웨이블렛 변환을 이용한 버츄얼 패브릭 이미지의 합성

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Creation of Virtual Fabrics By Wavelet Analysis Of Yarn Density Signals

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1. Introduction

With the advent of the electronic evenness testers and data acquisition technique, density profiles of yarn have been employed in order to simulate some fabric images without making actual fabric. In the visualization system, the digital values captured from a conventional evenness tester are placed on the computer screen along the x-y axes and mapped into rectangular regions with corresponding gray scale values. In spite of its simplicity and excellent visual effect, the system has several limitations. First of all, the system is heavily dependent on the length of yarn densities measured. In view of the fact that the area of actual fabrics to be produced is much larger than those of the fabric images produced from a limited amount of yarn data, visualization of fabric images by a direct mapping of limited yarn data would possibly produce false or inconsistent fabric images. One of the reasons that fabric images are not similar to real fabrics may be due to the fact that the visualization system uses very limited yarn data sets which usually are only a few hundred meters long. Since a yarn sample of 400m can generate length only $0.2m^2$ fabric image, it is important to develop a reliable data expansion algorithm which retains the original feature of a given yarn but cover a sufficient length yarn area of yarn for fabric imaging. In this paper, we developed a data expansion algorithm based on wavelet packet analysis for reliable synthesis of yarn density profiles.

2. Sub-band Exchange Algorithm Based on Wavelet Packet

For both data reduction and data compression, basically we try to find a way to threshold the data without a significant loss of information. Recent researches in wavelet community shows that for data expansion, wavelet coefficients have to be analyzed or modeled by some other techniques which employ probabilistic density function [1] or difference equation [2]. However, the p a reliable data expansion algorithm which retains the original feature of aapproaches always suffer from modeling error or oversimplification. Compared to those approaches, the "sub-band exchange algorithm" is model-free and well-appliable to the visualization research. The "sub-band exchange algorithm" can be defied by an algorithm which synthesizes the artificial signal by recombining the basic time-frequency components abler the wavelet packet decomposition. As shown in the previous section, the wavelet packet coefficients at each bin can be used for reconstruction of local sub-signals ordered by the time and frequency level. Finally, we exchange the sub-signals among yarn samples. Since the exchange has been performed between sub-signals with the same decomposition level, the total number of wavelet packet coefficients is not changed after the exchange. Only the amount of energy at specific bin is altered by incorporation of external components. As a result, the energy distribution of a reconstructed signal can be significantly changed by the operation, and a number of artificial signals retaining original features can be generated.

3. Experimental and Discussions

3.1 Experimental

As shown in Table 1, two different cotton yarn were employed for this experiment. Yarn #1 and Yarn #2 are made by open-end spinning with linear densities of 6*Ne* and 20*Ne*, respectively. The two yarn were measured, four packages each, for their evenness on a Zweigle evenness tester. From each package, a total of 100m was measured continuously at a constant speed of 200m/min and saved into data files after converting them to digital signals. Several diagrams were produced for each yarn using a computer program. Yarn board images using real and artificially generated yarn density signals were made in order to simulate yarn irregularity graphically. Visual images of simulated fabrics were also displayed by a graphical method. Finally, several fabric images were obtained from signals of real yarn as well as that from artificial yarn by generated yarn using "sub-band exchange algorithm." The fabric images were compared against each other in order to examine the differences.

3.2 Discussions

Several fabric images were simulated from both original and artificially generated yarn data sets and compared. It was expected that the artificially generated fabric images are more irregular than the original ones as the variabilities from different samples are incorporated into the new fabrics. Figure 1 show the fabric images of the artificially generated yarn.

4. Conclusions

This paper has explored the feasibility of applying a wavelet packet-based sub-band exchange algorithm for a data expansion and fabric simulation. In addition, a new method was developed for visualization of the fabric appearance. This method based on wavelet packet is truly significant in that our work on fabric simulation during the past few years has failed to provide the realistic fabric images. The new method provides an efficient data expansion algorithm for generating a large area of fabric image. More importantly, they also provide fabric visualization without having to weave or knit, thus providing an important new quality control tool.

5. References

1) Dijkermann, R., and Ravi, R., Wavelet representation of stochastic process and multiresolution stochastic models, **IEEE** *Trans. on Signal Processing,* **42**(7), 1640-1652 (1994).

2) Ali, M., Multiscale difference equation signal models: Part I-Theory, **IEEE** *Trans. on Signal Processing,* 43(10), 2332-2345(1995).

Table 1. Material Used

	Yarn Type	Count (Ne)	CV (%)
Yarn #1	Cotton/Open-end	6/1	16.5
Yarn #2	Cotton/Open-end	20/1	12.4

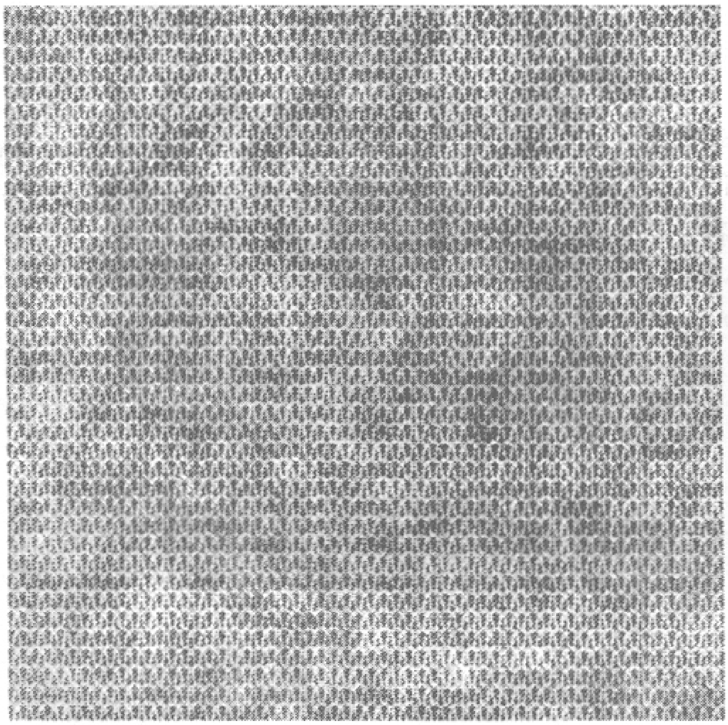

Figure 1. A virtual fabric image.