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Virtual draping by mapping

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ABSTRACT

We propose a method of virtual draping by representing the actual draping process, i.e., a pattern is made a from cloth model by mapping. Additionally, the garment form is simulated from the obtained pattern. The process of making the pattern is as follows. A rectangular planar cloth model is made and slit for dart as needed. The slit cloth model is mapped to the surface of a dummy model. The shape of the cloth model under the condition of relaxation on the surface of the dummy model is obtained by mechanical calculation. A three-dimensional pattern shape is obtained to remove unnecessary part of the cloth model. Finally, a planar pattern shape is made by mapping the three-dimensional pattern inversely to a plane. A garment form is also simulated from the obtained pattern. The pattern for a pencil skirt can be made employing the proposed method. We make an actual pencil skirt and simulate its form using this pattern. Thus, the deformation of a cloth and the attaching process can be considered. The present study maps the cloth model to the dummy model to make the garment form and thus represents draping more closely.

1. Introduction

1.1. Background

A consumer usually chooses a garment that fits his or her body as much as possible from many mass-produced garments. However, it is often difficult for a person to find a perfectly fitting ready-to-wear garment when his or her body shape and dimensions deviate from standard proportions.

Garments that fit an individual body shape can be designed by draping. The garment pattern affects a garment's size and silhouette and it is thus important to consider the individual's body type and to make an individualized garment pattern when making garments. Draping is a pattern-making method in which cloth is directly applied to a dummy. The garment is then formed by cutting and pinning the cloth. Draping allows a garment to fit a body because the pattern is based on the shape of the dummy, and it ensures the garment is similar to the image envisioned by a designer.

Draping in the real world has demerits as well as merits; e.g., draping in the real world requires experience and involves significant cost and time. Actual draping is therefore virtualized to reduce costs and time. Additionally, virtual draping readily allows changes be made to the material and size of a garment and modification of the garment after it has been made. Virtual draping is thus an attractive alternative.

In the present study we construct a garment pattern on the basis of the actual draping procedure in a virtual space by, by mapping a digital model of cloth to a digital model of a manikin taking into account the physics based interaction of the two. In addition, an actual garment is made from the virtual pattern and its form is confirmed. The virtual garment is made according to the desired pattern, and the completed garment is simulated.

1.2. Related work

There has been a wide range of studies involving garment and cloth simulations, such as studies on pattern making based on the shape of a dummy model, the fitting simulation of a garment and try-on simulation [1–9]. Studies on pattern making are especially important in creating a fitting garment and mass customization. Virtual draping allows garment patterns to fit a dummy model by forming the garment from the dummy model shape and then transferring the garment to two-dimensional (2D) space. In addition, it has applications to a fitting evaluation, a more effective making of a garment and a complete simulation of the garment form. The establishment of virtual draping will thus be an important contribution to the creation of a garment.

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In almost all studies on virtual draping, a pattern is made by directly generating a garment model around a dummy model [1–7]. In most existing virtual draping methods, the garment form is represented by curves, a wireframe and surface, and changed by deforming the curves and wireframe to obtain the pattern. Cho et al. proposed a pattern-making method for various body forms [1]. The pattern of the garment is obtained by developing the contoured surface of the dummy model. Wang et al. presented a method of making a garment pattern using two types of curve: contour curves and style curves [2]. First, the garment surface is modeled and contour curves are generated. The garment form is changed by deforming the curves; e.g., darts and a grain line are added to the garment surface using style curves. The 2D garment pattern is then made. Huang et al. made a wireframe model using body features and produced a garment form by deforming the wireframe [3]. The three-dimensional (3D) garment of the wireframe is developed and a 2D garment pattern is obtained. This method allows ease of movement by deforming the wireframe. Au et al. made a garment pattern using planes and garment boundaries [4]. The planes are inserted into the dummy model, and the garment boundaries are outlined on the planes. A 3D garment model that fits the dummy model is then created by creating developable surfaces between the planes along the boundaries. The obtained garment model is developed and the 2D garment pattern is obtained. In the above studies, the garment form is often produced by creating a mesh directly around a dummy model or deforming the dummy model. However, the methods described above are far from a virtual draping method involving a procedure of actual draping. The above methods omit some processes of actual draping or employ alternative processes. For example, in actual draping, cloth is applied to a dummy and a garment form is then formed by deforming the cloth. In applying the cloth, a grain line is applied along a preset line such as center line on the dummy. Darts are created by folding the excess cloth. On the other hand, our system mimics the applying procedure. The key point of this study is to make a garment by forming a solid form from a planar cloth model. The advantage compared to the previous studies of our proposed method is as follows. Excessive deformation of the cloth model is never created because of the mechanical calculation. The mechanical properties of the various cloths can be applied to the cloth model. This method is closer to the actual draping method than the previous studies.

Other studies follow an approach different from that described above; specifically, the garment model is represented by mapping or applying the 2D cloth model to the 3D dummy model. Meng et al. made a 3D garment form by mapping the garment pattern to the dummy model and sewing the pattern [5]. They presented their method in which the pattern is edited interactively by setting a relationship between the 2D pattern and 3D garment model. Their approach is similar to our approach in that the 2D object is mapped to the 3D body surface. However, whereas their aim is the interactive editing of the already made garment pattern and evaluation of the fit, our aim is to create the garment pattern from a rectangular cloth model mapped on the dummy.

A method proposed by In et al. is also similar to our method but in a different way from the above method [6]. In et al. proposed a method that produces the garment form from a rectangular cloth model and obtains the pattern using the garment form. Our virtual draping method employs the same approach in that the actual draping procedure is mimicked. In the method of In et al., however, the garment form is interactively created using only virtualized manipulations, such as cutting and pinning. In contrast, our method obtains the pattern by a geometric mapping of the cloth model onto the dummy model surface. Mapping the cloth model is much more efficient than manipulation of the virtual cloth.

The present paper performs virtual draping by adopting an approach that differs from the above traditional methods. A method whereby the pattern is created by applying the cloth model to the dummy model surface as in actual draping is needed for a more rigorous simulation of draping and to ensure that the pattern resembles an actual pattern. We propose a virtual draping method that obtains a pattern by effectively representing the actual draping procedure using a mapping method. One of the advantages is operating efficiency. Time consuming work in actual draping can be replaced with simple operation in the virtual draping. Another advantage is rapid prototyping. Just after the patterns are made, the form of a garment can be predicted by simulation. Users can confirm the form of the garment, adjust or modify the patterns at once. Draping in the real world takes much more time and cost to adjust or modify patterns compared to the virtual draping.

2. Virtual draping

In actual draping, a pattern is formed through a series of procedures. The procedures and how to make darts differ according to the type of garment. However, the basic procedure is the same for any garment. First, lines, such as the center line and hip line, are marked by taping on a dummy surface according to the garment design. A garment is made from patterns. Each pattern is made from rectangular sheeting applied to the dummy. The size of each rectangular sheeting is determined by measuring part of the dummy. The cloth is applied so that the grain of the cloth corresponds to a taping line such as the centerline on the dummy, and certain points are pinned to fix the cloth. To apply cloth on a curved surface, the cloth is slit and darts are tucked. A garment is thus formed by this process. Next, lines that determine the form of the garment pattern and other parts are marked with rough dotted lines. The cloth is removed and the pattern is obtained by developing the garment. In this study, the pattern is obtained by virtualizing the above procedure. The process of mapping the cloth model to the model of the manikin also accounts for the deformation in the cloth as it hangs on the manikin. The form of the cloth so obtained is used to obtain the pattern by inverse mapping. The present study maps a cloth model that has slits so as to apply it to a dummy model, and darts are made from the slits. Finally, a pattern is made from a garment form that is made using the cloth model.

2.1. Models

Objects such as cloth, the dummy and hands are modeled and a system that uses the models is created to virtualize real-world draping. Note that our method does not represent exactly the processes of actual draping. In the case of draping in the real world, patterns are made by applying the cloth on the dummy by hand. In the present study, however, the pattern is effectively created using a mapping method and mechanical calculation instead of applying the cloth on the dummy.

A dummy body in the real world is modeled for the virtual draping system. The dummy model comprises measurement data for an actual dummy. The surface shape of a dummy is measured using an VOXELAN LPW-2000FW. Fig. 1 shows the dummy model. The dummy model consists of 633 horizontal cross-sections. A virtual center axis is calculated. There are 256 points on the circumference of each cross-section. These points are the intersections of the half line from the center axis and the circumference of the cross-section. The direction angle of the n-th half line is $2n\pi/256$ from the right direction of the dummy model. The data of the dummy model comprise distances $d^m{}_n$ from the center axis and the intersection on the circumference, where m is the number of the cross-section and n is the number of the direction.