

National Textile Center

FY 2003 (Year 12) Continuing Project Proposal

Project No. S01-PH07

Competency: Management

On-Line Weight and Shrinkage Control of Cotton Knits

Project Team:

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Objectives:

The primary goal of this research is to understand the fundamental characteristics of structural changes in knitted goods upon processing and to establish innovative techniques to measure fabric parameters at different levels of manufacturing. Since the inception of the project an automatic fabric evaluation system was devised to analyze knit structures and objectively evaluate fabric properties. The system is capable of identifying fabric construction parameters, areal density and cover. In addition, a novel approach was developed to identify fabric defects through the integration of image processing techniques and Neural Nets. In the current stage of the project we will focus on: i) optimization of defect detection system, and ii) implementation of decisions made by the structural evaluation system and the defect detection approach in process control for a true on-line control of knitted goods.

Progress Statement:

In industrial setting, knitted fabric defects can be eliminated or reduced by means of on-line monitoring system and automatic defect detection devices. At this stage of the research, achievements of the research team were:

Morphological analysis: A system has been developed to measure knitted fabric parameters using image analysis techniques. This technique can be used to evaluate courses per unit length, wales per unit length, fabric cover and weight per unit area. Six fabric samples were tested after various fabric processes and at different relaxation conditions. The structural changes that occurred to the fabric were documented using the new approach. Manual techniques were used to evaluate the fabric structural parameters and results were compared to that of the automatic fabric evaluation system. A good level of accuracy was observed between the two approaches.

Development of an Intelligent Fabric classification System: In the process of manufacturing knitting defects are likely to happen. Six defects are expected to occur - broken needle, fly, hole, barre, thick yarn and thin yarn. Using Neural Networks approach we have made considerable progress in identifying each of these defects. The overall approach encompassed six steps: knitting fabric samples, image capturing using a CCD camera, image processing, binary image preparation as a preprocessor for Neural Nets,

image feature extraction and finally Neural Nets classification. Typical defects in knitted fabrics are shown in Figure 1.

Images were processed using an edge detection algorithm, binarized and resized to 128 x 128 pixels to reduce the running time of the classification program. Eight features were extracted from the images to create distinguishable defect classes. They are: i) standard deviation of the sum of the binary image columns, ii) standard deviation of the sum of the binary image rows, iii) range of the sum of the binary image columns, iv) range of the sum of the binary image rows, v) absolute value of the median subtracted from the mean value of the sum of the binary image columns, vi) absolute value of the median subtracted from the mean value of the sum of the binary image rows, vii) mean value of the sum of the binary image columns and viii) mean value of the sum of the binary image rows. These features were chosen because of possible variation of these parameters from one defect class to another.

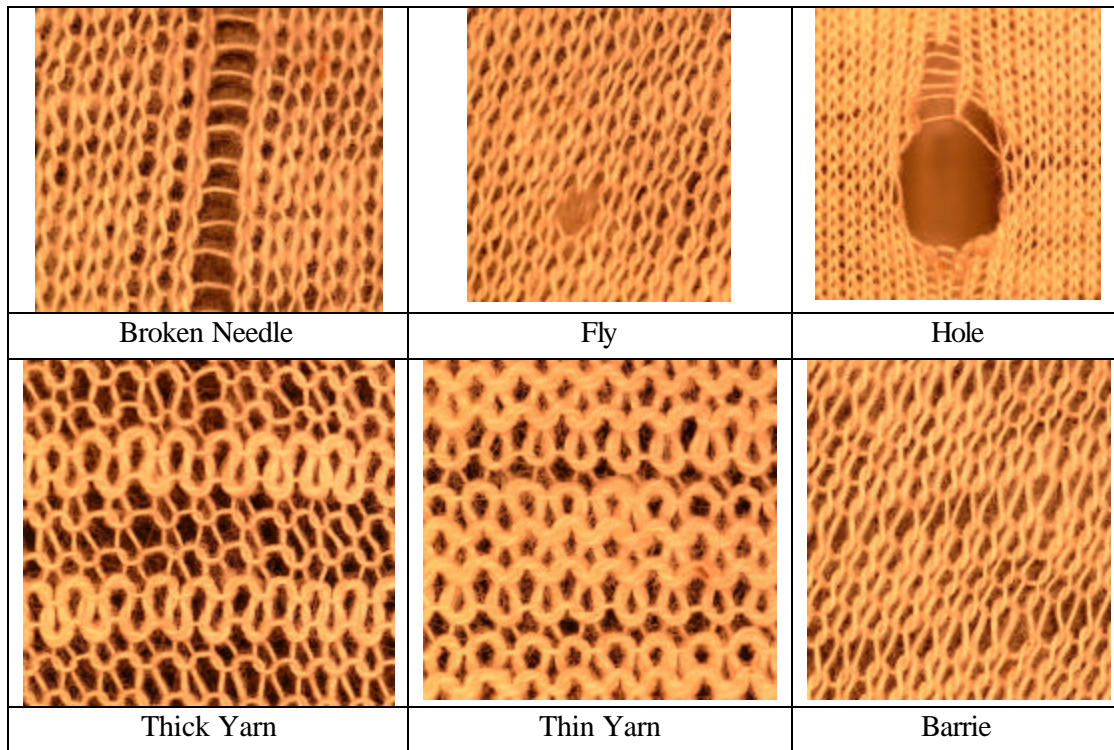


Figure 1: Types of defects typically encountered in knitted fabrics

Typically the use of neural networks as a classifier include a learning phase in which the NNt is trained to identify the features and the desired output to adjust its weights. The second phase is the test phase, in which NNt is tested on another set of images it did not see before. In the current work, seven images from each defect were used to train the NNt and three images for each defect were used as the testing pattern. Matlab NeuralNet toolbox was used as the image analysis and software classification tool. Neural Network programs that were developed were successful in classifying most of the defects. A hole image was classified as a barre. No direct reasoning can be found for such behavior except that we are dealing with a statistically controlled system for a multitude of variables. Also, one broken needle was classified as a hole and one hole was classified as a broken needle. It is believed that the hole defect detection was not always successful because of the resemblance in shape with the broken needle defect and also the hole defect does not have an exact shape.

Next Year's Goals:

The next phase of this project will include: i) optimization and testing of Neural Net classification routine using binary images, ii) investigation of possible use of grayscale images in Neural Nets to reduce data loss during the binarization step, iii) verification of defect detection approach using statistical analysis, vi) establishing a comprehensive data base of defects to develop a standard defects registry, iv) creating a decision making plan that would issue specific orders to knitting machine and v) Establish the hardware and software required (e.g. digital-to-analog card by LabView) o control the manufacturing process.

Approach:

In this project, online control of knit production was approached from two integrated views- structural morphology and defect detection. Morphological operators were defined and implemented with a good degree of success which we believe is adequate for this task. On the other hand, work on defect detection is still in progress. A Neural Net approach was developed and initially tested for a limited sample of binary images of defect. It showed a reasonable degree of success that we believe can be improved through optimization and possible use of gray scale images to reduce data loss that occurs during binarization of colored images. Furthermore, we believe that a statistical approach where each defect is characterized by its statistical parameters and compared it the defect free status can be used to support findings using the Neural Nets approach.

The next logical step in the online control of knit production is the physical implementation of the off-line morphological operators and defect detection. To this end, an online production control technique will be implemented using LabView and digital to analog control cards. Initial trials will be made at the machine to optimize the control process of structural recognition and defect detection. The device will be mounted and tested on the machine while it is stationary for adjustment. Procedures will be established for on-line control of the knitting machine.

Outreach to Industry:

Significant collaboration has already been established with the industry with respect to the supply of knitted fabric samples for the image identification process. National textiles supplied different knitted fabric samples for the experimental work. Work on morphological and structural feature recognition has been accepted for publications in Textile Research Journal and presented in International Textile conferences. These articles are: *Abou-iiiana, M., Youssef, S., Gowayed, Y. and Pastore, C., "Assessment of Structural Changes of Knits During Processing, Textile Research Journal,* and *Abou-iiiana, M. et al "On Line Weight and Shrinkage Control of Cotton Knits" Textile Institute World Conference Proceedings, Cairo, Egypt March 2002.* Furthermore, we have had industrial interaction with National Textiles and Cotton Inc.

New Resources Required:

Most of the computing and modeling facilities for this proposed project are available in the participating schools. We have all the imaging, scanning and software required for the project.