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Characterization and Control of Fabric Properties in Textile and Apparel Manufacturing

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RELEVANCE TO NTC GOALS:

The apparel segment of the U.S. textile industrial complex is under tremendous pressure from foreign competition. The apparel industry is trying to respond to this pressure by changing its production philosophy to accommodate the consumer demand for ever increasing style variation and retailer demands for more frequent Just–In–Time (JIT) deliveries of smaller orders. The apparel industry must be able to respond to these demands to remain competitive in the U.S. and abroad.

Apparel manufacturing in a Quick Response (QR) environment must have the ability to quickly optimize its processes when faced with rapidly changing fabrics with variable material properties. This variability is inherent (statistical) within a given fabric and between different types of fabric. In order to deal successfully with this challenge, it is necessary to understand how important material properties permeate through the manufacturing chain. We must develop technologies to measure these important properties quickly and reliably (not dependent on traditional laboratory techniques and constraints). It is important to lay the groundwork for dealing with property variability in the design of apparel fabrics as well as in the manufacturing and finishing of these products.

An interdisciplinary team of researchers from Textile Engineering (TE), Electrical Engineering (EE), Mechanical Engineering (ME), and Textile Technology (TT) are conducting research to collectively address the following research themes: 1) model fabric behavior, 2) on–line characterization of material properties, and 3) on–line manufacturing control. New developments in computer modeling and sensor technology are being applied to address these themes.

GOALS:

LONG TERM: Develop new technologies and methods to characterize fabric properties on–line (during processing) and control textile and apparel manufacturing processes to optimize quality and productivity in a Quick Response or Just–in–Time manufacturing environment. Educate graduate and undergraduate students to help strengthen and lead U.S. fiber, textile, and apparel companies into the 21st century.

SHORT TERM: Using common fabrics a basis, 1) validate 3–D fabric deformation models, 2) refine and validate a theoretical model for predicting visco–elastic behavior of fabrics in roll form, 3) develop and validate a theoretical model for measuring fabric stiffness on–line, 4) develop sensor technology to characterize fabric on–line during high speed sewing, and 5) quantify fabric frictional behavior and mechanical properties as a function of orientation. Involve at least three undergraduates in research activities, and graduate at least two Ph.D. and two Master's students.

TECHNICAL QUALITY AND ACCOMPLISHMENTS

An interdisciplinary team of researchers from Textile Engineering, Electrical Engineering, Mechanical Engineering, and Textile Technology have collectively addressed the following research themes: 1) model fabric behavior, 2) on–line characterization of material properties, and 3) manufacturing control. The depth of the research is reflected by theses submitted. These are listed below. A brief summary of each of the five research tasks is also provided.

Thesis Completed and in Preparation

1. Kim, Y. G., "Fabric Manipulation Simulation Including Material Non–linearity and Contact", PhD Dissertation, Completed June 10, 1993.

2. McDevitt, T., "Flexible Fabric Mechanics analysis Using Large Deflection Beam Theory", MS Thesis, completed August 1993.

3. Kong, D., "Development of a Control System for Fabric Roll–Making Operation", MS Thesis August 1993.

4. Timble, N., " Structural Factors Affecting Interfacial Forces Between Fabrics, PhD Thesis", submission in Final Form expected by October 25, 1993.

5. Li, H., "Simulated Roll–Like Loading in Laboratory and it's effects on Fabric Properties" complete.

6. Deng, S., "Nonlinear Fabric Mechanics Including Material Nonlinearity, Contact, and Adaptive Global Statics Algorithm," PhD Dissertation, Final Defense scheduled August 22, 1994.

7. Barrett, G. R., "On–line Fabric Identification and Adaptive Control of the Sewing System for Improved Apparel Assembly."

8. Farrington, C. E., "Deformational Characteristics of Plain Knitted Yarn Loops Under Shear Loading," PhD Dissertation.