30B04

Monitoring of Yarn Evenness through Signal Processing

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INTRODUCTION

Monitoring and control through signal processing has been recognized the most important technique in modern manufacturing. Under the data-rich computer integrated manufacturing (CIM) environment, the process/quality control of yarn and fabric uniformity has become the focal point of worldwide attention for cotton spinning and weaving industries.

A research has been focused on experimental studies for capturing the analog signals directly from the Uster Tester-3® by employing a special data acquisition system (DAS). This activity has been extended to relate the amplitudes and the sliver weight. In addition, captured signals will be processed to verify that the system works properly.

EXPERIMENTAL

As it has been in the past, data acquisition is still the key issue in developing an on-line process monitoring and control system. The schematic diagram of the data acquisition system is shown in Figure 1. As shown in Figure 1, it consists of DAS-1600®, a plug-in board from MetraByte®, for an analog and digital I/O board, the Streamer® from MetraByte®, a software for storing data into hard disk, and SAS® for statistical analysis including time series analysis.

A cotton sliver, weighing 70 grains, was used for measuring the density profiles.

The analog signals were captured while the sliver and roving were measured for their unevenness with a Uster Tester-3®. The material speed on the Uster Tester-3® was 25 m/min and the sampling rate of the data acquisition system was 0.0208 KHz. This sampling rate corresponds to measurement of the mass at every 20 mm segment for sliver[1].

RESULTS AND DISCUSSION

The amplitudes of the output signals of slivers from the Uster Tester-3® can be captured properly if we select a measuring field length of 20 mm or longer. However, the Uster® output, such as the density diagram or spectrogram, does not provide the absolute value of the linear density. Instead, they are based on the relative magnitudes of the amplitudes. Therefore, if we get the absolute values of the linear densities within a fiber assembly, the variance of the densities can be obtained from the signals by obtaining a factor linking the relative and absolute values.

First, we have tried to find out a relationship between the amplitudes of output signals and the corresponding weights of fiber assemblies. As shown in Figure 2, there exists a good linear relationship (R^2 =0.998) between the amplitudes and the sliver weights. This result confirms that the electrode sensor of the Uster Tester-3® is precise enough to measure a wide range of sliver weight.

Second, we captured 1250 amplitude signals from a cotton yarn of 25m length and calculated their mean value. This value was compared against the yarn count estimated from the 25m length. This method was repeated 20 times, each with 25-meter yarn segment. The results indicate that we can successfully isolate the yarn count variations by applying the technique we have developed. In Figure 3, the range of yarn counts covered was roughly 10% of the 20/1 Ne nominal cotton count.

While the evenness of a sliver (100% cotton, 55 grain) was measured on Uster Tester-3®, the analog signals were captured simultaneously by the data acquisition system at two different sampling rates as follows;

Test Number	Sampling Rate	Remarks
Test-200	1 freq / 1 mm	8 times faster than Uster®
Test-300	1 freq / 8 mm	Same rate as Uster®

The CV% are shown in the following table.

Test Number	Uster® Result	DAS Result
Test-200	7.91	7.68
Test-300	7.96	7.90

As shown in the table, the CV%'s of the Test-300 were very close to each other (7.96 vs. 7.90), whereas the results on Test-200 were somewhat different (7.91 vs. 7.68). The sampling rate for the data acquisition system was 8 times faster than that of Uster Test-3® as mentioned before. It means that more accurate data can be gathered to calculate the variance and the mean. The variance from the more sample data from same population shows the smaller value and the resultant is smaller CV%.

The spectrogram is a well-known tool for detecting the existence of a periodicity in assessing the evenness of textile materials such as slivers, rovings, and yarns. The spectrogram of Uster Tester-3® is a unique form (bar chart) of expressing the periodicity compared to the ordinary spectrograms (graph) produced in the time series analysis. By using the SAS-ETS[2], same forms of spectrogram could be obtained as shown in Figures 4 and 5.

By comparing the Uster Tester-3® CV% and spectrogram against the those from the captured data, it was verified that the data acquisition system works quite correctly and accurately.

CONCLUSIONS

A data acquisition system is developed to capture the analog signals directly from the Uster Tester-3®. The captured data show a linear relationship between the amplitudes and the sliver weights. By comparing the Uster Tester-3® CV% and spectrogram against the those from the captured data, it was verified that the data acquisition system works quite correctly and accurately.

REFERENCES

1. Pelton, W.R. and Slater, K., J. Text. Inst., 63, 295, 1972.
2. Brocklebank, J.C. and Dickey, D.A., *SAS System for Forecasting Time Series*, SAS Institute Inc., Cary, NC, 1986.

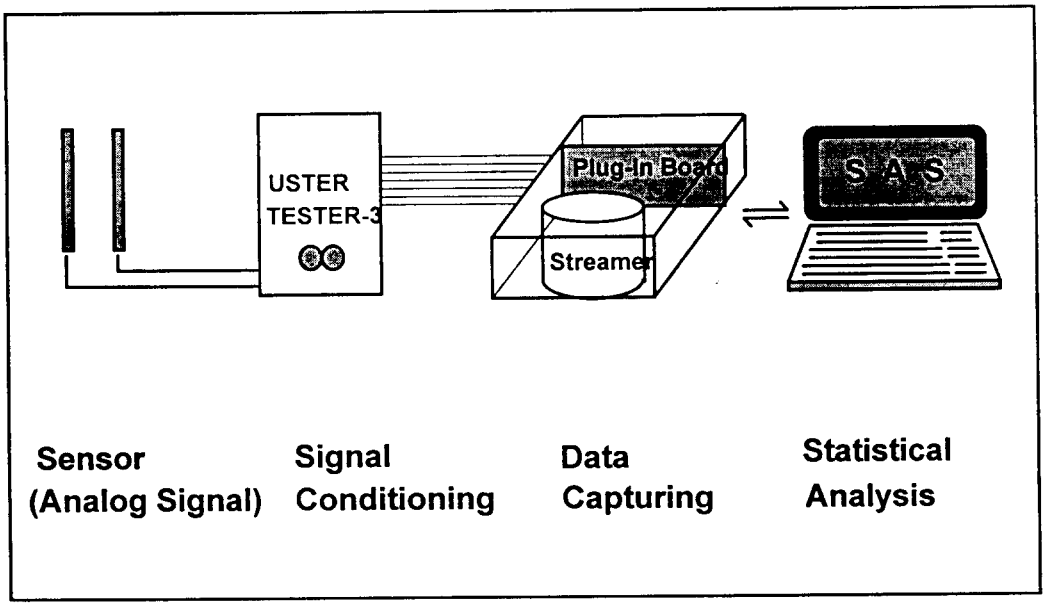

Figure 1. A Schematic Diagram of the Data Acquisition System

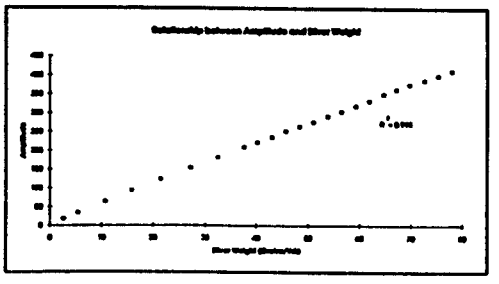

Figure 2. Relationship between the Amplitudes and the Sliver Weight

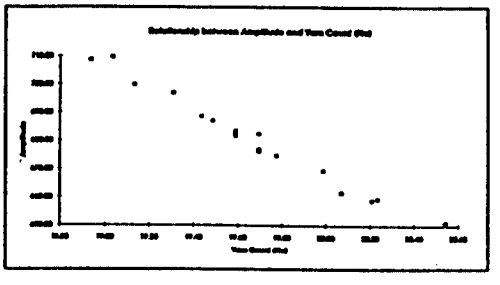

Figure 3. Relationship between Amplitude and Yarn Count (Nc)

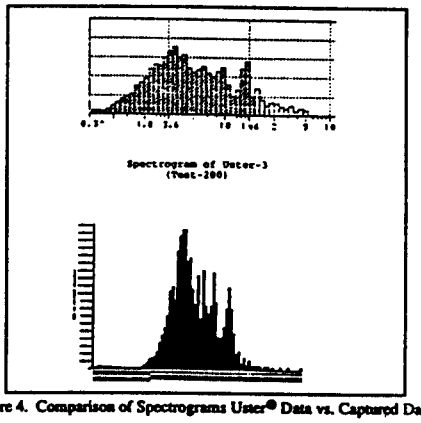

Figure 4. Comparison of Spectrograms Uster® Data vs. Captured Data

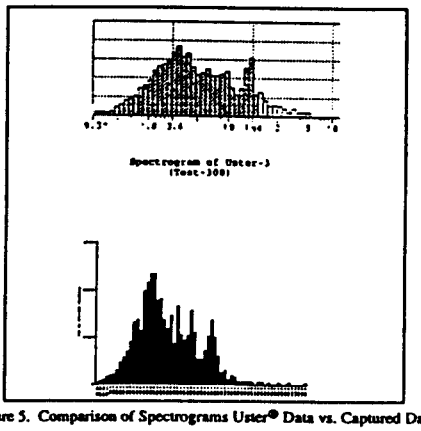

Figure 5. Comparison of Spectrograms Uster® Data vs. Captured Data