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Efficient Penetration Resolving in Multi-layered Virtual Dressing Based on Physical Method

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Abstract

Around the research of garment simulation, multi-layered virtual dressing is still a difficult issue, one big reason is that the effect of penetration always appears between adjacent garments at the beginning of the virtual dressing with existing garments. In this paper, a simple system for physical based multi-layered virtual dressing is designed. At the same time, a novel method for efficiently resolving the penetration problem appeared between multi-layered garments during simulating is presented. Of the method, a filter algorithm for identifying penetration points during collision detection is provided. The experiment results show that this method is practical and easy-use with generating realistic effects.

Keywords: Penetration Resolving; Multi-layered Virtual Dressing; Physical Based

1 Introduction

With the rapid development of computer technologies, the virtual dressing systems become more and more attractive in the practical applications. Among those researches, most researchers focus on the clothing shape and dynamic simulation [1–3]. However, the research of multi-layered virtual dressing is still a difficult issue. PBS (Physical Based Simulation) method can be used to construct the multi-layer clothing layer by layer in the simulation, but it is not suitable for practical virtual dressing applications because computation cost is high. As an ordinary user, they just want to review the combination of different single garment which they like. For instance, when a girl chooses a T-shirt, she may want to see which skirt is of best fit with this T-shirt, they do not care about how the T-shirt or skirt sewed. So if existing 3D garments can be selected to construct the multi-layer dressing, that will be more suitable for the daily manner. So in order to simplify the multi-layered virtual dressing process, a multi-layered virtual dressing system with existing virtual garments is important. In general, the garment models are constructed independent and without constraint relationship each other. Therefore, compare with single-layered virtual dressing, the main problem of multi-layered 3D garment virtual dressing is how to process the penetration phenomena appeared between adjacent garments at the beginning of the virtual dressing.

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Those clothing simulations based on physical method are important to visualize the realistic garment. The main problems are physical model construction and collision resolving.

Especially the multi-layered virtual dressing simulation based on physical methods is more complicated. The first, massive points are on the garment surface which may potentially lead to a great of collisions. Second, different for single-layered garment simulation, during the construction of multi-layer dressing with existing garments, there are penetration occurred in multi-layered virtual dressing at the beginning of the simulation, even during the process of clothing simulation. Bridson et al. [3] presented a robust collision handle method which is widely used subsequently, but the limitation of these methods are not adapt to the multi-layer garment simulation because they are history-based manners which need non-penetration initial position to start simulation.

Therefore, in order to resolve these problems, in this paper, we provide a novel method based on physical method that can efficiently resolve the penetration problem occurred at the beginning of or during the process of multi-layered virtual dressing simulation. The more realistic effect of multi-layer dressing can be generated by the proposed method. This virtual multi-layer dressing system is efficient in the virtual dressing applications.

The key technique in this method is to find the areas of proximity and penetration first, then a filter is designed to distinguish between these areas during contact pairs detection. When the areas of proximity and penetration are identified, the multi-layer garment simulation based on the physical method can be proceed. The main contribution in the proposed method includes efficient penetration processing and improved physical simulation in the multi-layer dressing.

2 Related Work

Mass-spring systems are conceptually simpler and easier to implement than more physically consistent models derived from continuum mechanics using the finite element method [4]. In contrast to scientific computing, highly accurate material modeling is not always necessary for physics-based visual applications. As a result, mass-spring systems are widely used for one to three dimensional structures, such as using in hair [5] and cloth [6], and 3D animation [7].

Regardless of whether one employs a mass-spring system or another method based on continuum mechanics, for clothing simulation applications, some collision resolving techniques are necessary. Bounding volumes can be applied to cull away a portion of non-colliding triangle pairs, such as oriented bounding box [8], k-DOPs [9], axis-aligned bounding box [10], dynamic BVH [11]. An elementary processing [12] was proposed for determining the collision state of two non-adjacent triangles. Min et al. [13] provided a method that use non-penetration filter to reduce both number of false positives and the elementary tests between the primitives and an algorithm for finding poly-depth subsequently. Bridson et al. [14] proposed an robust and efficient algorithm to process collisions, contact in cloth simulation. Mezger et al. [15] proposed an algorithm using the K-DOPS bounding box. Most methods mentioned above handle collision and contact response in a history-based manner, i.e., these methods depend on the initial pattern of the fabric, once the initial fabric has intersected already, the entire simulation afterwords could be ruined. Volino et al. [16] proposed an algorithm in a history-free fabric configurations to recover intersecting surfaces via the Global Intersection Analysis, however, it is invalid for oriented deformable surface. Zhong reported a method that the existing garments are dressed layer by layer [17]. This method is more efficient without clothing construction for using existing garment to construct the multi-