Abstract

The evaluation of fibrous structures under certain operation parameters allows the understanding of the relations between the behavior of these structures and the controlled conditions. Ultimately, this provides an opportunity to control the material's performance by adjusting its processing conditions. This work presents a collection of research articles that focus on the evaluation of one-dimensional (yarns) and two-dimensional (fabrics) fibrous structures. At the first level, studying the yarn geometry and the internal structure was presented in two papers that considered the ring-spun as well as the air-jet spun yarns as main scope of study. One paper covers the calculation of the yarn diameter and its variation through experimental and analytical methods with a comparison to the available laboratory methods. The percentage of fibers and their radial distribution in the yarn's cross-section were evaluated in the other paper with case studies of cellulosic fibers that have different cross-sections.

Fabrics, as two-dimensional fibrous structures, were investigated at their production stage, as well as at their end-use stage. The quality of fabrics is mainly determined during their production, and the inspection of the fabric for faults is an essential process in any weaving mill. The automation of the fabric fault detection process is a challenging research topic and a development of a machine prototype that performs this task as well as the development of the analytical algorithms were presented in the current work. The algorithms of analysis were enhanced and presented in another research article that describes the implementation of the principle component analysis (PCA) for boosting the performance of the fault classification algorithm.

As fabrics are used and subjected to different forms of strains (especially of abrasion and friction) their wear performance becomes crucial, and the evaluation of the fabric pilling emerges as an important test that needs to be more characterized objectively. This was the main goal of the selected two papers on the objective evaluation of the pilling resistance in knitted and woven fabrics, as two production technologies that affect the fabric's surface properties. The evaluation algorithms were introduced in the form of an integrated system that built upon the best literature practices at the four stages of pilling evaluation. The high correlation between the objective evaluations obtained from the developed "smart" system and the subjective evaluations obtained from experts, suggests a promising technique for standardization.

It might be "unfortunate fact" that; textile industry has many parameters that are characterized *subjectively* based on *human operators*. Therefore, the main tools implemented in this collection of research articles for evaluating the fibrous structures were the image analysis (IA), the computer vision (CV), and the soft-computing (SC). These tools provide contemporary solutions for automating the tasks performed by human workers without sacrificing the "human intellect";

that is mimicked in these algorithms in the form of “artificial intelligence”. Computer vision, with the aid of the soft-computing techniques, is capable of *perceiving* the fibrous materials and *reconstructing* them in a digital form that can be *segmented* and *understood* automatically which significantly facilitates the evaluation of these fibrous structures.

Although research in computer vision and soft-computing in the textile industry began long time ago, there are many reasons for these fields to be currently attractive for researchers. To name some of these reasons we should refer to: the diversity of problems in textiles, the recent advances in computational methods and algorithms, as well as the developments in hardware that expanded the computation power. Therefore, the significance of the algorithms presented in this work arises from the fact that these algorithms aim at *improving*, *simplifying*, *automating*, and *reducing* the time required for the current evaluation methods. This will, ultimately, result in revealing some properties of the fibrous structures that are not clearly understood because of their tedious and laborious measuring methods. To give one example for this point; this work presented a methodology for digitizing fibrous materials in three-dimensional models using the x-ray computed tomography (CT) without interfering with the structure by chemicals as it is traditionally done. It is encouraging to implement the automated characterization techniques developed in this work to help in studying the internal structure of the yarn with their *massive amount* of data that can be obtained from these CT yarn digital models.

Given the *limited amount* of data that we have nowadays on yarns (due to the limitations of the current laborious methods), the reader can imagine the major change that might occur in our current state of understanding for yarn structures by automating these methods with objective characterization. Having said that, the work presented here allows only a few steps in the direction of solving some of the textile related problems and there is, still, a plenty of room for further development.

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