Drape simulation and subjective assessment of virtual drape

E Buyukaslan1-2, F Kalaoglu1 and S Jevsnik3

1Textile Engineering Department, Istanbul Technical University, Turkey
2 Fashion Design Department, Istanbul Bilgi University, Turkey
3Faculty of Technology, University of Banja Luka, Republic of Srpska

Email: kalaoglu@itu.edu.tr

Abstract. In this study, a commercial 3D virtual garment simulation software (Optitex) is used to simulate drape behaviours of five different fabrics. Mechanical properties of selected fabrics are measured by Fabric Assurance by Simple Testing (FAST) method. Measured bending, shear and extension properties of fabrics are inserted to the simulation software to achieve more realistic simulations. Simulation images of fabrics are shown to 27 people and they are asked to match real drape images of fabrics with simulated drape images. Fabric simulations of two fabrics were correctly matched by the majority of the test group. However, the other three fabrics’ simulations were mismatched by most of the people.

1. Introduction

Computer technology has been used for clothing industry for many years. Lately, simulation power of computers are drawing attention of apparel industry and online retailers. A satisfactory representation of a fabric drape and garment fit may tremendously change the future of apparel industry and online shopping. If simulations are realistic enough, this may help fabric and garment manufacturers, as they will be able to see simulation before production and make necessary amendments. Much drastic influence is expected for online shopping. It is reported that the returns for online apparel purchasing is strongly correlated to fit problems [1]. Big fashion brands hesitate or slow motion to adapt their sales activities to e-commerce due to customer’s fitting concerns. For example, H&M- one of the biggest apparel company- started online sales activity on 2013 only [2]. E-retailing apparel companies usually demonstrate their garments on a live model or with a high quality picture of the garment alone. Some web sites also offer zoom-in functions to provide clearer vision of fabric patterns and quality. There are also some attempts to enable customers to insert their body measurements to an online system and create their own parametric body models.

So far, none of the developed virtual systems are realistic enough and do not present a satisfactory image of garments on mannequins. The main problem of fabric/garment simulation is the complex structure of fabrics. Fabrics are non-linear structures and they deform under low stresses. Gravitational force, body movements, fabric-fabric friction and body-fabric friction influences the drape behaviour of garments. There are many studies to understand garment drape properties. However, the drape behaviour of fabrics and fitting of garments in virtual environment is relatively a new research topic. To understand garment fit in virtual environment, first, we need to understand fabric simulation well. There are several studies done in the literature so far. Ngoc and Anh studied fabric and garment drape in real and in virtual environment. They used six different fabrics and observed the drape behaviour of the real garment and virtual garment. They used a commercial 3D simulation software (V-stitcher),
observed drape coefficients, and drape profiles. They concluded that simulations reveal bigger and deeper folds while the real garment folds seem softer and smoother [3]. In another study, researchers scanned 20 different fabric samples draped on a pedestal and processed the 3D scanned images by an image analysis software and calculated drape properties (node number, drape coefficient and node depths). Meanwhile actual drape properties of real fabrics were measured by Cusick drape meter. Eventually, they used t-test to calculate the drape differences between the virtual model and real fabric. They concluded that fabric drape behaviour may variate for each test trial, so there is no certain target simulation. They stated that simulation is successful if drape coefficient of simulation is ±15% of real drape [4].

In this study, we observed drape simulations of five different fabrics by using a commercial 3D garment simulation software (Optitex). We showed drape images of real fabrics and simulated fabric images to 27 people and asked them to match simulation images to their actual counterparts. Additionally, we calculated drape coefficients of real drapes and virtual drapes to make a quantitative comparison. According to Kenkare and his colleagues assumption [4] we checked the accuracy of simulation by calculating drape coefficient of virtual image and real drape.

2. Experimentation

Five different fabric samples with similar constructions, compositions and weights are selected for this study. The purpose of doing so was to observe the simulation power of software for similar fabrics. One fabric was considerably different from others (see Table 1).

### Table 1. Textile Properties of fabric samples

| Fabric Code | Yarn Types (warp/weft) | Weave Type | Yarn Density (warp/weft) | Weight (g/m²) | Composition |
|-------------|------------------------|------------|--------------------------|---------------|-------------|
| A           | 30/1 RNG - 30/1 RNG    | 2/1 S Twill | 52/29                    | 168           | %100 Cotton |
| B           | 30/1 RNG - 24/1 RNG    | 2/1 S Twill | 60/35                    | 217           | %100 Cotton |
| C           | 30/1 RNG - 30/1 RNG + 44 DTEX EA | 2/1 S Twill | 59/28                   | 189           | %97 Cotton, %3 Elastane |
| D           | 20/1 RNG - 16/1 RNG + 78 DTEX EA | 2/1 S Twill | 53/23                   | 264           | %98 Cotton, %2 Elastane |
| E           | 37/2 RNG-37/2 RNG      | Fishbone   | 19/18                    | 215           | %100 Wool   |

2.1. Fabric Tests

Fabric samples were conditioned in standard atmospheric conditions before testing (BS 5058, 1974) and cut into 36 cm of diameter circular patterns. Fabrics’ drape tests are done by Cusick drape meter [5]. Image analysis is the most reliable and accurate method to measure drape parameters [6]. Vangheluwe and Kiekens are the first scholars to make use of image analysing software to calculate drape coefficient (DC) by counting pixels [7].

In this research an open-access image analysis software, ImageJ [8] was used to calculate DC of test fabrics. A camera was placed on top of Cusick drape meter. Real drape images of fabrics were then transferred to the computer and analysed by Image J in order to calculate DC. Virtual drape coefficient was also calculated by Image J. Simulation software (Optitex) allows users to display top view of draped fabric. Top view of the simulation is used to calculate DC value.

Mechanical testing of fabrics was done by Fabric Assurance by Simple Testing (FAST). FAST system was developed by CISRO in Australia to objectively measure fabric hand and the influence of
fabric mechanics on garment performance [9]. Mechanical test results are necessary to create simulations of fabric drape.

2.2. Real Drape and Virtual Drape

We couldn’t picture fabric samples on Cusick drape meter from several angles because of the box construction of instrument. Therefore, a circular pedestal, exactly at same dimensions as Cusick drape meter’s disc size (18 cm diameter, 2 mm thickness) was developed. Samples are allowed to hang freely on pedestal and drape images of fabric samples are shot from four different angles (front, back, left and right) by a camera.

To simulate fabric drape, a virtual pedestal, as same as actual pedestal, was created by a commercial 3D modelling software (3ds Max® by Autodesk) and imported into Optitex simulation software. 36 cm diameter digital fabric patterns were prepared by Optitex Pattern Making Suite. Finally, mechanical properties of fabrics measured by FAST system were converted to Optitex values to insert to simulation software. Optitex enable users to save simulation pictures from five different angles (front, back, left, right and top).

![Figure 1. Actual pedestal used to overlay circular fabrics](image1)

![Figure 2. Virtual pedestal created by 3dw Max](image2)

Images of real drape and virtual drape are converted to 16 bit, sharpened and contrast enhanced by 2% by ImageJ. The purpose of the image processing was to minimize effects of photo shooting such as light, colour and shadows.

3. Results and Discussion

Real drape images of fabric samples and their simulations are shown in figure 3 and 4

As mentioned earlier, we calculated drape coefficients of fabric samples for real drape and virtual drape by image analysis method. Calculated DC values of real drape and drape simulation of fabrics are given in Table 2.

| Table 2. Drape Coefficient (DC) values of real fabrics and fabric simulations |
|-----------------|-----------------|-----------------|
|                   | Real DC (no unit) | Virtual DC(no unit) | Percentage Difference (%) |
| A                 | 0.41             | 0.49             | +19,5                      |
| B                 | 0.60             | 0.39             | -35,0                      |
| C                 | 0.52             | 0.30             | -34,6                      |
| D                 | 0.71             | 0.57             | -19,7                      |
| E                 | 0.28             | 0.45             | +61,3                      |
It is necessary to re-mention Kenkare and his colleagues’ study that is explained in depth in introduction part. Their approach is “simulation is successful if drape coefficient of simulation is ±15 % of real drape” [4]. In Table 2, the percentage difference of real DC’s and virtual DC’s are given. According to the table, the simulations of Fabric A and D are the most accurate ones in terms of drape coefficients. However, they are still not within acceptable limits (±15 %) to be accepted successful. Fabric E simulation is far beyond the limits; therefore, it is the least accurate simulation according to the assumption.

It is true that drape coefficient is not yet along enough to judge simulation accuracy. So, we also asked 27 people to match simulated images with real drape images and tried to understand subjective evaluation of simulation success.

Figure 3. Real drape images of fabrics from different views

Figure 4. Drape simulations of fabrics from different views (created by Optitex)
Table 3. Results of real drape image and simulation image matching test (number of people)

|       | A    | B    | C    | D    | E    |
|-------|------|------|------|------|------|
| Real  |      |      |      |      |      |
| A     | 7    | 7    | 5    | 8    | 0    |
| B     | 1    | 14   | 3    | 7    | 2    |
| C     | 11   | 1    | 5    | 6    | 4    |
| D     | 7    | 2    | 12   | 6    | 0    |
| E     | 1    | 3    | 2    | 0    | 21   |

According to table 3, most of the subjects could match simulations of fabric B and Fabric E to their actual counterparts. (14 people for Fabric B, 21 people for Fabric E). For Fabric A, 26% of the subjects could match images while this ratio is 52%, 19%, 22%, and 77% for Fabric B, Fabric C, Fabric D and Fabric E respectively. The average success rate of simulation is the mean of these values, which is 39%. Subjective evaluation of the simulation quality confirms that Fabric B and E simulations are the closest to the real drape behaviour while the least successful simulation belongs to Fabric C.

4. Conclusion
In this study we observed drape behaviour of five different fabrics in reality and in virtual environment. The fabrics are tested mechanically by FAST system and these values are inserted in simulation software (Optitex). Drape test of real fabrics were measured by Cusick drape meter and drape coefficients were measured by an image analysis software. Real drape behaviours of circular fabrics were observed on a circular pedestal and images were saved from four different angles. To create drape simulations to correspond the real drape of fabrics, we first developed a 3D model of the circular pedestal. Finally, software created simulations of fabrics. Drape coefficients of virtual fabrics were calculated by image analysis. Real drape coefficients and virtual drape coefficients of fabrics were compared. According to this comparison, simulation software capability is poor to reflect drape coefficient property. In addition to quantitative comparison, we also wanted to observe subjective evaluation of drape simulation. So that, drape images of real and virtual fabrics are shown to 27 subjects and they are asked to match images. Even though, comparison of drape coefficient is substantially different for real and virtual drape, most of the subjects could match simulations to their actual counterparts correctly for Fabric B and Fabric E. The average success rate of simulation (only evaluating image matching capability of subjects) is calculated as 39%.

The drape coefficient comparison and subjective matching of real and virtual drape images of tested fabrics showed that the simulation software (Optitex) is sufficient to some extend to reflect drape properties. However, it is a fact that users will not adapt to this new technology unless the simulation is lifelike realistic.

5. References
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