THE DETECTION AND CLASSIFICATION OF TEXTILE PILLING. A REVIEW

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Abstract: One of the criteria for quality assessing of a garment by the consumer is durability. Resistance to pilling is one aspect of durability that controls the appearance of the product and a source of insatisfaction about the product. This paper presents state of the art pilling assessment techniques, with a view on the application of image processing for fabric pilling detection and measurement. The review exposes scientific research in this field starting from the early years till the latest developments. The present study will be finalized on a framework for modern processes of quality assurance for apparels and knitted products using computer vision.

Keywords: pilling, fabric testing, computer vision

1. Introduction

Customers remain the decisive arbiters of the quality of textile products and their performance. They consider factors like cost, comfort, durability, fashion, end use, and perception of others, in a holistic perspective, to consolidate their expectations about the target product [1].

Performance evaluation of a garment by the consumer is based on objective criteria, and subjective factors, but harder to define. Thus, fabric is a component of the product that in addition to physical concrete attributes may induce more abstract concepts in terms of subjective satisfaction of the product. A material that is perceived to be durable can also be perceive as an element of saving money, being worn a longer period of time, helping the wearer feel good, look good and be respected by others [2].

Pilling is a phenomenon that consists in appearance of bunches of tangled fibers on the surface of the fabric or knit, after a certain period of use. They adversely affect the appearance of the product, but also cause a bad touch if fabric is used especially for clothing.

The fabric type conditions pilling resistance of material. Knitted fabrics fuzz and pill more than woven fabrics, because of their released structure, and fuzz is more common for non-woven fabrics due to the presence of bonds [3, 4].

Fabric pilling is influenced by parameters like fiber properties, yarn characteristics, and the finishing processes of fabric. Thus, pills tend to expand on the fabric composed of blended fibre and high tenacity synthetic fiber. The presence of softeners or fibre lubricants on a fabric will increase pilling.

The handling of higher twist yarn, reduced yarn hairiness, longer fibres, increased linear density of the fibre, a high density of fabrics, special mechanical and enzyme treatments to remove released fibre ends and to reduce fibre migration will decrease the tendency to pill [5].

2. Pilling testing methods and instruments

Companies must be able to keep under control this aspect of the product which can lead to decrease customer satisfaction and thus financial losses, through prevention and testing techniques of pilling in different conditions (testing as purchased and after laundering or dry cleaning).

In pilling testing, samples of fabric are exposed to conditions that are likely to end-use wear and development of pills by the action of abrasive materials.

Fabric resistance to pilling test methods includes ICI Pilling Box Tester, Martindale Tester, Random Tumble Pilling Tester, Universal Wear Tester and Brush Tester. In ICI/M&S Pilling Box Tester, samples are fixed on a polyurethane tube and tumbled randomly in a cork-lined box for a definite time (EN ISO 12945-1, BS 8479).

In Random Tumble Pilling Tester, (ASTM D3512), specimen is placed in a cylinder lined with cork and tumbled around within the chamber. Small mass of lint fiber is added to generate lint pills on the fabric.

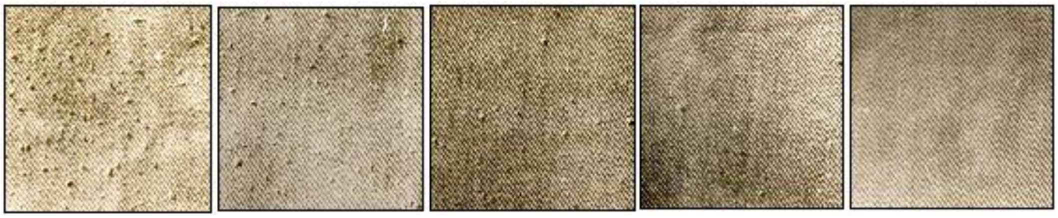
In Martindale Tester (ASTM D4970, ISO 12945-2), samples are rubbing in a straight line that extend into an ellipse and gradually changes into a straight line in the opposite direction until fabric threads are broken or until a shade change happens in the fabric.

In Universal Wear Tester (ASTM D3514), samples are rubbing with a special silicone pad that simulate human skin, like in shirt collars.

Brush Tester (ASTM D3511) has two rotation platforms, one for a smooth brush and the other for specimens. After a time, the brush is removed by another sample, continuing the rubber against the fabric.

Traditional pilling evaluation consists on visual comparison between the samples and standard photographs with a different degree of pilling that have been developed by the standards institutions (ASTM, AATCC, ISO, BS, M&S etc.) [16]. Most scales are divided into five grades, where 5 corresponds to no pilling or surface change and 1 corresponds to very severe pilling (Figure 1).

Durability Performance Specifications for Sample Product Categories [ASTM Recommended Performance Specifications, 1996] recommend for regular apparel the 3.5 pilling value, using Random Tumble Pilling Test for skirts, pants, shorts, outwear products, for 30 minutes.



Grade 1 Grade 2 Grade 3 Grade 4 Grade 5

Figure 1. ASTM 3512 Photographic Pilling Standards

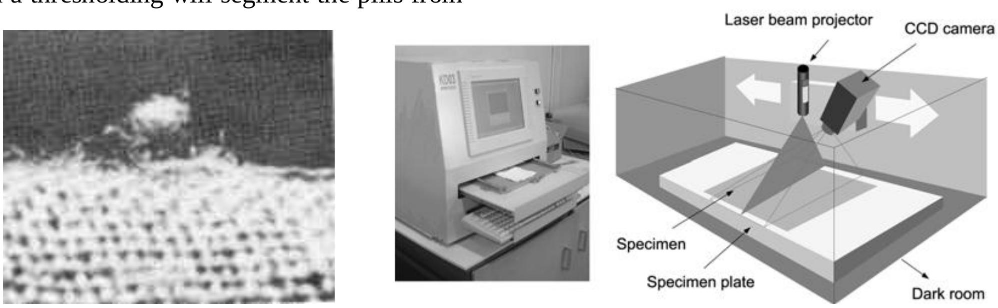
The visual textile pilling evaluation is subjective and can born bias [6]. For an objective assessment, there are two techniques for pilling evaluation on a rubbed fabric: by counting the number of pills, which are appearing on the surface of samples, or by removing and weighing them. The most recent objective evaluation of pilling resistance consists in applications of image processing techniques.

3. A review of image processing techniques

Early applications of computer vision to pilling extraction and characterization are dating from the nineties [17], [19]. In [7], [8], after a series of image preprocessing techniques adopted to reduce the image acquisition non-uniformity, a Fast Fourier Transform is applied and undesired shading is filtered. Using the power spectrum of the FFT, the peaks are thresholded and a template matching technique is employed to clearly detect the pills. Morphological properties are then used for pilling characterization. [9] are using cast shadows to detect pills on textured material. Using an oblique illumination technique and basic image processing steps, shadows are segmented and extracted by a non-supervised gradient based thresholding algorithm.

The use of basic and classic image processing methods are used nowadays in applications as [10], [15], where a three dimensional measurement system is conceived, using a scanned laser beam and a CCD Camera that moves together over the material surface. The FFT is used to remove periodic noise and the flatten filter will remove illumination and curvature irregularities. Next, a second order edge detection followed by a median filtering and a thresholding will segment the pills from the texture background. Edge flow detection is employed in [18] in order to segment pill contours from color texture background. Also three dimensional surface scan method can be found in [11], where the authors presents a method of evaluating pilling by the use of a laser projected line on the material surface. The image acquired is then transformed into a 3D model of the surface in order to detect the pilling density and compare it with the ASTM standard photographs.

Pilling appears on a textured surface and consequently, texture discrimination and filtering techniques are becoming widely employed. The paper of Kim and Kang [12] presents a method to attenuate the repetitive fabric patterns and the enhancement of pills. Also, the approach of pilling evaluation is based on the wavelet reconstruction scheme using undecimated discrete wavelet transform, which is shift-invariant and redundant. The two-dimensional discrete wavelet transform is used by Zhang, Wang and Palmer [13], in order to develop a texture feature detector more efficient with texture details. The wavelet energy signature extracted from the images offers richer and complete representation of pilling texture in the image. Then, feature vectors are extracted using principal component analysis and the pilling propensity is then graded to the known scale using discriminant analysis.



a) b)

Figure 2. a) Pills as a formation of tiny ball on fabric; b) Schematic of 3D scanning system [10]

The same team of authors, approaching the pilling detection on various materials and conditions has published an extensive research and a large number of papers. [3] are using the property of nonwoven fabric pilling images consisting of brightness variations caused by randomly distributed fibers, fuzz and pills, and background illumination variance. A two-dimensional wavelet transform can separate their different frequency and space distributions as the energies of the six direction detail sub-images, captures the brightness variation caused by fuzz and pills of different sizes. A neural network classifier will then input the extracted features in order to grade the assessed images. A more robust method is further developed by [14], in order to be less sensitive to brightness and contrast variation of images, but also to rotation and dilatation, thus yielding to multiple industrial implementations.

4. Conclusions

Objective assessment of fabric pilling resistance is a viable option for laboratory product evaluation. Many researchers are developing techniques based on image processing, in order to automate the testing procedures and especially to make them more sensitive and efficient that the manual procedures.

The current study will lead to a framework implying modern processes of quality assurance for apparels and knitted products using the latest advances in image processing techniques.

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