Fast Virtual Garment Dressing on Posed Human Model

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Abstract: Due to the multiplicity of the implementation, virtual garment simulation requires the capacity of dressing a sewn garment onto various posed human models in a real time. In this paper, a three-step method has been proposed to accelerate the dress-up procedure. The virtual garment is first dressed onto a human model in a standing pose to record a distance map between the garment shell and the human model. And then the distance map is employed to generate a coarse match when the pose of the human model has been changed. Finally, a fine-tuned 3D configuration without surface penetration is generated after a draping/relaxation scheme. Experimental results suggest this method is a useful and fast treatment for dressing sewn virtual garment on various posed human models.

Keywords: virtual garment, distance map, mesh conforming, draping, global relaxation

(a) Default pose (b) Mesh conforming (c) Penetration recovery (d) Draping & relaxation

Figure 1 Illustration of cloth/pose synchronization solved by our method

1. Introduction

The state-of-the-art technology has made cloth simulation a very important topic in both the academic investigation and the industrial implementation (movies, games, online shopping, etc). A common avenue for 3D garment dressing is through virtual sewing and draping: the garment patterns with various boundary shapes are placed around the human body and are seamed by either the sewing force or the sewing springs. Further, the sewn garment is draped along the surface of the human body under the gravity and the other external forces such as air flow and friction. However, this is not always a straightway when dressing the human model with a sewn garment under various poses. For instance, in an environment of simulating sports-wear, the user may want to investigate the performance of a simulated garment under different movements to reach the maximum of evaluation. It is inconvenient to decompose the garment into patterns and to re-sew these patterns in every pose.

In this paper, we propose a three-step method to address this kind of issue. The first step is to register the distance between each garment vertex and the closest vertex selected from the human model, which actually generated a "distance map" that represents the current residual space between the garment shell and the human body. For the cloth/

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pose synchronization, it is believed that the transition of the body pose indicates the transformation of this residual space. Therefore, in the second step, the "distance map" is employed to determine the new position of each garment vertex when the pose has been changed. The third step is to resolve the penetration introduced by the pose transition to reach the final 3D configuration of the virtual garment. The super elongation and compression produced by the pose transition is rectified in terms of a vertex position adjustment and a strain control scheme.

Throughout the literatures, little previous research had been done specifically on dressing a sewn garment onto posed human models. The most related work is Cordier and Magnenat-Thalmann's technique of dressing animated virtual humans [23]. They subdivided the cloth layer into stretchy parts and loose parts for their hybrid approach of garment animation. The garment layer was actually partitioned into several moving regions with different constraints driven by the movements of the skeleton, which required careful segmentation of the cloth layer and complex computation for the semi-geometrical and semi-physical draping.

Our approach on cloth/pose synchronization is based on the common techniques from cloth modelling and collision resolving. The target of cloth modeling is to develop a physics-based method to simulate the dynamics of cloth in animation. Many cloth models had been proposed in the past two and a half decades. The most general approach was to treat the fabric as a two-dimensional elastic model [1, 4-13]. More broad surveys on this topic can be found in [2, 3, 19].

Another major concern of cloth/pose synchronization is to solve the collisions generated in the pose transition, as shown in Figure 1 A robust remedy of collisions should not only rely on preventing surface intersections from occurring, but also requires being able to "repair" those intersections whenever they occur. Vassilev et al [22] proposed an image-based collision detection and response scheme to perform the interference tests, which is a hardware accelerated collision remedy. Zhang et al [24] presented a coherence-based method to detect collisions between the garment and the human model. Collisions can be rapidly detected by tracking the movement of the most likely intersected geometric elements based on the property of coherence. Bridson et al. [15] proposed a continuous collision detection scheme to avoid crossovers entirely and guaranteed that the cloth was free of intersections at the end of a time step if it was free of intersections before. Volino et al. [16, 17] used a statistical approach to determine which parts of the cloth need to be corrected. These history-dependant approaches worked well for unconstrained cloth. Unfortunately, when garment models were dressed onto animated avatar, they might be forced into a tangled state despite the efforts of collision handling schemes. To overcome this issue, Baraff et al [14] proposed a history-free intersection handling method through a Global Intersection Analysis (GIA). Recently, Volino and Magnenat-Thalmann [18] proposed another history-free method for resolving intersections based on minimization of the intersection paths.

2. Algorithms

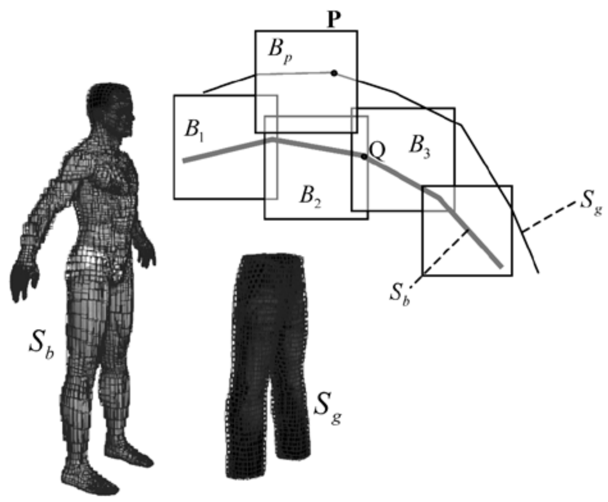

Figure 2 Searching the shortest distance via AABB acceleration.

2.1 Distance map

The cloth model employed in our approach is a mass-spring system solved by an implicit integrator (backward Euler integration) [7]. For the clearance of explanation, we use S_b to represent the 3D surface of the human body, and S_g to represent the 3D surface of the virtual garment. To synchronize S_g with S_b, we