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A Wavelet-based Yarn Quality Assessment for Fabric Visual Qualities

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Abstract : Random and/or periodic defects occur in all spun yarns. These irregularities can often lead to defects in finished fabric. Yarn evenness tests are used to obtain statistical data about yarn properties, such as CV%, which is useful in comparing several sets of similar data that differ in mean value but may have some commonality in relative variation. Although this statistical data is helpful in determining relative yarn quality, accurate predictions of how the yarn will appear in fabric form are still difficult to obtain. As an promising alterative, wavelet analysis has been employed to localize yarn defect so as to predict the visual qualities of the fabrics.

Key words : wavelets, quality assessment, fabric images, irregularities, objective measurement

1. Introduction

The quality products has become increasingly important with the rise of new manufacturing technology and international competition in the textile industry. The interest in the quality control of textiles has resulted in research that exceeds back to the growth of cotton and continues through to the finished textile products. Yarn researchers, developers, and manufacturers, in particular, concerns themselves with these quality issues as they relate to the quality of the final fabric. In the past, the use of yarn boards, (ASTM D 2255-90) was the widely accepted means for visually assessing the quality of a yarn, yet they fails to give an accurate prediction of how a yarn will look in fabric form. Yarn evenness tests are used to gather important statistical data about yarn properties, such as CV% and variance curves. This data can be useful in determining relative yarn quality, however, accurate predictions of how a yarn will appear in fabric form are still difficult to obtain. These facts clearly indicate the need for a yarn quality rating system for visual fabric qualities. A need clearly exists for developing a yarn quality rating system that translates the measured yarn properties directly into visual fabric qualities. The system will be based on the aforementioned indices that will characterize, measure, and rank the quality attributes of the constituent yarns without involving subjective (human) judgement. The most important unsolved issue remains to be the lack of measures for defining and quantifying the quality of "good" and "bad" yarns based on a set of objective criteria that is consistent with human judgement. The research is aimed primarily at defining such a set of objective criteria by developing several indices for measuring and quantifying such fabric defects as cloudiness, streakiness, and other visual deficiencies of fabrics. The quality characterization of yarn signals using wavelet analysis will provide the means for determining a set of yarn quality indices that are needed for rating classification.

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2. Experimental

2.1 Spun-Yarn Samples

All yarn samples used in this phase of testing were provided by Sara Lee Yarn Company. All the yarn samples were conditioned for at least 24 hours at atmospheric condition to ensure that moisture regain and test environment did not influence testing. Every yarn package was tested using the Zweigle G-580® Yarn Thickness Tester. Each test run consisted of 1x1000meters at 400 meters per minute.

Graphical overviews of the yarn characteristics for each package, produced by Zweigle G580, were collected and analyzed. The yarns were then subgrouped within their respective group according to values obtained from Zweigle G580 for the following:

a) % Coefficient of Variation
b) NEPS/Kilometer
c) Thick Places/Kilometers
d) Thin Places/Kilometers

The subgroups were grouped for use in single jersey knitting trials. Subgroups were formed by analyzing the yarn quality attributes, mentioned above, for each yarn. Based on yarn property values, each yarn was ranked within its group and then designated a subgroup according to yarn property values relative to the mean value of the entire group. In select cases, yarns were subgrouped based on an individual yarn property value (i.e. HIGHEST NEPS/km, LOWEST THINS/km, etc.)

Although 15 cones of yarn were tested, several yarns possessed little difference among quality characteristics and were therefore not selected for knitting trials. The breakdown of the subgrouping is as follows:

Table 1. Breakdown of Yarn Subgroups

Yarn	Sub	Samples	Attributes
28/1Ne, Open-end	a	Y5,Y6,Y9	Lowest CV%
	b	Y4,Y14,Y7	Highest CV%
	c	Y15,Y1,Y4	Lowest Neps/km
	d	Y5,Y9,Y11	Highest Neps/km

2.2 Knitted Fabric Samples

All fabric samples were knit using the Master Sampler-18, jersey sample knitting machine. Each fabric sample has been produced using similar parameters to those to produce fabric sample in order to provide a fairly large area for analysis. The machine specifications for knitting the fabric samples were as follows:

Table 2. Machine Parameters

Needles	564
Gauge	18-cut
Cylinder diameter	10 inches
Feeds	3

Five measurements were taken on each fabric sample and the average results were 34 c.p.i (courses per inch) and 25 w.p.i wales per inch). Fabric samples have been visually analyzed against a dark background and compared based on subjective judgement with some insight coming from the comparisons on a set of criteria for visual quality that has yet to be determined, and use such criteria in conjunction with results from the optical scanning of the fabric samples.

3. Results and Discussion

An example was constructed to illustrate that yarns of the same count, but different quality attributes exhibit different wavelet characteristics at all sub-signal levels. Both yarns samples used in this example were chosen from a group of 28/1 Ne, 100% cotton, open-end yarns and their Zweigle quality profiles are follows:

Yarn	CV%	Neps/km	Thicks/km	Thins/km
4	16.1	201	381	19
5	20.4	1028	645	403

The quality attributes of these yarns are very different, therefore, a wavelet sub-signal comparison should illustrate notable differences at all levels. This means that the variance of each sub-signal at all levels should also be quite different. This would confirm that wavelet analysis is a reliable indicator of differences that can be found in spun yarns. The actual results of wavelet analysis is shown in Figure 1.

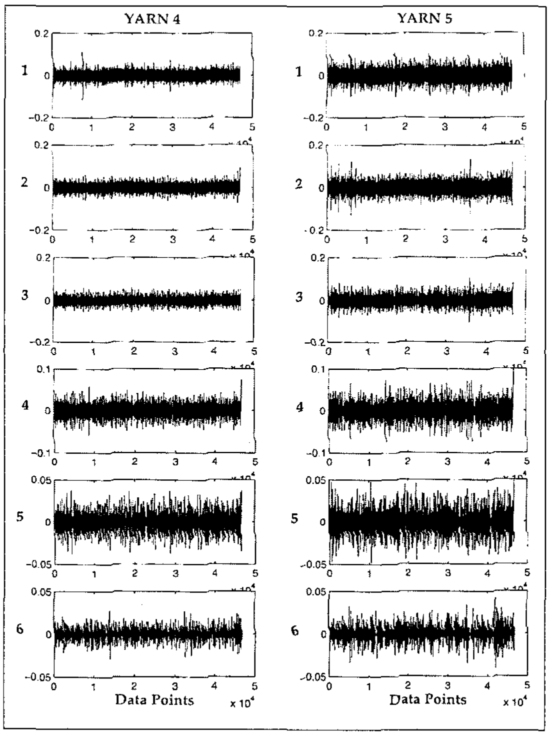
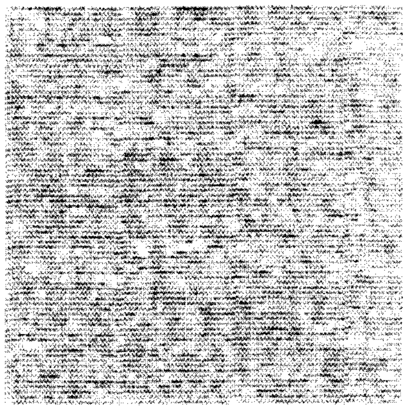
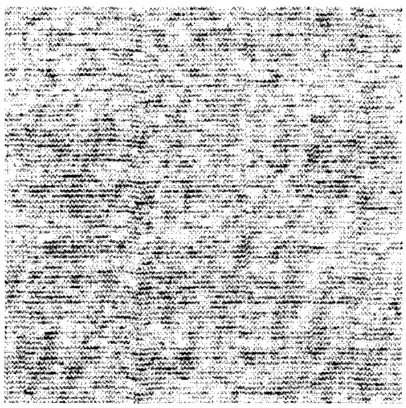


Fig. 1. Wavelet Representation of the Yarn Diameter Profiles

The actual results of wavelet analysis were consistent with the expected results. The analysis results were also verified by comparing two actual fabrics knitted by manufacturing machines currently used in textile mills. As shown in figure 2, two fabrics represent noticeable difference in their appearance, which can be correlated with levels of variability in wavelet variances on several scales. The fabric image by yarn 6 was much evener in appearance than one by yarn 11. The fabric knitted by yarn 11, however, shows high level of variability along all directions.



(a)



(b)

Fig. 2. Comparison of two fabrics knitted by yarn 4 (a) and 5 (b), respectively

4. References

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