this paper, we demonstrated that realistic human animation could be achieved by combining the scanned data with the human animation models.

2. 3-D scanner
3-D scanners divide roughly into active and passive. Passive scanners reconstruct the surface from stereo images (Figure 1) or from a video recording of the object in relative motions. The 3D information of a point (P) on the surface can be calculated from its images (l) and (r) captured by the left and right cameras whose orientation and intrinsic parameters (focus length and distortion parameters) are calibrated. Most existing stereoscopic systems are not truly passive, as a texture must be projected on the object to facilitate the determination of the corresponding points (l) and (r).

![Figure 1 Stereo Images](image)

3D-Matic has access to the C3D® photogrammetry system (Figure 2) which can capture 3D models of people, animals and objects that are both metrically accurate and photorealistic in appearance, using digital camera technology.

![Figure 2. C3D® Photogrammetry system](image)

Figure 3 shows a sample 3D model obtained by the C3D® photogrammetry system. The model was fused from several stereo image pairs and colour textures were mapped after 3D constructions.
Active optical systems provide photorealistic representation of shapes and textures with reasonable speed. Figure 4 illustrates the optical arrangement of a laser scanning system. The laser beam/sheet reflects from a rotating mirror and scans the surface of the object. The images of laser dot/line on the surface are used to reconstruct the 3D surface of the object.

The most well-know optical triangulation 3D scanner is the one developed by Cyberware of Monterey, California, USA. Cyberware® products can capture photorealistic images of objects. The scanner's head contains a laser sheet generator, a system of mirror, and black–white and colour video cameras. Scanning occurs by moving the object on a rotation and translation platform, or by moving the sensor around the object in a circular motion. One version, the whole body scanner Cyberware WB4, can digitise a complete human body as a combination of four scans in about 17 seconds. Each scan has 250×1000 points of resolution. The four scans can be glued using commercial software packages. Figure 5 shows a sample of whole body scanned data (Cyberware® data).
3. Segmentation of the scanned data

In order to convert the scanned whole body data into the form of the commercial human animation package Poser4®, we segmented the whole body. A segmentation program written in Java and Java3D has been implemented. Three key points/landmarks on the body were clicked on the body surface to define an intersection that divided the body into two parts (Figure 6). Casting rays were defined based on the selected three key points. The geometric centre of the three points was origin of the rays and, the origin and the normal vector of the plane of the three points was used to form the rotate axis of ray. The intersected points between the casting rays and the polygons of the scanned surface were used define an intersection that segmented the scanned surface into separate parts. The intersected points were on the cross-section contour. The centre of the intersection was defined as a node of the skeleton of scanned data.
The intersections defined by every three points divided a polygonal mesh into two. The scanned body surface was segmented by the intersections. Individual body parts were restored in VRML. Figure 7 illustrates a left arm and a segment of upper arm defined by two intersections. On the right, Figure 7 displays segmented Cyberware® whole body data. Different body parts are displayed in different colors.

![Illusions of the segmentation: left – a left arm and a segment defined by two intersections, right – segmented Cyberware® whole body data.](image)

4. **Animating the scanned human body**

We used Poser4® to animate the whole body scanned data (Figure 5) in order to demonstrate the advantages of combination of the scanned body data with the human animation model. Before the scanned human body can be animated in Poser4, it has to be articulated. The segments of the body were imported into Poser4. A hierarchy body structure was built up and the joints and joint parameters were edited, inverse kinematic chains of body were edited either. Figure 8 shows a few frames of the scanned body animation. The segmentation took less than 30 minutes and animation was done within hours, such that a specific person could be seen acting in the virtual world.
5. Conclusions

Availability of 3D scanners enables real-life humans to be transferred into the virtual world. Existing human body models provide excellent animation tools. Having proper interfaces connecting the scanned data and the human animation models, we can animate the scanned data so that specific persons can be seen walking, playing tennis and working in dangerous environments in the virtual world. The deformation simulations of the animation models can be evaluated by analysing the shape changes of humans in different postures. Further physical deformation mechanisms can be extracted from the scanned data. Realistic human animations can be achieved by using the realistic scanned body surface combining with the realistic motion controls and deformation simulations.

6. Proposed work to do

We can generate realistic human animation with realistic shape and motion by combining the scanned data with the human animation models. Further work needs to do in following fields,

- To segment the whole body scanned data automatically. It is vital to have an underlying knowledge of certain key landmarks, since these landmarks are important for tasks such as animation model registration and kinematic modelling.
- To conform the shape of the animation models to the scanned surface. This will involve matching pre-constructed 3D human models to captured 3D bodies such that it will be possible to apply animation procedures to the matched model.
- To improve the techniques of surface deformations. This model will be capable of producing dynamic shape changes in response to the muscle flexure and the posture changes. To achieve this level of detail, we anticipate creating explicit skeleton-muscle models.
- To incorporate a human skin model. It will become possible to both re-light the model in a realistic fashion and also “zoom into” the model surface beyond the resolution at which the skin was imaged. Using a skin model, we would also hope to visualise and model other physical effects.
7. Acknowledgement

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References:


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