Optimization of Cloth Simulation Parameters by Considering Static and Dynamic Features

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1 Introduction

Realistic drape and motion of virtual clothing is now possible by using an up-to-date cloth simulator, but it is even difficult and time consuming to adjust and tune many parameters to achieve an authentic looking of a real particular fabric. Bhat et al. [2003] proposed a way to estimate the parameters from the video data of real fabrics. However, this projects structured light patterns on the fabrics, so it might not be possible to estimate the accurate value of the parameters if fabrics have colors and textures. In addition to the structured light patterns, they use a motion capture system to track how the fabrics move. In this paper, we will introduce a new method using only a motion capture system by attaching a few markers on fabric surface without any other devices. Moreover, animators can easily estimate the parameters of many kinds of fabrics with this method. Authentic looking and motion of simulated fabrics are realized by minimizing error function between captured motion data and synthetic motion considering both static and dynamic cloth features.

2 Capture Motion Data of Fabrics

As a trial, four typical variations of fabrics are examined: silk, denim, cotton and synthetic fiber that is composed of polyester 65% and rayon 35%. 81 markers with about 5cm interval are attached to each square swatch of fabric with the size of 50cm by 50cm. Two markers on the top corner are considered as points of action. A swatch is swung back and forth, and markers are tracked by using 14 VICON motion capture cameras which record with 120 fps. 500 frames are used to estimate parameters.

3 Error Function

We observed that when impressions of real and simulated fabrics look similar, their shapes, moving speed and bending behavior play an important role. Therefore, we focused on marker coordinate to evaluate shape, marker velocity to evaluate speed and curvature to evaluate how fabrics bend for each corresponding vertex. Then the error function is defined by eq(1),

$$E = \sum_{i}^{N} \frac{\alpha\left|\bar{x}_i^R - \bar{x}_i^S\right| + \beta\left|\bar{v}_i^R - \bar{v}_i^S\right| + \gamma\left\{\left|\bar{\kappa}_{1i}^R - \bar{\kappa}_{1i}^S\right| + \left|\bar{\kappa}_{2i}^R - \bar{\kappa}_{2i}^S\right|\right\}}{N} \quad (1)$$

where N is a number of vertex, $\bar{x}_i$ is an average of coordinates in all frames, $\bar{v}_i$ is an average of velocity in all frames, $\bar{\kappa}_{1i}$ is an average of curvature for vertical direction, $\bar{\kappa}_{2i}$ is an average of curvature for horizontal direction. Note that we calculate the neighborhood of the vertex using Catmull-Rom Splines when we calculate the curvatures. In addition, $\alpha = 1$, $\beta = 0.5$ and $\gamma = 2$ in this paper.

4 Optimizing Parameters

In this paper, NVIDIA® PhysX was used as a cloth simulator. In PhysX, there are many parameters we can adjust but if a collision between cloth and rigid bodies is not considered, only five parameters should be adjusted: stretching stiffness, bending stiffness, damping coefficient, density and thickness. Note that shear stiffness wasn't estimated just because there isn't such a parameter in PhysX. The value of those parameters are decided by minimizing the error function in eq(1) by simulated annealing.

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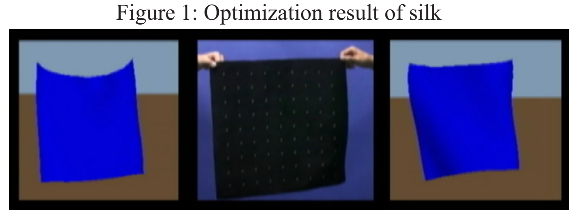
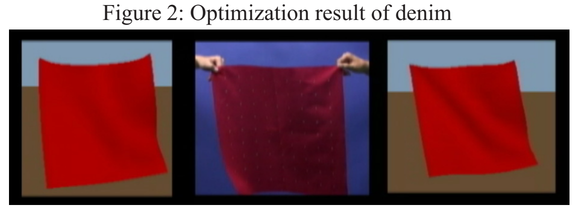
(a) manually tuned (b) real fabrics (c) after optimized

Figure 1: Optimization result of silk



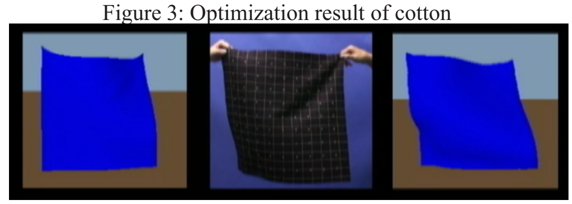
(a) manually tuned (b) real fabrics (c) after optimized

Figure 2: Optimization result of denim



(a) manually tuned (b) real fabrics (c) after optimized

Figure 3: Optimization result of cotton



(a) manually tuned (b) real fabrics (c) after optimized

Figure 4: Optimization result of synthetic fiber

5 Results

We show the results of silk in figure 1, denim in figure 2, cotton in figure 3 and synthetic fiber in figure 4. Note that pictures which are the same types of fabric are compared in the same time. We reproduced the silk swelling and got a soft impression. On the other hand, the denim gave us a hard impression after we optimized. The cotton stretched unnaturally at the edge of the top, but it is improved after optimized. The synthetic fiber moved similar to the real one especially at the edge of the bottom.

6 Conclusion

We proposed an optimization framework for identifying the parameters of cloth simulation from a motion capture system. In consequence, we successfully reproduced the motion of colored and designed fabrics. In addition, it is notable that this method doesn't depend on the types of simulator.

As a future work, we believe that it is possible to estimate parameters even though we use a fewer number of markers. Along with this idea, we also need to define better error function by using these results so that we can get better results which behave more similar to the real fabrics. Finally, our goal is to apply estimated parameters to more complex simulation, for example shirts and pants.

References

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