Digital Fiber Authentication: AI-Based Morphology Analysis for Cashmere and Premium Animal Fibers

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Abstract

Reliable authentication of premium animal fibers remains a major challenge for the textile industry. High-value materials such as cashmere, yak, alpaca and fine wool are frequently traded in complex supply chains, where blending, mislabeling and industrial finishing can make visual or purely manual identification difficult. Established microscopic methods provide valuable reference standards, but they are often labor-intensive, operator-dependent and difficult to scale for high-throughput quality control.
Here, we present an AI-assisted workflow for objective single-fiber morphology analysis of premium animal fibers. Textile, yarn or raw-fiber samples are first separated into individual fibers and imaged microscopically. Instead of relying on a single measurement such as fiber diameter, the approach evaluates a broader set of morphological features, including scale pattern, scale density, scale height, edge structure, diameter distribution and additional surface characteristics. These features are combined with machine-learning-based image analysis to support reproducible classification and documentation of fiber composition.

The workflow is initially focused on cashmere authentication and differentiation from visually similar animal fibers such as yak and fine wool. Particular attention is given to processed and finished textile materials, where chemical or mechanical treatment can modify fiber appearance and reduce the reliability of conventional manual assessment. By combining standardized sample preparation, microscopic imaging, AI-based feature extraction and structured reporting, the method aims to provide faster, more objective and more scalable quality decisions.
This work contributes to the digitalization of textile testing and supports technology transfer from academic fiber analysis toward industrial quality control. The long-term goal is a robust testing platform for high-value natural fibers, enabling improved fraud detection, transparent material declarations and more reliable certification along the textile value chain.

Keywords: AI, assisted fiber analysis, cashmere authentication, animal fiber identification, single, fiber morphology, microscopic image analysis, textile quality control, machine learning, material verification, premium natural fibers, digital textile testing.

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