SIMULATING CLOTH IN REALISTIC WAY USING VERTICES MODEL BASED

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Abstract
A cloth object is a 3D mesh composed of vertices, indices, and polygon faces. While they are understandably important for rendering, those vertices do double−duty when it comes to cloth simulation because they are affected by its physics. A cloth's vertices are therefore referred to as *cloth points* (or *points*, for short). By manipulating the coordinates of the cloth's points over time (with forces such as gravity, wind, or anything else you can throw at it), you can create the appearance of a flowing, elegant piece of material.
To closely emulate a real piece of cloth, these cloth points have a specific mass value associated with them that determines how the point moves according to how much external force is applied. Points with a higher mass require more force to accelerate them, whereas points with a lower mass tend to accelerate more due to external forces being applied. This is a factor of momentum, which states that the force required to move an object is equal to the mass times the acceleration you wish to achieve (F=ma).
The mass- spring system that has been used for the 3D simulation of cloth enables the parametrization of internal forces such as bending, stretching or damping of the fabric. This provides us with the ability to implement different types of fabric by just modifying these parameters (parameters of the springs).
The cloth mesh's polygon edges also have an important role−they hold together the cloth's points. Well, the polygon edges really don't hold the points together−rather, those edges represent a bunch of tiny little springs that hold together the points. As the points in your cloth move, each spring tries to maintain a state of static equilibrium by pushing and pulling the points until the forces are balanced. Visually, this makes it look like the points are being kept at a certain distance from one another.
Key words: simulating, mesh, vertices, cloth, polygon, realistic.

1. Introduction

The 3D physical model of the cloth can be obtained from the garment pattern and after it can execute the simulation. Designing the 3D garments around the virtual body we can transfere the clothing design concept. For physical model and numerical solution to compute realistic animations of clothes it necessary to develop a model based on finite elements for viscoelastic, flexible textile surface. For that it must use an elastic model and viscous parameters for warp and weft directions independently.
For 3D simulation of a garment product we need import the virtual body, to generate the particle model according to the textile surface properties, to position and assemble 2D pattern over the mannequin and to execute the simulation.
The paper presents aspects of 3D simulation of apparel products using that support different types of human bodies created in the virtual environment.
This goal is achieved by using of the finite element mesh. Mesh is done both in body and clothing to the product. It follows the correspondence points that define the perimeters of the main body and body product level. The objective of this method is to model various clothing products to highlight their behavior under static and dynamic. Static or dynamic behavior can be predicted by knowing the forces acting on the surface of the textile product, taking into account the constraints imposed by the type and combination of parts of clothing. The textile material can be described by its geometry and physical properties and can be perceived as a two-dimensional surface is moving in a three-dimensional space. In clothing product textile material suffer some deformation due to multiple requests (bending, stretching, shearing) in multiple directions [2].

The textile material can be modeled as a continuous or as a particle-system model. Always, the continuous and the particle-system model were in competition. Although the two models are different they lead to similar results.

Continues technique is based on elasticity theory and the textile material is considered has a homogeneous structure. Modeling of the textile material in clothing product is done numerically using finite element method. The finite element method divide the surface or textile in a representative set of triangles and find the appropriate functions that satisfy the balance elements equations. Particle-system based model is due to gaps existing in a continuous model, which couldn't play the complex behavior of the textile surface to extension or bending tension [3].

Clothing products virtual modeling arises from the need to simplify the process of design and manufacturing. Simulation is necessary to visualize the shape and garment appearance, and its behavior and response to various requirements.

But, like many real phenomena, it is impossible to accurately model clothes, or to simulate them motion. This would require modeling the quantum level. Even if they understand fully the implications of physics, the problem would be in terms of computational intractable.

The overall properties of the fabrics are extremely complex, observing the non-linearity, anisotropy. In decoration product, textile material suffer some deformation due to multiple requests (bending, stretchung, friction) in multiple directions.

The internal forces like bend, stretch, and shear allow the fabric to deform in a realistic manner. External forces such as gravity, wind, and collisions make the textile surface to interact with its environment. In the absence of these forces, a piece of fabric will remain a flat plane.

A simulation of textile surface should be effective and reflect the true reality. Systems capable of real-time animation can produce great results, but uninteresting for textile, because results are not reliable and can be used to predict how you will look and behave in the real world textile surface. Simulation of high fidelity the textile surface require hours to produce a few seconds of animation. Simulation of 3D textile surface material is an important step in the design of products for items for interior decoration. Virtual simulation helps to the analyze prototypes that will be made from textile material and quickly find the best prototypes. The advantage of simulation in virtual environment is offering new alternatives in product design.

2. Simulation method

In 1990, the group MIRAlab [4], University of Geneva, Switzerland began solving simulation clothing in virtual models. They started from the model of Terzopoulos et al., adapting it especially for clothing by improving amortization and response to the impact with various solid.

The main contributions in research of modeling and 3D simulation are engineering design software for virtual clothing, the self-collision and the textile material response to the collision study, geometrical representation of textile material folds during simulation, and studies in efficiency and behavior of different numerical methods.

For modeling products they using virtual models created by the 3D body shape scanner captures and the development of new bodies by changing parameters. The body can be generate also from using the specialized modeling software (see Fig. 1).

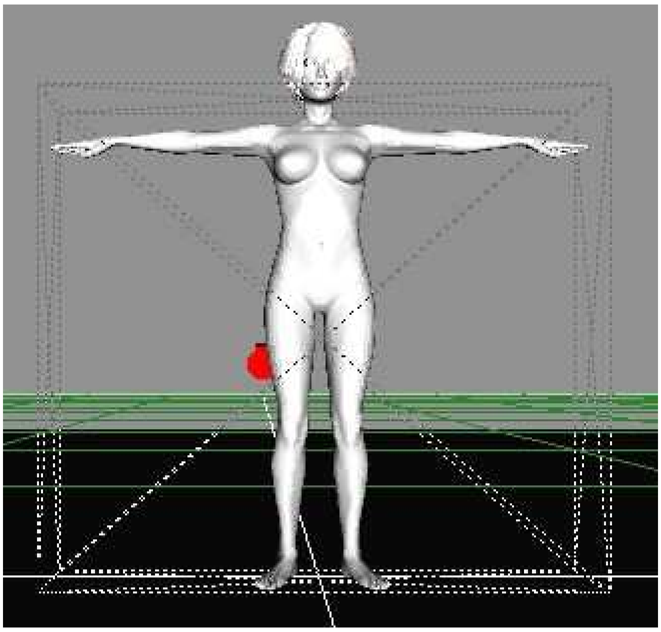

Figure 1：Virtual body for modeling garment product

The body must be exported like wavefront .obj file to another software for modeling the garment, like a single object or like a multiple object (see Fig. 2). Like multiple object there is generated a list with all the body parts that can be imported.

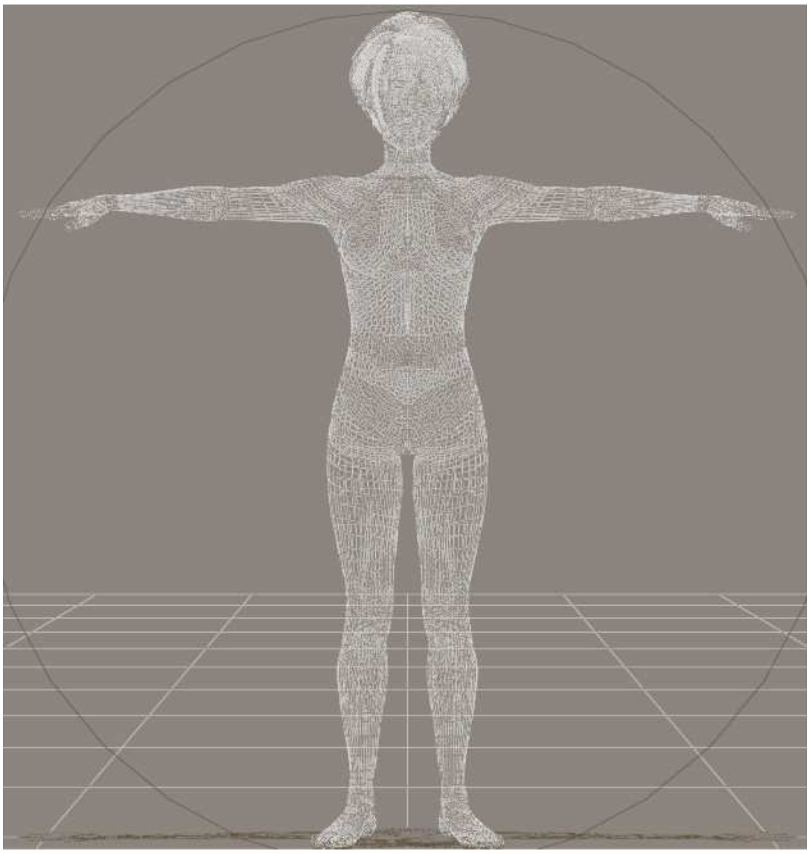

Figure 2 : Different body mesh parts

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simulation because they are affected by its physics. A cloth's vertices are therefore referred to as cloth points (or points, for short). By manipulating the coordinates of the cloth's points over time (with forces such as gravity, wind, or anything else you can throw at it), you can create the appearance of a flowing, elegant piece of material.
To closely emulate a real piece of cloth, these cloth points have a specific mass value associated with them that determines how the point moves according to how much external force is applied. Points with a higher mass require more force to accelerate them, whereas points with a lower mass tend to accelerate more due to external forces being applied. This is a factor of momentum, which states that the force required to move an object is equal to the mass times the acceleration you wish to achieve (F=ma).
The mass - spring system [3] that has been used for the 3D simulation of cloth enables the parametrization of internal forces such as bending, stretching or damping of the fabric (see Fig. 3).

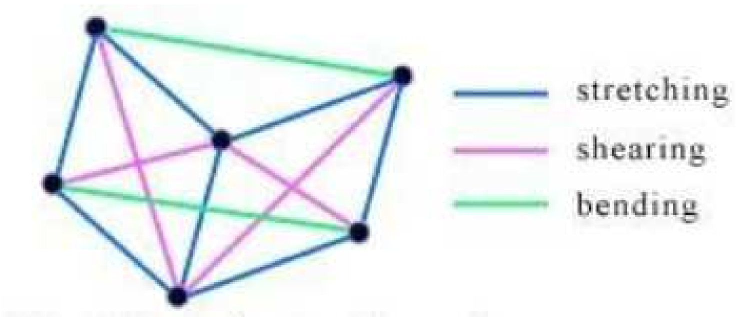

Figure 3 : The mass-spring model [2]

For virtual textile surface modeling when stretching, bending or shear, they are using 3 types of springs (figure 3) :

- for stretching springs are used to define a mesh of the polygonal surface, whereby the textile surface is represented;
- for bending (waving) springs used bows made by the union of 2 nodes which have arcs (links) common;
- for shear springs use bows made by interconnecting nodes belonging to a polygonal mesh in the surface but are not adjacent.

It can implement different types of fabric by just modifying these parameters (parameters of the springs).
The cloth mesh's polygon edges also have an important role−they hold together the cloth's points. Well, the polygon edges really don't hold the points together−rather, those edges represent a bunch of tiny little springs that hold together the points. As the points in your cloth move, each spring tries to maintain a state of static equilibrium by pushing and pulling the points until the forces are balanced. Visually, this makes it look like the points are being kept at a certain distance from one another.
For a successful design product is required a 3D simulation of the garment product.
The simulation of the clothing product starts from 3D modeling, that can be done by drape the textile surface on the industrial body mannequin, or in the virtual environment.
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The textile surface drape in virtual environment can be made by :

- using a parameterized body type using the data obtained with a 3D scanner;

- using a body type model done in 3D graphics software (see Fig. 4).

To achieve this goal it is using the following data : body type, the textile material in the virtual environment and patterns garment made in a 2D graphics software.

3D modeling in virtual environment has the final objective to obtain the 3D appearance of the clothing product modeled in static way.

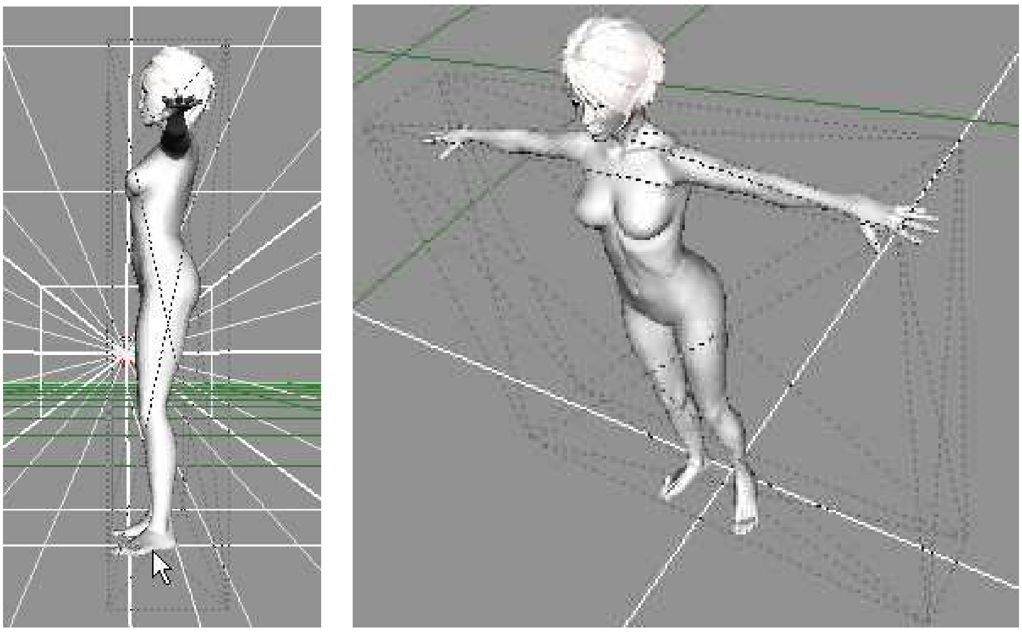

Figure 4 : Body obtained in graphic software – different views

3. Experimental results

The virtual body can be resize virtually for every sized and that is possibly to use for non-standard configurations bodies.

The objective of the using of the surface mesh elements is to obtain representative simulation considered the type pattern drape cloth on the body surface regarded as support - Collision object, for the determination of collisions that may occur.

Garment simulation is performed on a virtual parametrized mannequin type by modeling or resizing the patterns surfaces. Pattern are made and imported like surface .dxf file.(see Fig. 4).

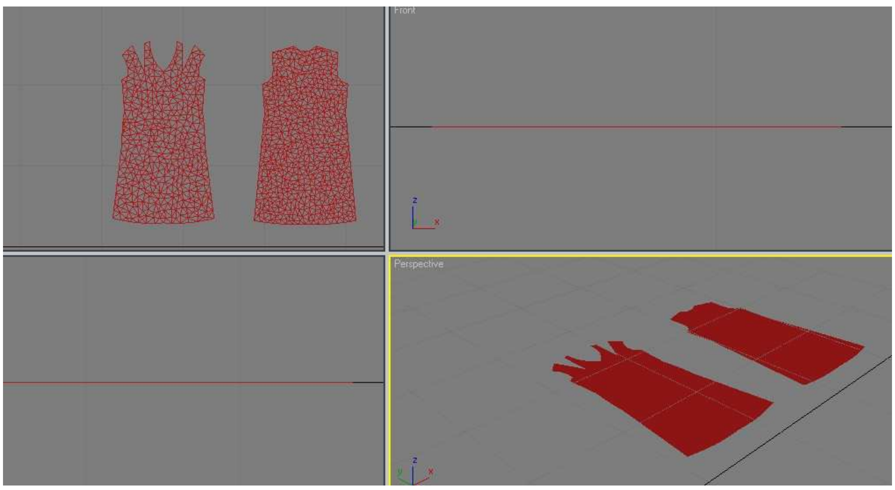

Figure 5 : 2D pattern .dxf file format

The 3D body can be resize virtually for every sized and that is possibly to use for non-standard configurations bodies (see Fig. 6).

Figure 6 : Different morphotype bodies

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Assembly patterns is done using function and simulated seams, stitching is accomplished by overwriting points defining the border areas to assemble (see Fig. 7). In this way can check if a pattern is good for the same size and a different body morphotype (different shape).

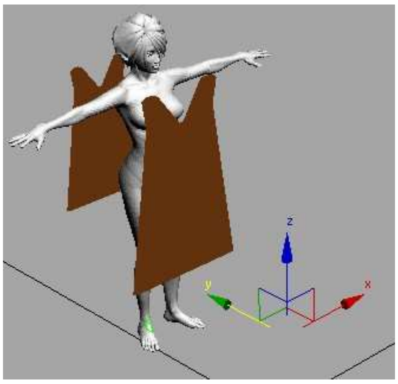

Figure 7 : Pattern assemble

Cutting products requires a careful study of surface textiles, garment design to be made, but also on how to achieve 2D patterns.

The spatial form of garment products is influenced by the interdependence of the features of extensibility, flexibility, material drape and by the morphological indices that characterize the human body.

The clothing products modeling arises from the need to simplify the process of design and product design. Cloth vertice simulation is necessary to visualize the shape and appearance of product design, and its behavior and response to various demands (see Fig. 8).

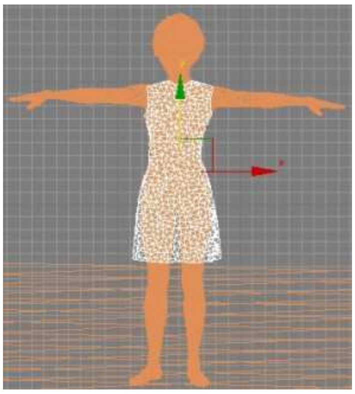

Figure 8 : Cloth vertices simulation

3D simulation for clothing products is to define the geometric parts of the product and objects that will interact with the product (ex. parts of product or the human body). It is necessary to simulate the constraints and the impact of body - product, product - parts of the product. The study of the constraints consists to find the limits of movement of the product, such as those caused by the seamless of coat parts or product mount in a fixed point.

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4. Conclusion

The constraints simulation and the impact of body - product, product - parts of the product it is very important. The study of the constraints consists to find the limits of movement of the product, such as those caused by the seamless of coat parts.

The 3D simulations using virtual mannequins is important because in this way, the design process is integrated with pattern design. The garment patterns can easily validate or can easily make change to them.

By using the body mesh for gament product simulation we can :

- checking the correspondence between product characteristics and destination of its use;
- developing and verifying prototypes in virtual environment cause a rapid product development;
- time economy in execution, the choice of prototype, achieving optimal physical prototype;
- saving raw materials and equipment;
- check de correspondence between different body shapes and the pattern.
- can choose the optimum pattern construction for each body morphotype.
- high productivity for staff charged with achieving physical prototypes;
- fast reaction to market requirements.

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