TEXTURE ANALYSIS IN FABRIC MATERIAL FOR QUALITY EVALUATION

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ABSTRACT
The texture analysis in quality estimation of fabric material plays an important role. Any off print design may be extracted by using the different parameters of texture like contrast, correlation, energy and homogeneity. Contrast measures the local variations in the gray-level co-occurrence matrix. Correlation measures the joint probability occurrence of the specified pixel pairs. Energy provides the sum of squared elements in the GLCM, also known as uniformity or the angular second moment. Homogeneity measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. The gray-level co-occurrence matrix can reveal certain properties about the spatial distribution of the gray levels in the texture image. The number of gray levels in the image determines the size of the GLCM. In the presented work, the textile image is exposed to various image processing tools to obtain finally a binary image. The binary image is then analyzed to find the asymmetrical or an object other than the knitting design as a defect. The defect identification in textile image is made by using the matlab function bwperim that gives the outline of the defect. This way the defect may be extracted and measurements regarding the perimeter, length, dia etc. may be done.

Keywords: Textile Imaging, Segmentation, Gray Level co-occurrence Matrix. (GLCM)

INTRODUCTION
Fabric defect detection plays an important role in automated inspection of fabric quality based on computer vision, which aims at locating defect regions accurately. The fabric defect detection is of vital importance in the textile industry. Currently, automated inspection of the fabric defects based on computer vision, which can meet the requirements of practical products has the advantages of high precision and efficiency over the traditional human visual inspection. There are two main directions for the detection techniques of fabric defects. One is using transform domain-based features, e.g. Gabor transform and Wavelet transform. The other is statistical texture analysis, e.g. the gray level co-occurrence matrices (GLCM) describes texture feature of the fabrics by combining with gray level distribution and spatial relations, which is recognized to be of highly value to fabric defect detection.

Related Works
Escofet et al., (2001) discussed the image processing based application in textile industries. Machine vision system is very useful tool in identifying online fabric material at fast speed and that too at high repeatability.
Hu and Tsai (2000) discussed the wavelet approach in decomposing the fabric image and then analysis in HH-band. The maximum information is available in LL-sub-band and if some texture is present that can be analyzed in other bands.
Hu and Tsai (1996) research about Wrinkle Assessment of Fabric a light profile based analysis is proposed in this work. The light profile’s heights are the main informative parameter in this study.
Portilla et al., (1996) researched about automated textile defect recognition system using computer vision and artificial neural networks according their study Inspection processes done on these industries are
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mostly manual and time consuming.

Randen and Hakon-Husoy (1994) discussed the wavelet approach in fabric quality defects and their identification. The fabric defects many a times are analyzed quantitatively or qualitatively. In case of quantitative analysis, the defects size, location and type is of prime importance. However, qualitative analysis, the defects presence is of prime importance. Normally haar wavelet is employed for decomposition of the fabric image area and analysed in different sub bands of the wavelet decomposed image.

Hosseini (1995) studied the digital aspects of the fabric defects from statistical point of view. The presented approach was real time analysis of the fabric material on shop floor. The image decomposition for analysis is decomposed into bit planes. Bit planes depicts fair idea about the location and size of the textile defects.

Hu and Tsai (2000) discussed the defects identification in fabric material like lines, tears, and spots. A furrier analysis of the fabric image in frequency domain is suggested here. As the fabric design mostly contains different design patches or blocks, frequency domain approach is very useful in segmenting the fabric design from that of the similar kind of defects.

Jasper et al., (1996) studied about the neural approach in textile/fabric defects identification. However, this approach requires a large no. of training samples and a validation is required for real test on shop floor. Neural approach is good if similar kinds of defects are observed in a fabric material. A feature set is required for identification of fabric defects based on some parameters. These features are normalized between [0 1] and are made as input neuron to the neural network system.


Kang et al., (2010) studied about Fabric Defect Detection Using Auto-Correlation Function which introduces a new fabric segmentation approach for detecting fabric defects using auto-correlation Function. This proposed approach consists of 4 steps calculating the texture primitive template by auto-correlation function from defect free fabric image in train phase, Enhancing the defect areas, through calculation the difference between each texture primitive template and texture image, constructing the mean image to reduce high frequent information of background image, and compute a perfect automatic threshold to present a binary image as a defect pattern. Banumathi and Nasira (2012) researched on neural approach of fabric material analysis. They used a back propagation neural network by taking nine input neurons and three hidden neurons in one hidden layer. The output quality is suggested at one output (Kang et al., 1999).

Kang et al., (2001) researched about automatic fabrics faults processing using image processing technique in MATLAB according which defective fabric parts can be processed using Matlab with image processing techniques. In developing countries like India especially in Tamilnadu, Tirupur the Knitwear capital of the country in three decades yields a major income for the country. The city also employs either directly or indirectly more than 3 lakhs of people and earns almost an income of 12, 000 crores per annum for the country in past three decades (Hu and Tsai, 2000). To upgrade this process the fabrics when processed in textiles the fault present on the fabrics can be identified using Matlab with Image processing techniques. This image processing technique is done using Matlab 7.3 and for the taken image, Noise Filtering, Histogram and Thresholding techniques are applied for the image and the output is obtained in this paper. This research thus implements a textile defect detector with system vision methodology in image processing (Kang et al., 2001).

Mallat studied about Bayesian classification of fabrics using binary co-occurrence matrix according to their research Classification of fabrics is usually performed manually which requires considerable human efforts. The goal of this paper is to recognize and classify the types of fabrics, in order to identify a weave pattern automatically using image processing system. In this paper, fabric texture feature is extracted using
Grey Level Co-occurrence Matrices as well as Binary Level Co-occurrence Matrices. The Co-occurrence matrices functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, and then extracting statistical measures from this matrix. The extracted features from GLCM and BLCM are used to classify the texture by Bayesian classifier to compare their effectiveness (Mallat, 1998).

Marcelja studied about fabric defect detection in spatial domain. A survey of existing techniques for fabric defect identification and analysis is discussed in length. The prime domain of survey was in frequency, spatial and statistical approach (Marcelja, 1980).

Millán and Escofet discussed the bit plane decomposition of the fabric image. It has been observed that low bit plane contains more information as that of the higher bit plane. It has also been observed that the bit wise decomposition of fabric image does not provide size normalization. If the camera for imaging is brought close or far from the actual scene, then the analysis value varies Millán and Escofet again discussed the image analysis in wavelet domain using haar wavelet. An entropy based analysis is also discussed here using the genetic algorithm. In this approach, a large amount of data is required for training of the system and analysis is concluded only after proper validation of the algorithm (Millán and Escofet, 1996).

Algorithm

The presented approach for fabric defects identification consists of the following steps: Image acquisition, gray scale conversion, image enhancement, segmentation and feature extraction, feature analysis for defect classification and analysis.

The acquired image using CCD camera is in jpeg format and needs to convert to gray scale format. A gray scale color format is 8-bit color format and the color ranges from 0 to 255. Color intensity 0 being the black and 255 the white and in between 0 to 255, there are shades from black to white.

Further, a discrete cosine transform is used for off line printing of fabric design on cloth material. DCT based approach is very useful in differentiating the defects and design pattern on cloth material. If DCT based energy and entropy are computed for a standard fabric pattern, then any shift or variation from the standard fabric image will show a variation in energy and entropy.

Below are some of the fabric images taken by CCD camera:

![Fabric Images](image)

**Figure 1: Fabric Images**

**GLCM Matrix Extraction:**

A GLCM matrix is generated from the given fabric image. A GLCM matrix is the mapping of pixels arranged in a special format. The property of GLCM matrix is very useful in differentiating the different texture from each other.

A GLCM matrix is explained in the below given image:
The GLCM property includes contrast, energy, homogeneity and correlation. These properties are defined below:

**Contrast** → Measures the local variations in the gray-level co-occurrence matrix. Contrast is 0 for a constant image. The contrast is given by:

\[
\text{Contrast} = \sum_i \sum_j (i-j)^2 P_d(i, j)
\]

**Correlation** → Measures the joint probability occurrence of the specified pixel pairs. Correlation is 1 or -1 for a perfectly positively or negatively correlated image. Correlation is NaN for a constant image. The correlation is given by:

\[
\text{Correlation} = \frac{\sum_i \sum_j (i-\mu_x)(j-\mu_y)P_d(i, j)}{\sigma_x \sigma_y}
\]

**Energy** → Provides the sum of squared elements in the GLCM. Also known as uniformity or the angular second moment. Energy is 1 for a constant image. The energy is given by:

\[
\text{Energy} = \sum_i \sum_j P_d^2(i, j)
\]

**Homogeneity** → Measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Homogeneity is 1 for a diagonal GLCM computation of entropy. Homogeneity is given by:

\[
\text{Homogeneity} = \sum_i \sum_j \frac{P_d(i, j)}{1 + |i-j|}
\]

**RESULTS AND CONCLUSION**

The proposed approach is based on gray level co-occurrence matrix features and DCT based entropy and energy of the fabric design. The features so extracted are capable of differentiating between the fabric design and defect if properly applied. The approach discussed here therefore works in both domain i.e. spatial in terms of GLCM matrix and DCT in the form of frequency domain. The presented algorithm has to be applied in real time at the shop floor in a textile industry.

**REFERENCES**

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