Evaluation of Fabric Drape Coefficient Using Image Processing and Fractal Dimension

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***Abstract*— recently, there has been a renewed interest in investigating the aesthetic behavior of fabrics due to the developments in objective evaluation techniques. To understand drape behavior, it is essential to know how drape is measured quantitatively. In this study, at first the application of an imaging system to the detailed objective measurement of the drape profiles of a range of woven fabrics, captured from a common drape tester, is investigated. Drape coefficient values collected via the image processing technique correlate strongly with those established using the common cut and weigh approach. In next fractal dimension based on count boxing method is used to evaluate the image fabric drape. The result shows that fractal dimension method can be used to determine the fabric drape as well as common drape coefficient.**

Keywords- drape; image processing; fractal dimension

I. INTRODUCTION

Fabric drape is one of the most important fabric properties due to its effects on the appearance of clothing. Drape is defined as “the extent to which a fabric will deform when it is allowed to hang under its own weight” [1]. Drape is the main factor that affects the aesthetics and dynamic behavior of fabrics determining the adjustment of clothing to the human silhouette and providing the description of the fabric deformation produced by gravity when the fabric is partially supported. This unique characteristic provides a sense of fullness and a graceful appearance, which distinguishes fabrics from other sheet materials. In order to measure this fabric property, Research Laboratories developed the F.R.L Drape meter [2]. Later Cusick [1], developed a drapemeter based on similar principles. By developing drapemeters, significant contribution to the practical determination of this fabric property is achieved. In Fig.1 a drapmeter system is illustrated. As it’s shown in Fig1.b bigger Plate shows a circular specimen of fabric about 36 cm in diameter supported on a circular disk of 18 cm diameter on the drapemeter.The unsupported area drapes over the edges of the support disk forming the drape configuration of the fabric specimen. The drape coefficient (DC) defined as: area under draped sample Divided by area of specimen. In order to calculate the areas in this method, a circular piece of paper, of radius R, is placed under the center of the tester.

The perimeter of the shadow of the draped fabric is then drawn on the paper. The circle of paper is folded and weighed to give W1. The paper is then cut along the perimeter of the shadow, and the paper in the shape of the shadow of the area A is weighed to give W2. DC is expressed as the ratio of W1 and W2.

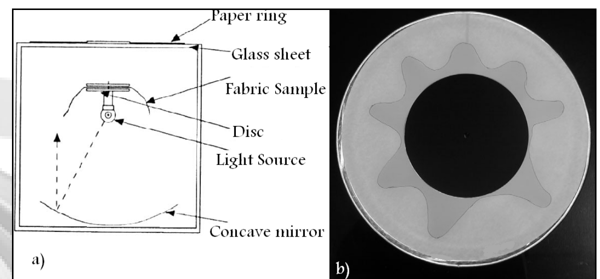

Fig. 1: a) Drape meter schematic b) Drape configuration of fabric on drape meter

In 1993 Vangheiuwe and Kiekens employed digital Image Analysis to measure the drape coefficients of a fabric due to the pixels showing on the projected area [3]. That way the subjectivity caused by the paper-weighting method could be avoided. In 2005, Kenkare and May-Plumlee captured a digital image of draped fabric using Cusick’s Drapemeter, which was then processed using Adobe Photoshop software to measure the drape coefficient [4 -5]. In 2007, Shyr and Cheng successfully developed an automatic measuring system for dynamic drape to evaluate the static and dynamic drape coefficients of natural-fibre fabrics [6].

II. METHODOLOGY

Typically the image analysis setup is illustrated in Fig.2 which consists of a drapemeter, a digital camera to capture the draped image of the mounted fabric sample, and a computer to analyze the captured image and translate it into appropriate output. The method used in this study for locating the drape contour of fabric is shown in Fig.3. The steps include the use of a drape image, conversion to a gray scale image, calculation of the gradients of the image, calculation of the threshold value of the gradients using Kittler & Illingworth’s threshold method, and finding the edge points of the fabric contour from the outer margin.

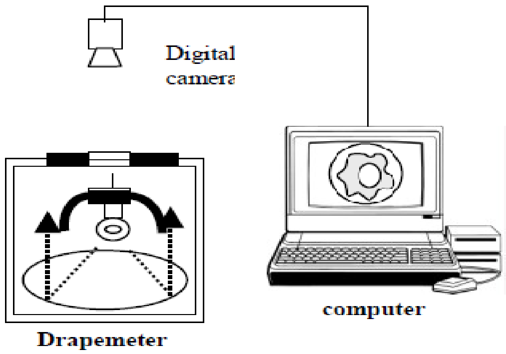

Fig. 2: Image analysis setup for DC calculation

The connection of these points forms a contour, which is then used to calculate the area of the fabric drape, and the drape coefficient.

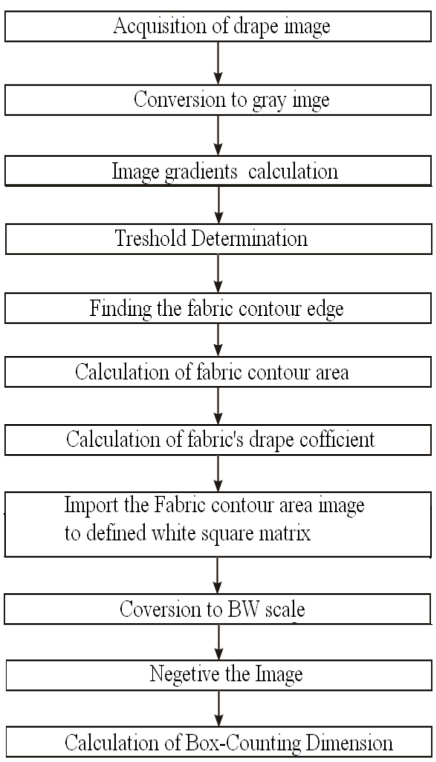

Fig. 3: Diagram of procedures for locating a drape fabric's contour

In order to calculate the drape Coefficient in draped fabric image, according Fig.4 the area of the draped fabric in proceed image (A_1) and the fabric area without drape (A_2) are determined and DC is defined as ratio of A_1 and A_2.

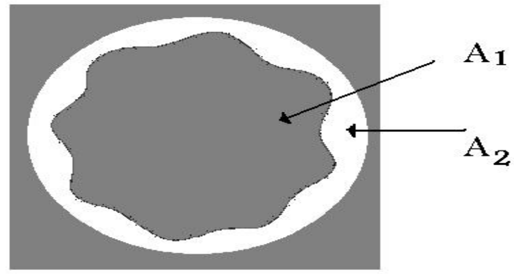

Fig. 4: A_1) draped fabric area, A2) fabric area

Fig.5 shows the image processing steps to achieved Draped fabric contour and DC calculating.

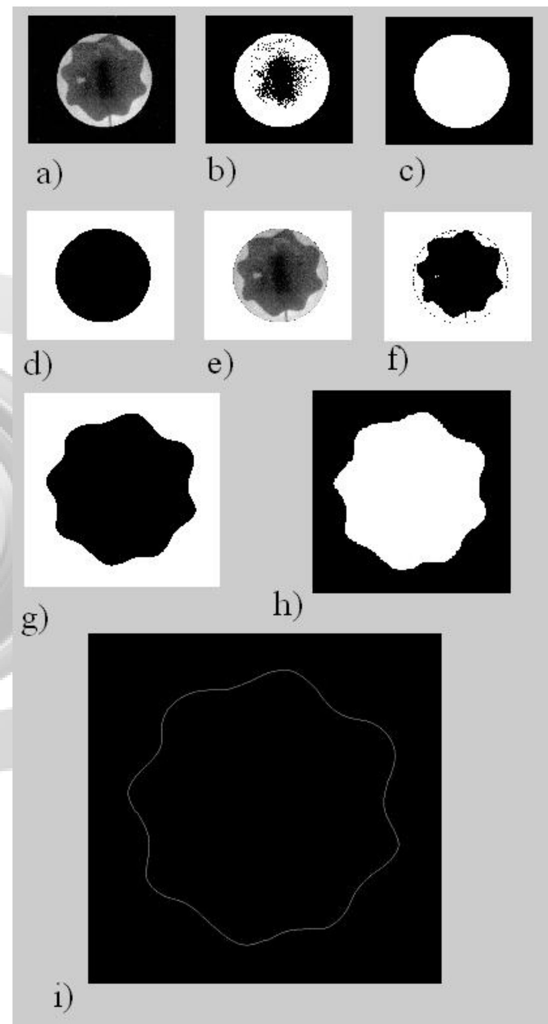

Fig. 5: image processing steps: a)gray scaling, b) BW scaling c)holes filling, d)negative image, e)adding gray scale image to negative image, f)BW converting ,g)noise omitting ,h) negative image, i)edge finding.

A. Box-Counting Dimension

The box-counting algorithm is the most widely used method to estimate the fractal dimension. The reason for its popularity lies in its simple computer implementation and its wide applicability to features with or without self-similarity. In addition, the box-counting algorithm can be carried out in two or three dimensions. To compute the box-counting dimension, the image is subdivided into equal-sized squares of side length ***s***. Under the assumption of a binary image (background of value zero, image object(s) of nonzero value), all boxes that contain at least one nonzero pixel are counted. Then the box size s is increased by a certain factor, usually doubled. The resulting data pairs of box size s_k and counted boxes n_k are then log-transformed, and the box-counting dimension D_B is determined by linear regression [7]:

$$\log n_k = -D_B \log s_k \qquad (1)$$

Fig.6 illustrates the box counting dimension graph for drape image Fig.5i.the dimension is defined as the slope of the graph.

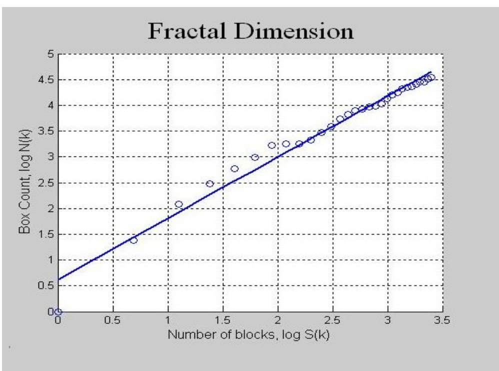

Fig. 6: box counting dimension graph for drape image Fig.5i

III. EXPERIMENTS

A. *Material*

The present study obtained empirical results for 30 selected samples of three different woven fabrics drape. The fabric properties are given in Table I. Fabric for the experiment was bought from the open market.

TABLE I: WOVEN FABRIC PROPERTIES

Sample code	*Fabric type*	*Warp density ends/cm*	*Weft density picks/ cm*	*Thick-ness mm*	*Weight g/m2*	*Pattern*
PE_L	polyester	31	23	0.33	114	plain
PE_H	polyester	40	25	o.36	120	plain
WP	45%wool 55%polyester	30	26	0.56	222	twill

B. *Results*

The drape Coefficients of all fabric samples evaluated by common technique which using paper weighting. Fourth more drape Coefficient is calculated by using image analyzing which described in part 2.the result which is illustrated in Table II shows very strong correlation between common and image proceeds drape Coefficient(r=0.99).this mean that the image processing technique which is used to extract the essential data to calculating drape Coefficient, has not reduced the image accuracy. In next step the fractal dimension of samples based of count-boxing method is determined. As it's shown in Fig.7 the behavior of fractal dimension and drape Coefficient is the same. That implies that fractal dimension can indirectly describe the fabric behavior of the fabrics. The reason of this treatment is lies on the effect of fabric drape on fabric image contour, which means the fabric with high drape behavior cause more complex contour in fabric image and with the aim of that the fractal dimension for complex shapes is higher than simple geometrical shape, the result will the same as DC.

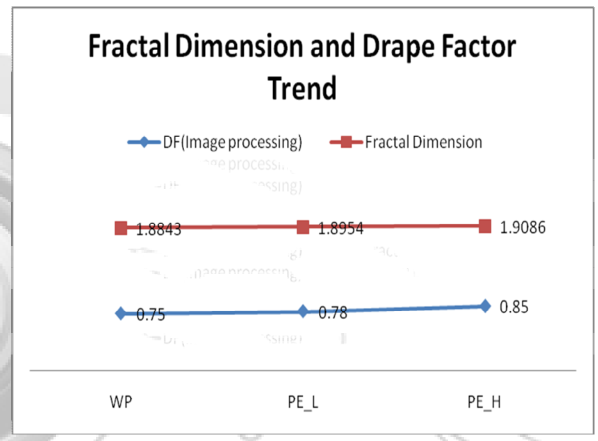

Fig. 7: comparing the fractal dimension and drape Coefficient trend

TABLE II: THE RESULT OF DC CALCULATION IN COMMON AND IMAGE PROCESSING METHOD AND DETERMINING FRACTAL DIMENSION OF ALL SAMPLES

No	*Sample WP*		
	DC Paper weighting	*DC Image processing*	*Fractal Dimension*
1	0.75	0.77	1.8906
2	0.73	0.73	1.8775
3	0.72	0.75	1.8855
4	0.74	0.75	1.8851
5	0.74	0.74	1.8808
6	0.74	0.76	1.8886
7	0.74	0.75	1.886
8	0.73	0.76	1.8872
9	0.74	0.75	1.8837
10	0.72	0.73	1.8784
mean	0.74	0.75	1.8843

No	*Sample PE_L*		
	DC* *Paper weighting	***DC* *Image processing***	***Fractal Dimension***
1	0.76	0.81	1.9033
2	0.79	0.78	1.8931
3	0.77	0.79	1.8976
4	0.77	0.78	1.8955
5	0.77	0.79	1.8985
6	0.77	0.77	1.891
7	0.78	0.77	1.8938
8	0.78	0.79	1.8966
9	0.76	0.77	1.8906
10	0.76	0.78	1.894
mean	0.77	0.78	1.8954
No	*Sample PE_H*		
	DC* *Paper weighting	***DC* *Image processing***	***Fractal Dimension***
1	0.84	0.84	1.9076
2	0.87	0.85	1.9095
3	0.85	0.84	1.9071
4	0.87	0.84	1.9058
5	0.89	0.86	1.9124
6	0.84	0.84	1.9095
7	0.9	0.84	1.9082
8	0.85	0.85	1.9083
9	0.86	0.85	1.9121
10	0.85	0.84	1.9054
mean	0.86	0.85	1.9086

IV. CONCLUSION

The study has indicated that imaging techniques can be implemented on rapid, automatic and cheaper to enable full properties of drape profile of fabrics. Furthermore research shows that the fractal dimension can be also used to describe the drape properties of the fabric. The advantage of using fractal method is extracting the information from the shape of the draped fabric .in other word the main disadvantage of common method is using the area ratio to describe the drape of the fabric. And drape is directly effect on a shape of the fabric, for example it can possible that two different draped fabrics have same area but different shapes however DC method gives same result.

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