The Journal of The Textile Institute
Vol. 102, No. 4, April 2011, 315–321

Taylor & Francis
Taylor & Francis Group

The influence of gray-level co-occurrence matrix variables on the textural features of wrinkled fabric surfaces

Seyed Abdolkarim Hosseini Ravanidi[a,b]* and Ning Pan[b]

[a]*Department of Textile Engineering, Isfahan University of Technology, Isfahan 84156, Iran;* [b]*Department of Biological and Agricultural Engineering, University of California, Davis, CA 95616, USA*

(*Received 21 November 2009; final version received 27 February 2010*)

The gray-level co-occurrence matrix (GLCM), or gray-level spatial dependence matrix, constitutes one of the most important algorithms capable of identifying the repetition, uniformity, disorder, contrast, gray-tone linear dependencies, and heterogeneity of textural features of various surfaces. In this study, to evaluate the wrinkle grade of textile fabrics, the GLCM from an image of a wrinkled fabric surface is established and examined in terms of the spatial displacement of its pixel pairs, the number of gray levels, and the angle orientations. The statistical textural features calculated from the GLCM include five metrics designated as energy, contrast, correlation, entropy, and inverse difference moment. It is revealed from the analysis that for a fresh wrinkle-free fabric surface, the periodicity of the surface geometry dictates the image textural features through alternation in the spatial displacement of the pixel pairs, whereas for wrinkled fabrics, our results show a highly correlated relationship between the objective wrinkle measurement of textural features and the subjective evaluations performed by expert panels. Among the five textural features, the best correlation was obtained between the inverse difference moment and the visual subjective scores, with a correlation coefficient as high as 0.993.

Keywords: inverse difference moment; texture; wrinkling; image processing; gray level

Introduction

When a fabric is subjected to visual inspection, there are many factors that may influence the perceived surface impression, including the fabric geometry, surface texture, wrinkle or crease, wear, and printed patterns, as well as the dimensions of the structural components and the color variations. Wrinkle is one of the most important characteristics in evaluating the visual quality of a fabric surface. Consequently, several methods in assessing the surface wrinkle have been developed since the 1950s (Hebeler & Kolb, 1950). One of these methods is the AATCC replica test (American Association of Textile Chemists and Colorists [AATCC], 1989). In this method, expert observers visually compare a fabric specimen with the AATCC replica standards and assign the specimen with the grade score of a replica of maximum similarity. Such a visual evaluation process, however, is time-consuming and prone to inconsistency due to inherent subjectivity and human bias.

Computer digital image processing can overcome these difficulties for fabric wrinkle grading and evaluation. Three major types of approaches have been developed in computer digital image processing to capture the textural characteristics of a surface, namely the statistical, structural, and spectral schemes. Within the statistical methods, the most common approaches are based on the so-called gray-level co-occurrence matrix (GLCM), whereas the structural techniques generate descriptions of texture for regularly spaced surface structures and the spectral methods detect surface global periodicity via a Fourier spectrum image (Baraldi & Parmiggiani, 1995; Bendat & Piersol, 1983; Cohen, Fan, & Attali, 1991; Escofet, Millan, & Rallo, 2001; Haralick, 1979; Heijmans, 1991; Shokr, 1991; Tien, Lyu, & Jyu, 2008; Tsai & Hsieh, 1999).

Digital image processing has been applied to a variety of applications. In a digital image, two types of signals are acquired to represent the spatial information in a spatial array of $N \times M$ and the degree of gray level to indicate the intensity. By the nature of digital image processing, N and M and the number of gray levels (GL) are expressed in the form of integer power of 2 and are also referred to as the spatial and depth resolutions, respectively (Gonzalez & Woods, 1992).

Some attempts have been made in objective assessments of fabric wrinkle using image processing (Abril,

*Corresponding author. Email: sahosseini@ucdavis.edu; hoseinir@cc.iut.ac.ir

ISSN 0040-5000 print/ISSN 1754-2340 online

DOI: 10.1080/00405001003737540
http://www.informaworld.com