3D DRESS DESIGN

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Abstract

In our 3D dress designing system the real sizes of human body are defined by a reduced measuring process with the help of a parameterized body-model. Shape and sizes of cloth-parts are derived from the geometry of human body model. Designers modify the model and shape of parts in space. A virtual mannequin wears the model dress. Material properties of textiles are simulated as well as those of the textures.

Key Words, 3D dress design. Parameterized body-model. Virtual mannequin. Simulation of behavior and appearance of dresses.

1. INTRODUCTION

Nowadays computers and softwares are advanced enough to design dresses in 3D. There are opportunities for designing dress parts in 3D and for virtual dress fitting.
There is a 3D dress design system developed at the Budapest University of Technology and Economics. Figure 1 shows the schematic structure of the system.

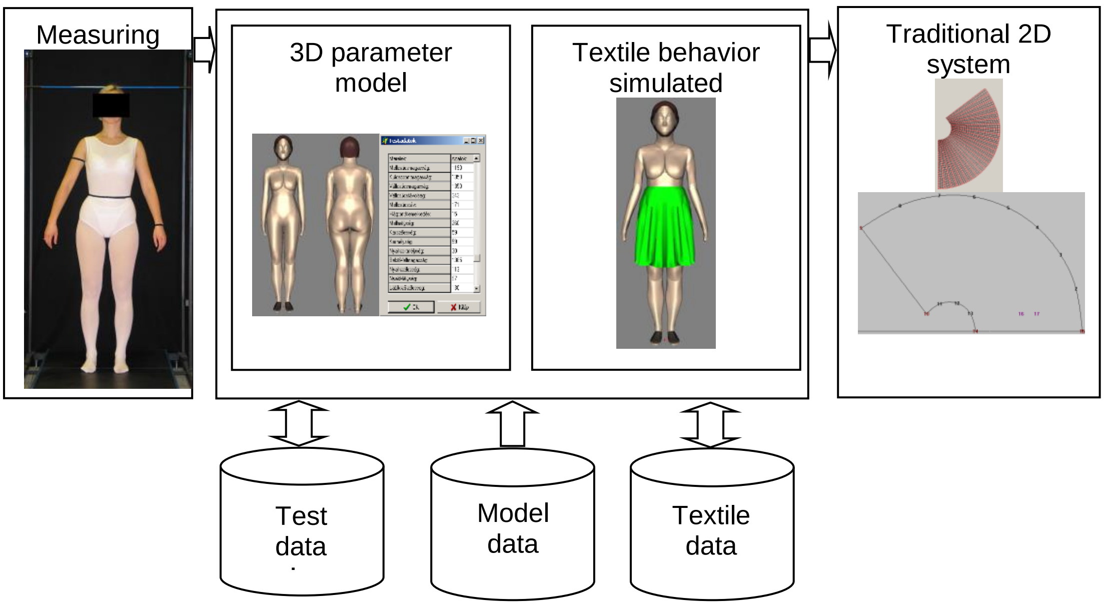
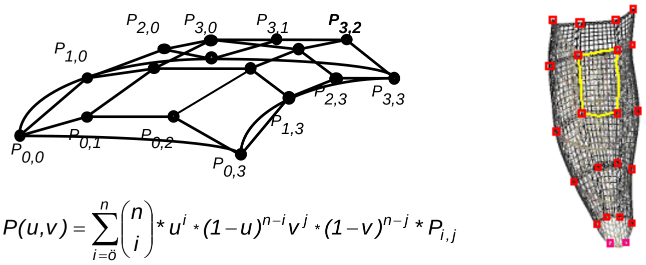


Figure 1 Structure of the System

Analysis of main properties of our system is the following.

2. MATHEMATICAL MODELING AND VISUALIZATION OF BODY SURFACES

Surfaces of body parts are modeled by B-splines patches defined by its vertices (Figure 2). Patches are connected to each other continuously in first order. Body parts are connected by limiting curves of surfaces. Positions of body parts vertices are defined as functions of real body sizes.



$$P(u,v)=\sum_{i=\text{ö}}^{n}\binom{n}{i} * u^{i} * (1-u)^{n-i} v^{j} * (1-v)^{n-j} * P_{i,j}$$

Figure 2 B-Splines modeled body parts

There is a program-system developed in Borland Delphi (Kuzmina, Tamás, Tóth, 2003). Body parts are modelled in an object oriented way. Visualization is based on Windows integrated Open GL system (McReynolds, Blythe, 2002).

3. AUTOMATIC DETERMINATION OF BODY PARAMETERS

Photos of front and side views are processed by picture processing techniques. Resulting profiles are fit to proper curves of the body model and actual body parameters are defined (Figure 3.)

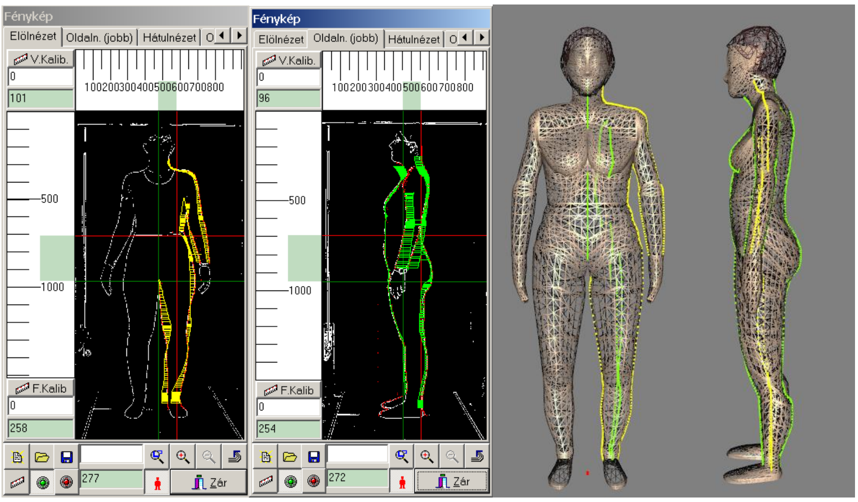


Figure 3 Photo-based Parameter Determination

4. DRESS DESIGN IN 3D

The model of dresses is created in the same way as the body model. Modified dress surfaces are defined by different moves of the points in normal direction. Moving distances can represent both wideness and different cuts. Designers can modify the position and shape of dresses interactively. 3D dress surfaces are dismantled upon rules of garment trade.
A knowledge-base helped the numerical method of laying out parts that result patterns of ready to made dresses. (Figure 4.)
As there is no way to lay-out 3D surfaces, they we should be cut by contraction seams. Positions and sizes of contraction seams (*l*, *h*, *m*) can be defined by the designer interactively or can be approved by the assumption the best position and size the minimum deformation of the material. (Figure 5)

Otherwise we can compute the deformation energy as a function of position and sizes of contraction seams (l_j, h_j, m_j). The optimal solution is defined by the minimum deformation energy.

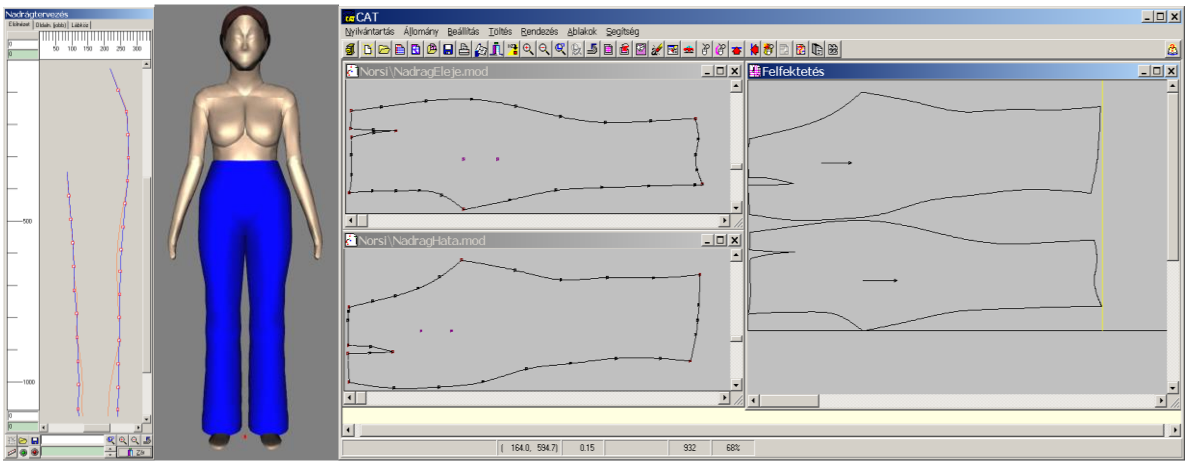


Figure 4 Designing of Trousers

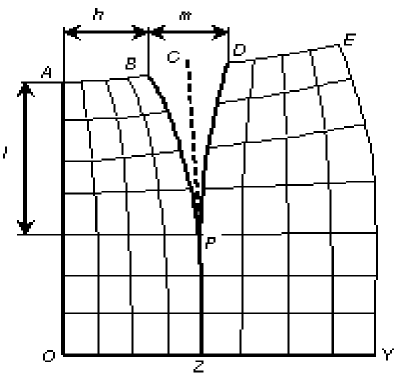


Figure 5 Position and sizes of contraction seams

5. MECHANICAL MODEL

Several different models have been set up for describing the movement of textile materials. (House, Breen. 2000) We have studied the mechanical model, where the mass particles, arranged in a rectilinear grid, are connected with the three types of springs and the shock absorber shown in Figure 6:

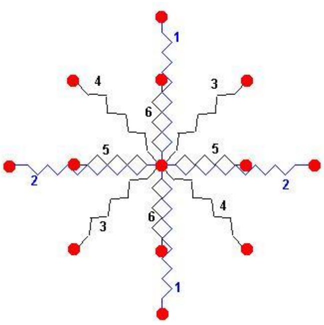


Figure 6 Springs and shock absorbers influencing a mass point.

There are: 1) structural springs and shock absorbers that connect nearest-neighbor particles along thread lines (5, 6), 2), shear springs shock absorbers that connect nearest-neighbor particles along

diagonals (3, 4), and 3) flexion springs shock absorbers that connect a particle with its second neighbor along thread lines (1, 2).
Each spring shock absorber shown in Figure 6 includes a damping element. Springs are assumed to be linear, while damps are proportional to velocity. The basic mathematical model is based on the Lagrangian equation (Béda 2002):

$$\underline{\underline{M}}\ddot{\underline{q}} + \underline{\underline{K}}\dot{\underline{q}} + \underline{\underline{S}}\underline{q} = \underline{F}(t)$$

The main idea is to determine the position of each point vertex/mass of the cloth at a time t by integrating Newton's second law of motion. In our case only the Runge-Kutta and the Adams methods produce quite stable results integrating the Newton Fundamental Dynamic Equation.

A dress should not penetrate another solid object. To model this behavior a collision detection algorithm must detect when a collision occurs and responds to the collision by correcting the new position or speed of the points in the collision:
1) Collision Detection: We use two general ways to detect a collision between a dress particle and objects n environment: using a distance factor as an allowed radius around a point on a surface of the object ("collision with a sphere") and the one-side distance factor between a particle and a surface of the object ("collision with a plane").
2) Collision Response (Resolving): Collisions are handled by applying laws of friction to objects in contection. Using laws of friction the point could have a sliding contact, where the point moves parallel to the surface, or a non-sliding contact where the point remains still. A friction coefficient is provided by the user..

5.1 Database of Materials

Mechanical properties are determined by simulation of drape-tester. Measured cross-section curves are interpolated by Fourier series (left side of Figure 7). The same Fourier coefficients are determined in the simulated model as a function of material parameters (right side of Figure 7). The actual material parameters are defined by the minimum difference between the modeled and the measured geometry. (Kuzmina, Tamás, Halász 2005)

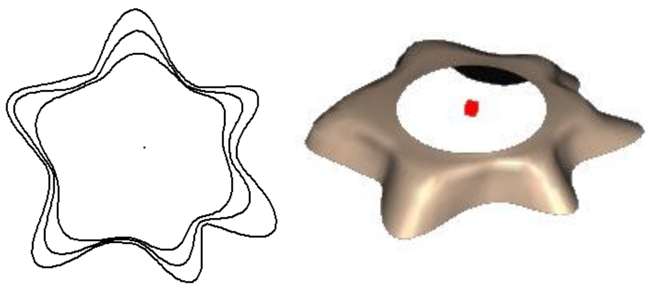


Figure 7 Cross-sections of measured and modeled geometry

Database of materials is the main part of our system. Database stores mechanical properties of materials as well as textures as bitmaps.

5.2 Simulating Behavior and Appearance of Dresses

As mentioned motion simulation is realized by real time numeric solution of Newton Phenomena. Pictures of material pattern are defined as a bitmap. Simulated shape and pattern bitmaps as a texture can give a real picture of dresses as we can see in Figure 8.

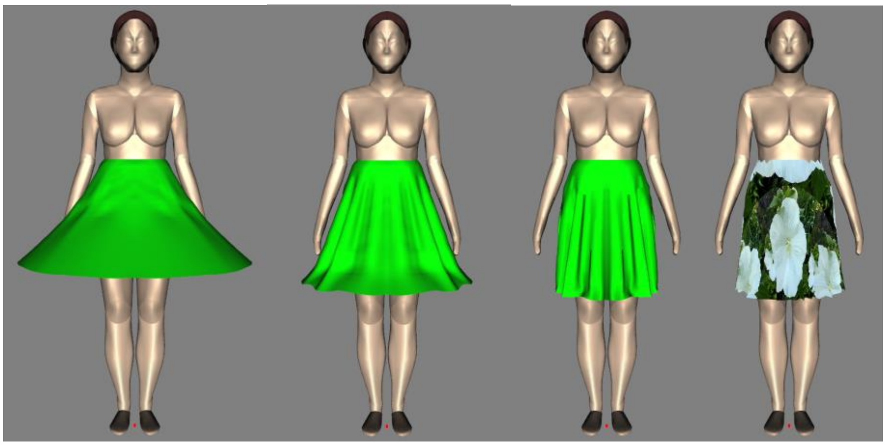


Figure 8 Behavior Simulation

6. DISCUSSION

Prepared easy measuring process provides usable results with some mistakes arising from the lock of a third view. Our parametric body model and knowledge base partially correct the errors.
The parametric body model and 3D dress design are modern and usable approaches as manufactured test-pieces proved it.
Mechanical models serve usable results for virtual mannequins, but unshaded texture processing of used Open GL version is a deficiency.

7. CONCLUSION

Our system is worth developing further. We plan to work on generalization of body models, designing special multi-layered dresses such as jackets, costumes by shoulder pads etc.. We will use 3D scanners for more precise parameter definition. Our system should handle dynamic dress fitting as well as body defects. Computation of stresses is essential in dress design.

8. REFERENCES

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