# SUMMARY


**Chapter 1 Detection of defects in woven Fabric**

There are about twenty-two types of defects usually associated with the woven fabric due to various processing irregularities. Out of these, only few are severe defects and need to be identified and eliminated. This calls for the development and refinement of techniques for the detection and identification of defects in woven fabric. Presently available defect detection techniques are classified under four broad groups viz. (a) Fourier transform techniques, (b) image processing techniques, (c) the technique of using Wavelet and other transform and (d) use of artificial neural network algorithm. These techniques are reviewed in the light of appropriate instrumentations with a view to evolve adoptable systems under off-line or on-line conditions. It has been concluded that optoelectronic instrumentation techniques have great potential for application since those offer advantages of parallel processing capability with higher probability of detection in randomly variable occurrence of defects of various types in woven fabric.

A paper is published by the author based on the work reported in this chapter.

*"Optical image processing technique for defect detection in woven fabric" Proc. Workshop in image processing WIPRA 96, Andhra Univ. Dec 1996.*

**Chapter 2 Optical Fourier Transform Technique for the Detection of Defects in Woven Fabric**

Interlaced warp and weft yarns in a woven fabric represents a regular periodic structure and therefore the Fourier transform (FT) technique has become a useful tool for identification of structural properties of woven fabric. The defects such as missing wefts or warps, the existence of knots, thick yarns etc. manifest itself as irregularities in the regular periodic structure of woven fabric. Therefore, the study of the effects of irregularities on the power spectrum of the Fourier transform data is necessary.

An analytical technique based on the FT of the fabric pattern is established in this chapter. The effects of some irregularities on the power spectrum have also been studied. Since it is easier to obtain Fourier transform in the optical domain, a laser based

optoelectronic system is proposed for identification of some fabric properties. The diffraction pattern of the test fabric is obtained optically by illuminating the test fabric with the help of a collimated beam of laser. The diffraction pattern is then captured by a CCD camera attached with a computer by a frame grabber. Experimental intensity plots for defect free and defective fabric are obtained and analyzed. It has also been established that the ratio of intensities of the first order and central order of the diffraction pattern of defect-free fabric changes with the occurrence of particular type of defect. Therefore the nature of deviation of the ratio may help toy classify a particular type of defect.

In the second part of this chapter, the fabric defects are imaged using optical imaging technique, which facilitates the use of spatial filtering of regular grating structure of the fabric. Using horizontal and vertical slits as spatial filter warp and weft can be are detected. The aperiodic defects are imaged for identification by using a pinhole of specific diameter as spatial filter. Experimental images for some representative defects are given.

The following are the publications by the author related to this chapter.

*"Fast Fourier Transform Technique For Identification of Structural Properties and Irregularities in fabric ", J. I.E (Textile Div), Vol. 79, No. 4, p1, 1998*
*"Optical imaging technique for defect detection in fabric", Ind, J. Fiber & Textile Res. Vol 23, No 6, p 277, 1998*

**Chapter 3 Detection of defects in Fabric by Joint Transform Correlation Technique**

The classification of defects of various types is difficult as evident from the analytical and experimental results of the Fourier transform technique discussed in chapter 2. A solution to this problem is provided when a joint Fourier transform of a reference pattern and the test pattern is taken and the joint power spectrum is further processed. Such a technique is termed as the joint transform correlation technique and is an extension of Fourier transforms analysis. In this chapter theoretical basis of joint transform correlator is presented for real time defect detection in fabric. Cross correlation peaks generated after the execution of second Fourier transform on the filtered joint power spectrum, indicate the existence of defects. Since the correlation peaks are embedded in high noise environment, a fractional-power-fringe-adjusted-filter is used for efficient detection of defects. The mathematical formulation of the technique is supported by the simulated results for the identification of some defects such as the existence of thick yarns, knots, missing yarns etc. The technique is tested under two situations where (a) a portion of fabric with interlaced structure is selected as reference and (b) only a type of defect is selected as reference. It has been shown that the detection capability is better in the later case. Because of the parallel processing capability of optical system, implementation of the joint transform correlation technique in optical domain is advantageous. Some comments have been made on the implementational issues using spatial light modulators.

Two papers are published by the author based on the work reported in this chapter.

*"A joint transform correlator for identification of defects in woven textile fabric" Proc. ICOL-98, DRDO, Dehra Dun, Vol 1, P74, 1998.*

*"Defect detection in fabric by Joint Transform Correlation Technique: theoretical basis and simulation", Textile Res. J. Vol 69, no 11, 1999.*

**Chapter 4 Detection of Defects in Fabric by Laser Based Morphological Image Processing**

Morphological operations, such as erosion and dilation have been applied both on direct and spatially filtered images of test fabric for identification of defects. It has been shown that detection of defects by morphological operation on spatially filtered image of fabric gives better result, particularly when the fabric is fine and contains defects of small sizes. The diffraction pattern of the test fabric is obtained optically by illuminating the test fabric with the help of a collimated beam of laser. A spatial filter is placed at the Fourier plane to remove the periodic grating structure of the fabric from the image. A second Fourier lens images the defects at its focal plane. Morphological operations with a critically selected structuring element are then carried out on the image after suitable preprocessing. Comparison of the technique with that of the computer based classical morphological operations on fabric image has established the advantages of the proposed laser based method for detection of defects. It has been shown that erosion operation gives better result than the opening operation.

Two papers are published based on the work reported in this chapter

*"Detection of defects in fabric by morphological operations on spatially filtered images" Proc. Int. Conf. Photonics 98, New Delhi 1998*

*"Detection of defects in fabric by laser based morphological Image processing" Textile. Res. J. Vol 70, No 9, p 758, 2000.*

**Chapter 5 Detection of Defects in Woven Fabric by Rank Order Operator**

Selection of a proper structuring element in morphological operation is always a problem while applying the technique in applications where many variables are involved such as the defect detection in fabric. To somewhat minimize the problem the nonlinear rank order operator has been applied on the binary image of the woven fabric for extracting different types of defects. The chosen rank of the filter is a function of the diameter and periodicity of the woven fabric the data for which is usually available. Therefore, the choice of a proper rank and a proper structuring element is much easier for detection of a particular type of defect for a particular fabric. The result of detection is very satisfactory by using rank order filtering operator.

A paper is published based on the work reported in this chapter

*"Optoelectronic technique of detection of defects in woven fabric by rank order operation": Proc. Int. Conf. Photonics 2000, Vol 2, p 732, Dec 2000, Calcutta.*

**Chapter 6 Detection of Defects in Fabric using Linear Associator Memory Model**

The notion that an associative memory can be studied as a dynamic system, characterized by the presence of attractors led to the evolution of many useful models. The linear associator model is one of the simplest models of associative memory where the test pattern is classified according to the minimum Hamming distance with the exemplars (trained) patterns. Since we can restrict the number of defects in woven fabric those are needed for identification, linear associator gives much easier solution to the problem. It has been established that the captured image of test fabric can produce a restructured image, which can be compared with the restructured images of stored exemplars for classification. Visual signals can be generated when detection and classification is complete according to the algorithms of minimum Hamming distance calculations. For smaller number of exemplars the method seems advantageous since it is not required to propagate the error for control in either feed forward or feed back directions. Testing with sample images proves validity of the proposal.