Design & Development of Digital Drapemeter

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Abstract - **Drape is one of the most important aesthetic property for the apparels. Traditionally fabric drape is assessed by the principle based on Cusick drapemeter. In the current research, the modified method for acquiring the digital images is used because Cusick's drapemeter and other commercially adopted drapemeters have few drawbacks. Manual error in tracing the draped image of fabric is one of its serious disadvantages. The work focuses on design & development of digital drapemeter and its software in Matlab for processing of acquired images. The result for the drape coefficient of the fifteen varying fabric weights shows good correlation with the BTRA drapemeter based on the principle of Cusick's drapemeter.**

Keywords - **drape, aesthetic, drapability, digital, Matlab, BTRA drapemeter**

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1. Introduction

Drape is an important factor affecting the aesthetic property of fabrics. Fabric drape is a very important low-stress mechanical property because it influences the appearance of clothing [1]. Drape determines the adjustment of clothing to the human silhouette. Drape is defined as "extent to which a fabric will deform when it is allowed to hang under its own weight." (IS: 8357 - 1977) [2].

Drape of fabrics was evaluated subjectively by a panel of judges in the early days of evaluating fabric aesthetic characteristics. Structured objective investigation of fabric drape behaviour can be traced back to a classic paper authored by Peirce [3]. Fabric drape was carried out by using a drape coefficient since 1950 by the development of the Fabric Research laboratories drapemeter. After that for the measurement of the drape parameters, methods were proposed by Chu et al in 1960 [4]. Further, Cusick [5, 6, 7] designed and developed drapemeter which is widely used to measure drape of the fabrics in the textile and apparel industries.

2. Methods

In the conventional method, a circular fabric which is sandwiched between the two discs of 12.5 cm diameter. An actinic source of light placed directly above the center of the discs with suitable attachment to give a parallel beam of light. A sheet of ammonia process paper is placed horizontally below the draped specimen. A metal template of 25 cm diameter is used to cut and hold the sample centrally. When the light falls on the specimen, the part of draped sample with ammonia is traced by weighing the traced ammonia paper the drape coefficient is calculated [1].

Attempts have been made by the Vangheluwe and Kiekens measured the drape coefficient using image analysis. CCD camera is mounted centrally above the drapemeter. The frame grabber digitizes the image. The drape coefficient is calculated by areas of the specimen and not on the masses. By using this the authors investigated the time dependence of drape coefficient at 10 minutes interval [8].

Since the present conventional technique is based on tracing of the draped image of the draped fabric, it is the subjective and laborious too. There will be subjective variation while tracing, cutting and weighing of the ammonia paper and it will be more time consuming. Hence, the present technique of drape measurement limits the use of drape in quality assurance.

3. Design and Development of digital drapemeter

3.1 Principle of the instrument

BTRA drapemeter based on Cusick principle is used for the drape calculation. A circular fabric specimen is sandwiched between two horizontal discs of smaller diameter, and the unsupported annular ring of fabric is allowed to hang down under the action of gravity. A planar projection of the contour of the draped specimen is recorded by the camera. The drape pattern obtained is processed through the software for the image analysis. The drape coefficient is calculated as the ratio of the projected area of the draped specimen to its theoretical maximum [9].

3.2 Designing of the instrument

Designing of the instrument is done by an exhaustive literature survey and in consultation with textile experts based on the BTRA drapemeter. Design changes were done into the existing conventional drapemeter for the accurate image acquisition and for a better reflection of the light source.

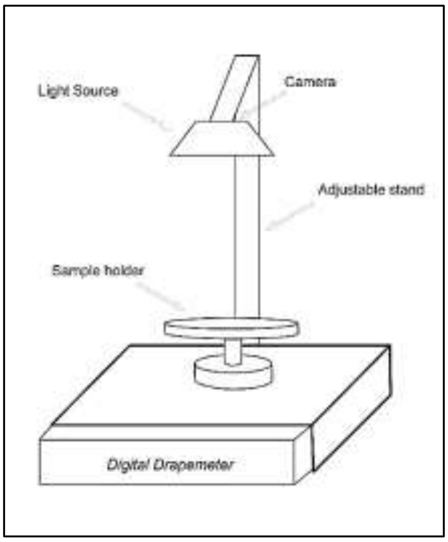

Figure 2: schematic diagram for the drape measurement

The figure 2, shows schematics of the image acquisition and analysis for drape measurement. The instrument length is 38 cm, width is 41 cm and the height of the instrument is kept 64 cm. The height of the drapemeter can be adjusted with screwing arrangement. The calibration of the instrument is done by adjusting the height of the instrument. Finally, the height was kept 64 cm. Fabric sample holder is of small two discs having a diameter of 12.5 cm. The sample holder discs are at the height of 7.5 cm from the base of the instrument. The lower disc with a screw for holding sample is fixed to the metal rod.

3.3 Fabrication of the instrument

As shown in figure 3, the setup is having a rod which is attached to screw so that the proper height of instrument can be adjusted. For all the fabric samples the height of the instrument was adjusted to 64 cm and fixed for the drape calculation. The CFL light source was fitted at the top side of the instrument so that the shadow of the drape images can be acquired easily. The camera of Zebronics brand was attached with the USB cable to the computer / Laptop.

Initial trials show the disturbance in the image acquired from the current light source. Hence the cardboard cabinet is used for the draped image acquisition from drapemeter.

Figure 3: Newly developed digital drapemeter

The cabinet is made with the cardboard box by fixing it to all the corners. A front opening is kept in the cabinet so that the samples can be easily mounted on the platform.

3.4 Image acquisition and its processing

The draped image of the sample is acquired by the webcam and saved on the laptop. The image acquired is the colour image. This required being converted into the binary image with the thresholding technique. For the image processing, Matlab® software is used. The image acquisition and conversion process is shown in figure 4.

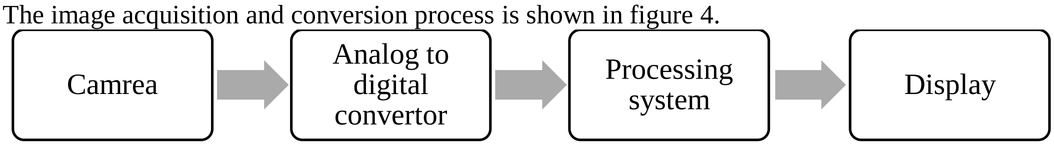

Figure 4: Basic component of an image processing

3.5 Drape coefficient by Matlab

The draped image of the draped sample is taken from the top of the machine. The image is transferred to the computer with USB cable. The draped image gives the value of 0 to 255 for the 3D image in RGB. The drape evaluation process is shown in figure 5.

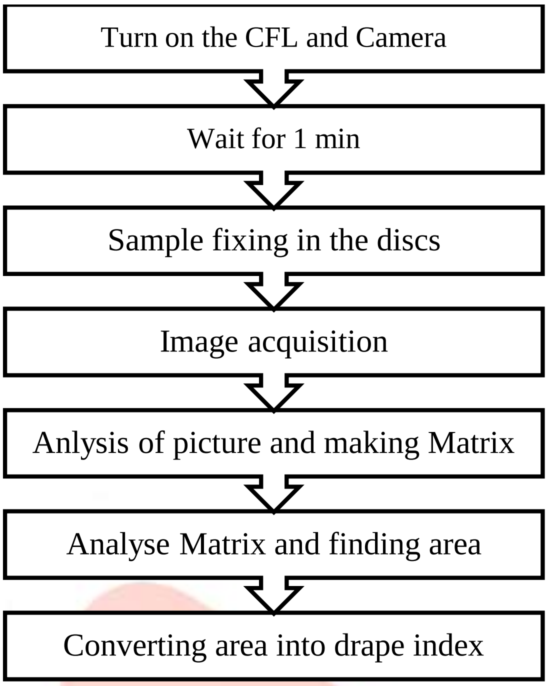

Figure 5: Process for drape measurement on the newly developed instrument.

For the draped area calculation the obtained value has to be converted into 0 or 255 so it will give the 2D image in black and white respectively. For easy calculation of drape area, The RGB image is converted into the binary image. So that it can give the binary numbers 1 and the remaining portion is given by 0. The detailed code for image acquisition is given in appendix I for the reference.

4. Graphical user interface

As shown in figure 6, graphical user interface (GUI) is prepared by using software. This GUI is the quick and easy interface so that user can easily access the software. This avoids the repetitive work of executing the same program and so it is much user-friendly.

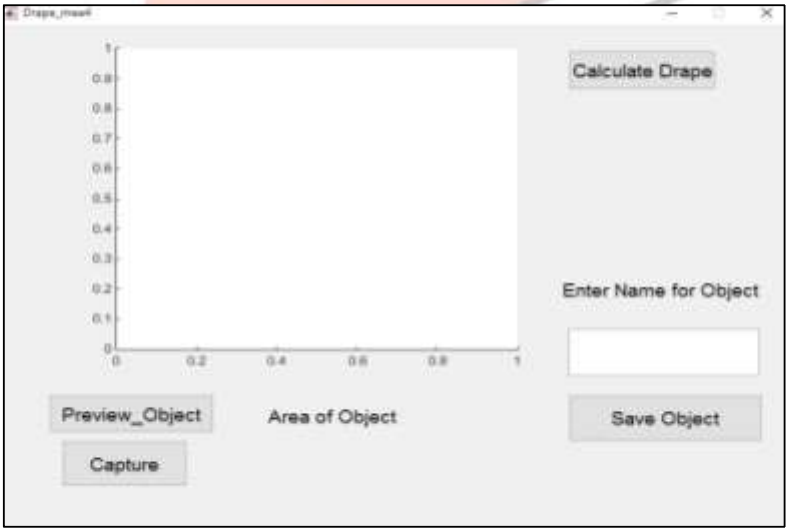

Figure 6: graphical user interface used for the drape measurement

The graphical user interface has the following interface keys.

1. Preview object: This button gives the preview directly of the object which was connected with USB webcam to the laptop or the personal computer. So initially to preview the draped image this button is used.
2. Capture: The capture button is used to capture the draped image of the fabric samples used under study. The capture will automatically with the software defines the boundary of the images captured so that only the draped area will be captured for the drape calculation.
3. Calculate drape: This button is used to calculate the drape of the fabric. This gives directly the drape coefficient values with the GUI. The calculate drape will compare the total area of the bigger disk used for the sample cutting. This area will be compared with the draped area acquired through the camera used for this instrument.
   the formula used for the drape calculation

$$Drape\ coefficient\ \% = \frac{Total\ area\ of\ the\ draped\ sample}{Total\ area\ of\ the\ actual\ sample(Disk\ area)} * 100$$

4. Enter the name of the object: The images acquired are further required for the study of the node profiles. So this button is given which will facilitate to enter the name to the images acquired and save directly it to the folder for the drape. So that the images can be used for the study purpose.
5. Save object: As explained earlier this button will save the images directly into the folder. So that the same images can be used for the further study.

5. Results and Discussion

5.1 Drape coefficient of newly developed digital drape meter

The study was carried for the coefficient correlation of the digital drapemeter and conventional BTRA drapemeter. Fifteen varying weights of the bottom wear fabrics are used for the study. The drape coefficient values of both the instrument are expressed in table 1.

Table 1: Drape coefficient of conventional and newly developed drapemeter

Sr. No.	Fabric material	Types of Fabric	Drape coefficient by conventional drapemeter	Drape coefficient by New drapemeter
1	Linen	Light weight	72.6	75.66
		Medium weight	86.93	76.67
		Heavy weight	88.01	81.85
2	Cotton	Light weight	70.34	74.63
		Medium weight	74.49	80.01
		Heavy weight	79.01	82.39
3	Polyester-Cotton blend	Light weight	60.91	62.39
		Medium weight	65.17	63.21
		Heavy weight	69.25	66.36
4	Denim	Light weight	68.45	77.31
		Medium weight	78.43	82.86
		Heavy weight	97.86	88.52
5	Corduroy	Light weight	83.53	80.56
		Medium weight	87.3	85.74
		Heavy weight	91.45	95.39

The readings as shown in figure 7 are highly correlated with each other. The Pearson correlation factor is 0.859. Which shows drape coefficient by digital drapemeter are highly and positively correlated with the conventional BTRA drapemeter. The readings from the conventional drape meter are significant with the readings from the newly developed drapemeter.

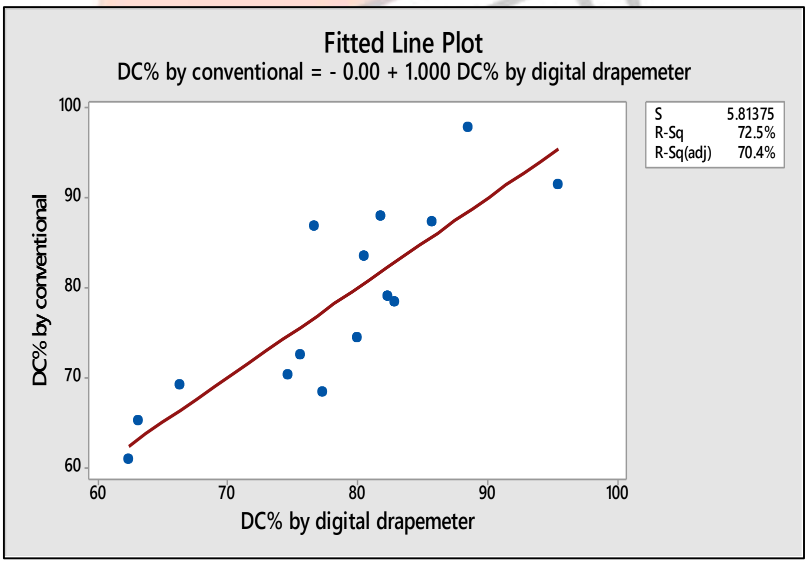

Figure 7: Regression equation for drape coefficient of conventional and digital drapemeter

8. Conclusion

Conventional methods for measuring drape utilizes the instrument developed by the BTRA based on the principle of Cusick before the digital technologies were widely available. In this research, a modified technique for the measurement of the fabric drape using image analysis and Matlab software has been developed. Drape coefficient by the digital drapemeter is highly correlated with the conventional BTRA drapemeter.

The digital method was found to have the advantage of eliminating the need of paper rings, reducing manual errors and storing archived images of the draped samples for future reference. Due to the benefits of the processing draped images using the modified digital method, it is a viable alternative to the current industry practices of processing drape characteristics using conventional BTRA method.

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