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Study on Quality Uncertainty Prediction Model Based on Data and Its Application Management ⋆

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Abstract

To predict textile quality fluctuation from the perspective of uncertainty factors, first, the reasons and patterns of quality fluctuation in the industrial textile processing were analyzed, and knowledge representation of textile quality attributes was studied. Second, through the theories of human-machine-environment-system-engineering (HMESE), probability, and statistics, the uncertainty factors that affect textile production quality were extracted, and generation mechanism, interaction relationship and behavioral characteristics of them was explored. Then, an improved human-machine-environment brittle model oriented to the textile processing was built. As verified by the experiment and simulation, the results have shown that the improved brittle model has achieved a full range analysis of quality uncertainty of the textile, which are from the reason and pattern of quality fluctuation to generation mechanism, mutual relations, and behavior identification of the uncertainty factors.

Keywords: Textile Processing; Prediction; Quality; Uncertainty

1 Introduction

The textile quality prediction theories and methods were studied in the early 1970s [3]. For example, M. Selvanayaki et al. studied the SVM-based yarn strength prediction method [4], S. Fattahi et al. proposed a fuzzy least square regression method of cotton yarn production process control [5], S. Mokhtar et al. put forward the fabric weaving process uncertainty test method [6], and so on. With the extension of the industrial textile processing theories, the involved variables are more and more [7]. For instance, Mohamed Naglaa et al. [8] used regression model to predict the mixing properties of cotton fiber, Mwasiagi Josphat Igadwa et al. [9] made use of hybrid algorithm to construct a yarn parameters to improve the performance of predictive model, and

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Mardani Mehrabad N. et al. [10] used finite element and multivariate spinning tension to analyze the uncertainty factors.

Many Chinese textile scholars also studied and proposed some prediction models and methods for the textile quality prediction and control [11], such as Yang Jianguo, who proposed yarn quality prediction model based on Support Vector Machine (SVM) via statistical theory [12], Zhijun Lv et al. used search optimization technique based on genetic algorithm to optimize yarn quality prediction model parameters with SVM [13], and discussed the effect on parameters for generalization performance of SVM model [14], Li Beizhi et al. took advantage of global search capability of genetic algorithm to solve the time-consuming problem with the selection parameters of SVM, and then proposed a SVM parameter selection method based on the genetic algorithm [15]. Hereafter, some scholars analyzed the reason why quality fluctuation of the textile from textile production processing theory, and explored the related prediction methods and techniques [16, 17], i.e., Zhao Bo et al. predicted the yarn quality through neural network and regression analysis [18]. In addition, others discussed the interrelationship problems between technology assessment and textile machinery [19].

With previous studies in different ways, we start from uncertainty factors that affect quality uncertainty of industrial textiles. The main goal is to explore generation mechanism and behavior characteristic of the uncertainty factor. Accordingly, we construct a prediction model for quality uncertainty to analyze its fluctuation pattern, study its generation mechanism, and dig its behavior characteristics.

2 Objectives

To further explore the reason and pattern of quality fluctuation in the textile processing, and forecast and indentify the relationship and behavior characteristic of quality uncertainty of industrial textiles, we began from the above four problems, and studied the following four aspects via the theories of HMESE and textile quality management.

(1) Explore fluctuation reason of quality characteristic value of industrial textiles.

(2) Study fluctuation pattern of textile quality characteristic values, and define random error and systematic error.

(3) Analyze generation and interaction mechanism of uncertainty factors caused textile quality fluctuation.

(4) Identify behavior characteristics of quality uncertainty caused systematic errors.

3 The Relationships between Quality Fluctuation and Uncertainty Factor

3.1 Fluctuation Mechanism of Textile Quality

The textile processing is a process that multi-factor (e.g., temperature, humidity, materials, human, equipment and environment, etc) and multi-process are interaction, and this interaction process relationship can make multiply factors be divided into the external factors and the inter-