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Cotton Yarn Engineering Using Robust Regression and Criteria of Mallow's Cp

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Abstract: The main purpose of the present study was to predict yarn's important properties i.e., tensile, unevenness, hairiness, and imperfections of cotton yarn with minimum random errors and maximum accuracy. In this work, cotton fiber properties were measured from rovings carefully untwisted. HVI system and evenness tester of Premier were used to measure the various properties. All yarns (108 samples) were spun at yarn counts of 16, 20, 24, 28, and 32 Ne with optimum twist factor. The robust regression and criteria of Mallow's Cp were used to evaluate the data. Optimal equations with appropriate variables and relative importance of various variables were also investigated. After the goodness of fit, desirable Cp and very large adjusted R^2 values were observed. Furthermore, the analysis of variance tables showed that the obtained equations were significant at usual significance levels.

Keywords: Robust regression, Mallow's Cp, Imperfections of yarn, Cotton spinning, Quality properties of yarn

Introduction

Modeling of yarn properties such as tensile, evenness, and hairiness are common topics of research in the field of textile engineering. Two main approaches used in these studies are statistical and mathematical ones. Statistical models have relatively higher predictive power than mathematical models. One of the most common statistical approaches is the multiple regression method. So far, statistical models for prediction of cotton yarn properties from fiber properties have been established [1-11]. Prediction of cotton yarn properties from fiber properties have also been reviewed in details by Hunter [12].

For instance, Kilic and Okur [1] investigated the relationship between yarn diameter/diameter variation and cotton yarn strength. Multiple linear regression models were established to allow the estimation of yarn strength from the other yarn parameters such as yarn diameter, diameter variation, twist, twist variation, capacitive and optical unevenness. Strumillo *et al.* [2] determined the functional dependencies of selected fundamental parameters of cotton yarn quality, such as: tenacity, elongation at break, unevenness of linear density, hairiness and the number of faults on yarn's linear density. With the increase in the linear density (tex), the tenacity, elongation at break, and the hairiness increase. But with the increase in the yarn's linear density, the number of faults decreases. Ureyen and Kadoglu [3] used linear multiple regression method for the estimation of yarn quality characteristics. They found that in addition to fiber properties, yarn count, twist and roving properties had considerable effects on yarn properties. Statistical models are also found for the prediction of cotton yarn strength and breaking elongation from HVI fiber properties, using linear multiple regression method by Majumdar *et al.* [4,5]. Recently statistical equations were found for the prediction of tensile properties of 100 % cotton ring spun yarn by Ureyen and Curkan [6]. The prediction of hairiness and unevenness was also investigated in the second part of this study [7].

EI-Mogohzy [13] stated that the subject of yarn engineering represents a critical issue that must be addressed in views of today's information and computer capabilities, and the revolutionary developments in fiber production. Challenges that have lasted for many years should be attacked and handled using engineering approaches. The traditional standards of fibers, yarns, and fabric characterization should be revisited so that reliable and meaningful physical relationships between these characteristics can be established.

It should be mentioned that some researchers such as Ureyen and Kadeglu [3], Ethridge and Zhu [8], and Hunter [9], have found some results which are not consistent with the reality.

The main aim of this study was to predict yarn's various properties with minimum random errors, maximum accuracy and actual values for fiber properties into yarn. In this work, in addition to yarn's important properties, we have used yarn imperfection as a dependent variable. Then, we measured the fiber properties from untwisted rovings. We developed statistical models to obtain more consistent and useful results, using robuts regression and criteria of mallow's Cp. In addition to optimal equations with appropriate variables, relative importance and approximate contribution of different variables were investigated.

Background

Robust Regression

In statistical models, an outlier is an extreme observation. Outliers are data points that are not typical of the rest of the

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