NEW METHOD FOR DYNAMIC DRAPE MEASUREMENT OF FABRICS

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ABSTRACT

Fabric drape testers are used to measure mechanical parameters of fabrics for visual simulation. In traditional equipments, operators lay the fabric sample manually, therefore the influence of random laying is a problem and has been tried to be eliminated by different methods. The Sylvie 3D Drape Tester, developed at Budapest University of Technology and Economics, includes a 3D laser scanner and a step-motor based laying mechanism. Our basic hypothesis was that the cause of high deviation in shape wrinkles is the dynamic strain imposed on a draped fabric. We have completed Sylvie 3D Drape Tester with a special equipment simulating the dynamic strain situation.

Key Words: Drape tester, fabric parameters, material test, mechanical simulation, dynamic strain situation.

1. INTRODUCTION

Mechanical parameters of fabrics must be known for fabric behavior simulation and therefore the drape testers are used to measure these parameters. However, the main problem is the deviation of the measured values as well as defining the reasons behind it.

Results of drape measuring are dependent on many factors as the laying and deflating of fabric samples is one of these. In a traditional equipment, the operator lays the fabric sample manually. The influence of random laying is tried to be eliminated by different methods. For example fabrics must be rotated by speed of 120 t/min until 10 sec according to JIS L-1096 J 999 standard or fabrics are lifted and lowered three times according to JIS 1018 standard. There are some approaches already including a “fabric-lowerer” to eliminate problems of shaking and rotating the fabric so that it can lead to less disturbance and therefore wrinkles are arisen gradually. Such an approach produces higher draping coefficients, but less deviation and in this case it is easier to obtain reproducible results compatible with the traditional methods [1, 2].

Measuring the draping parameters in static condition is not enough to simulate ready-wear clothes from the aesthetical point of view because of body movement. There are some studies related to examine draping coefficient in rotated fabrics while in some studies the force measurement involve to pull a round fabric through a round hole and definition of the diameters and velocity [3].

On the other hand, the Sylvie 3D Drape Tester, developed at Budapest University of Technology and Economics, includes a 3D laser scanner. The equipment scans surface of fabric and saves the all related data while the connected computer calculates the draping parameters. Since the table of fabric sample is moved by a computer controlled step-motor in this equipment, deviation of the draping parameters are found quite small similar to the earlier studies mentioned above [4, 5, 6].

Our basic hypothesis was that the cause of high deviation in shape wrinkles is the dynamic strain imposed on the draped fabric according to the literature and therefore we have completed Sylvie 3D Drape Tester with a special equipment. Then we were able to use well defined dynamic strain situations and have studied the influence of it. In this study, we introduce the special equipment developed, explore its influence on fabric draping and analyze the test results.

2. STRUCTURE OF THE EQUIPMENT

The computer controlled equipment (Figure 1.) is mounted in a black box. Computer controls the movement of a round table positioned in the centre providing a natural pleating of fabric for the measuring. The core part of the equipment is computer moved frame. There is a possibility to equip an exchangeable ring with different diameters simulating the dynamic stress. There are laser-beams lighting the sample through mirrors. Laser beams light the cross-section curves of the sample on different levels. There are four cameras on the frame taking the pictures of cross-section curves in different levels. Frame is programmed on a serial port. We have developed controlling programs by Borland Delphi [7], and Alkenius' Cam Remote components [8] are used to program the Canon firmware [9].

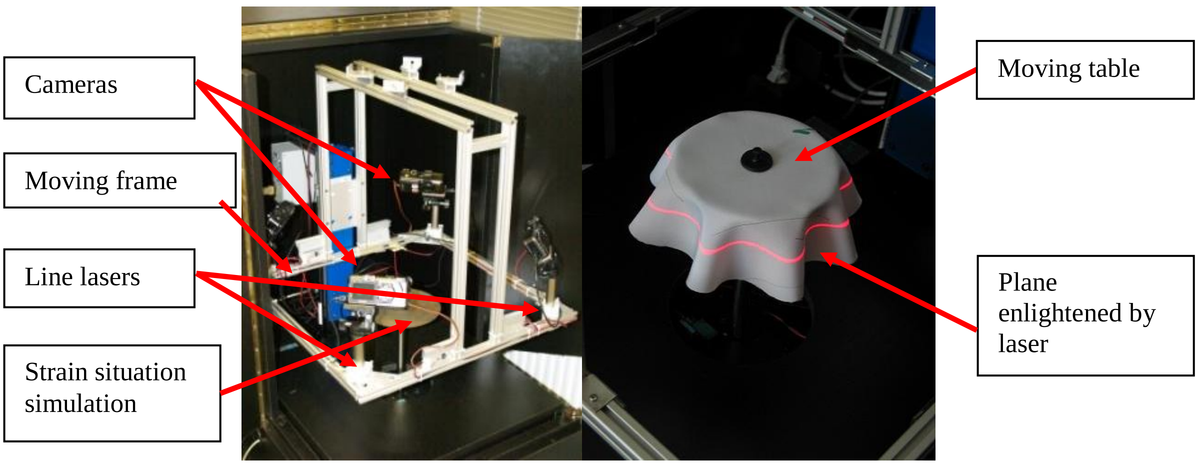


Figure 1. Sylvie 3D Drapetester

3. MEASUREMENT BY THE EQUIPMENT

Laser beams light a planar curve in every position of the frame. Then points of the curve are defined by processing of four pictures together. For 3D scanning, the plane to plane perspective transformation is bijection. Real corners of a rectangular calibration element and corner positions in pictures shown in Figure 2 are appropriate to define transformation parameters by homogenous coordinates [10] or by iterative calculation process [11].

There is an automated corner based calibration process integrated. Determination of corner coordinates starts at the corner closest to the actual camera. If we define the point of the edge image in the coordinate system connected to the left-bottom corner of the photo, then regression lines can be defined for every x_s on section $x<x_s$ and $x>x_s$. Let the error of the regression H is a function of x_s! In other words $H(x_s)$ is the sum of the differences of y_i point coordinates and the $a*x_i+b$ lines with unknown parameters (x_i are point coordinates) in front of the corner and behind the corner Eq. (1).

$$H(x_s) = \sum_{x_i<x_s}(y_i - (a_{x<x_s}x_i + b_{x<x_s}))^2 + \sum_{x_i>x_s}(y_i - (a_{x>x_s}x_i + b_{x>x_s}x_i))^2 \quad (1)$$

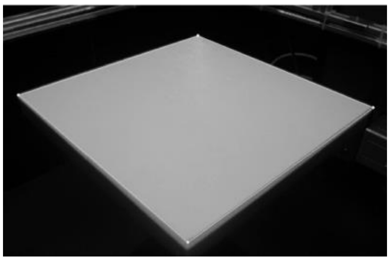


Figure 2. Quadrangle of the Calibration

Minimum of $H(x)$ will be at the real position of the corner at $x*$. Substituted back on $x<x_s$, or $x>x_s$ section y* will be identifiable. Coordinates farthest away from the camera can be counted similarly. The only difference is that regression lines should be searched on the edges of the square. Corner points on the left and right sides are derived as the intersections of the defined regression lines.

By calibration data the point-cloud of surface points are measured and edge points are determined by picture processing methods (Figure 3.).

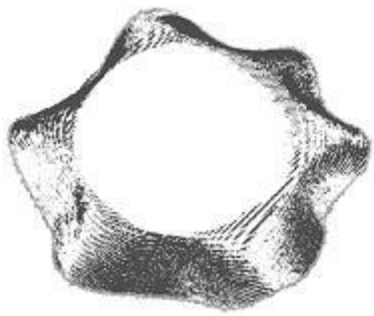


Figure 3. Pointscloud and Edgepoints

4. 3D RECONSTRUCRION

Edge curve is approached by a slice of Fourier series [12] in the cylindrical coordinate system Eq. (2). Size of the slice (n) can be defined by the software.

$$\begin{bmatrix} R \\ z \end{bmatrix}(\varphi) = \frac{1}{2}\begin{bmatrix} a_{R0} \\ a_{z0} \end{bmatrix} + \sum_{i=1}^{n}\begin{bmatrix} a_{Ri} \\ a_{zi} \end{bmatrix}\cos(i\varphi) + \sum_{i=1}^{n}\begin{bmatrix} b_{Ri} \\ b_{zi} \end{bmatrix}\sin(i\varphi) \quad (2)$$

Fourier coefficients are defined by least square method. If the N measured cross-edge points of the actual level are ($[R_k, z_k]^T, \varphi_k$) then the a_{Ri}, b_{Ri}, a_{zi}, b_{zi} coefficients are defined by the minimum of a functions Eq. (3) and Eq. (4).

$$\sum_{k=1}^{N}\left\{R_k-\left[\frac{1}{2}a_{R0}+\sum_{i=1}^{n}a_{Ri}\cos(i\varphi_k)+\sum_{i=1}^{n}b_{Ri}\sin(i\varphi_k)\right]\right\}^2=\min \tag{3}$$

$$\sum_{k=1}^{N}\left\{z_k-\left[\frac{1}{2}a_{z0}+\sum_{i=1}^{n}a_{zi}\cos(i\varphi_k)+\sum_{i=1}^{n}b_{zi}\sin(i\varphi_k)\right]\right\}^2=\min \tag{4}$$

Upon $z(\varphi)$ function of edge curve $z_i(\varphi)$ level functions (i=0…n) can be defined by Eq. (5).

$$z_i(\varphi)=i\,\frac{z(\varphi)}{n} \tag{5}$$

With help of $z_i(\varphi)$ function point-cloud is processed and $R_i(\varphi)$ functions are approached by Fourier slices as it was shown in Eq. (2). Geometry of the sample is modelled by Bezier surface patches. Control points of patches are on level curves. Patches are connected to each other continuously in first order by the Catmull-Romm model. Edge slopes are defined by the vertices of the actual element, too [7] (Figure 4).

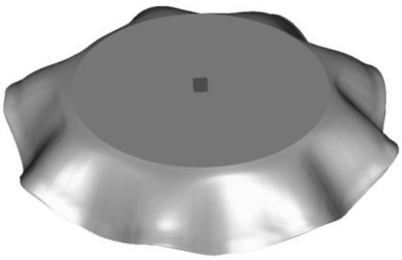
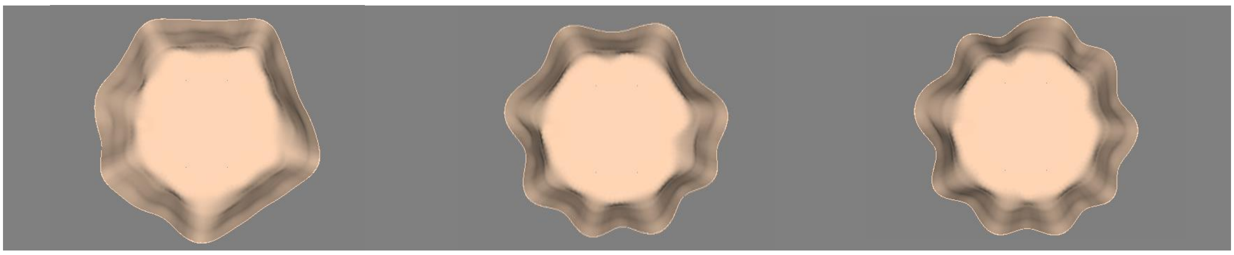


Figure 4. The Approximated Geometry

5. STRAIN SITUATION SIMULATING WITH DIFFERENT RINGS

Different dynamic stress situations are modeled rings with different inner diameter. When the table moves up the test-materials are drawn through the inner hole of rings. If we measure without any ring, then the draping process is quasi static. Measuring with different rings simulates throwing the material on the table with different velocity. It is closer to a real wearing situation.



No ring Ring D240 Ring D210

Figure 5. Measuring with different rings

Draping ratio and wavelength of the edge curve of material are decreasing, the number of waves is increasing and draping geometry shape is moderated when rings are used. The smaller inner radius makes more influences. Figure 5 shows the different resulting simulations while Figure 6 shows the change in draping coefficient as the function of the ring diameter.

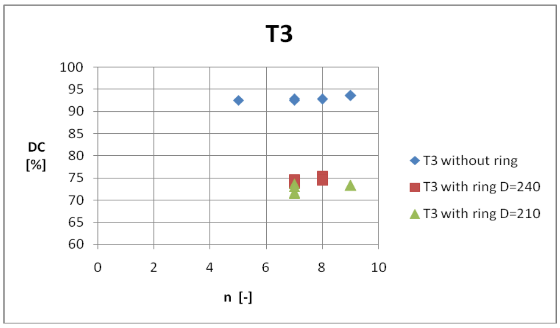


Figure 6. The change in draping coefficient as the function of the ring diameter

6. CONCLUSIONS

In this study, the Sylvie 3D Drape Tester which includes a 3D laser scanner and a step-motor based laying mechanism was introduced briefly. The dynamic strain imposed on a draped fabric was considered as the main cause for high deviation in shape wrinkles. Therefore, the effect of step-motor based fabric laying mechanism was discussed as oppose to the manual fabric laying on traditional fabric drape equipments. The influence of ring diameter in fabric drape measurement was also discussed. Test results indicated that draping ratio and wavelength of the edge curve of material are decreasing, the number of waves is increasing and draping geometry shape is moderated when rings are used. The smaller inner radius makes more influences.

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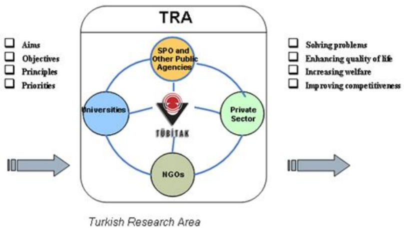

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