

Density Evaluation and Weave Pattern Classification of Fabric Using Image Processing

Miss. Ravina D. Karnik

*Research Scholar, Department of electronics,DKTE's textile and engineering institute,
Ichalkaranji,India.*

Prof.(Dr)Mrs.L.S. Admuthe

*Assistant Professor and Vice Principal, Department of electronics,DKTE's textile and engineering institute,
Ichalkaranji,India.*

Abstract

A method of combining image processing and multi-scale wavelet transform for the detection of the density of warp and weft of woven fabric automatically is proposed in this paper. Three foundational weaves with different yarn density, are evaluated via wavelet transform. With a series of image processing, wavelet transform and morphology processing, the density of warp and weft is obtained. In this study, we proposed a novel automatic method for the identification of woven fabric structure. This method is based on widely used digital image analysis techniques. It allows automatic warp yarn and weft yarn cross area segmentation through a spatial domain integral projection approach. Secondly, texture features based on grey level occurrence matrix are studied and developed by applying principal component analysis. The optimized texture features are analyzed by fuzzy c-means clustering for classifying the different cross area states. The texture orientation features are calculated to identify the exact state of cross area. Finally, woven fabric structures are automatically determined.

Keywords: woven fabric; density detection; wavelet transform; morphological processing; principal component analysis; fuzzy clustering; integral projection; gray level co-occurrence matrix; texture analysis; woven fabric.

Introduction

Visual analysis of a fabric sample is an essential process for reproducing this fabric, the densities of warp and weft yarns and probably the counts of warp and weft yarns by and/or evaluating its structural characteristics. Basically this analysis defines the weave pattern using a microscope. The process is traditionally carried out by a human inspector who uses a magnifier, ruler and some other simple tools to count the densities and visually define the weave pattern. Generally a manual operation like this is tedious, time-consuming and inconvenient for the inspector's eyes. Thus the judgment may not be accurate enough because it may vary from one inspector to another.

On the other hand, the dynamic development in computer speed and storage capacity opens the door for more advanced digital image analysis to replace the operations that depend on

human vision. Using digital image analysis enabled detailed analysis of basic structural parameters of textile products. It was used earlier to estimate the cross sectional area of wool fibres. A digital image processing approach was developed to evaluate fabric structure characteristics and to recognize the weave pattern. Images of six different groups were obtained and used for analysis. The groups included three different fabric structures with two different constructions for each. The approach developed decompose the fabric image into two images, each of which included either warp or weft yarns. Yarn boundaries were outlined to evaluate the fabric surface characteristics and further used for identification of the areas of interlaces to detect the fabric structure. The results showed success in evaluating the surface fabric characteristics and detecting the fabric structure for types of fabrics having the same colors of warp and weft yarns.

Methods

a. Methodology of Implementation-

This work is divided in :-

- i) Density Detection
- ii) Weave pattern classification

i) Density Detection:-

Planning process in general for density detection by measuring warp and weft of woven fabrics can be represented by the following figure:-

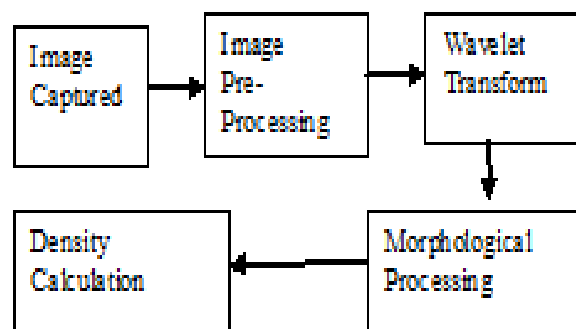


Figure 1. Block diagram for density detection of fabrics.

Images captured:-Fabric image is capture using camera.

Image pre-processing:-In order to improve the visual effect and facilitate people as well as machines to analyze and understand the images,image enhancement and media filter are use to reduce noisy and make fabric texture more clear.

Wavelet transform:-A fabric image at level s can be decompose into four components. The approximation at level $s+1$ and the details in three orientations(horizontal, vertical and diagonal)via two dimension(2D)DWT [1]. In the processing, the input fabric images should be processed via low-pass and high-pass filtering, and downsampling in a horizontal direction, so is the vertical direction. Then low frequency decomposition approximate number, high frequency horizontal, vertical and diagonal detail component are obtain. The same decomposition could be done for the low frequency image and same results are obtain. The decomposition steps of 2D DWT can be expressed in fig shown below:-while the wavelet reconstruction is the inverse transform of wavelet decomposition.

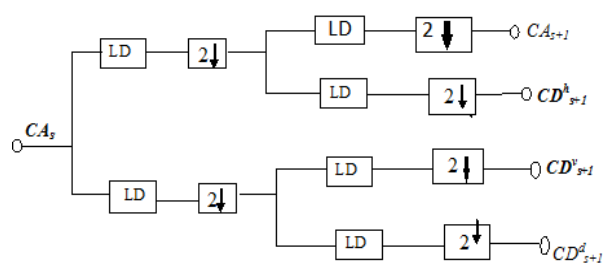


Figure 2:-The decomposition step of 2D DWT

Morphological Processing:- Binarization is that the images are shown in form of white and black.Among the binarization algorithms, Bernsen algorithm as a typical binarization algorithm and an adaptive method of dynamic selection threshold is apply to realize binarization processing [1]. Bernsen algorithm could be described as follows:
 $w(x,y)=0.5*(\max(f(x+m,y+n)+\min(f(x+m,y+n))w \leq m \leq w, -w \leq n \leq w$

Where $f(x,y)$ is the gray value of the pixel (x,y)
 $w(x,y)$ is the threshold of each pixel.

To distinguish the information between warp and warp, weft and weft morphological processing is required. This is done by using dilation and erosion techniques.

Algorithm for Density evaluation:-

- 1) Fabric Image can be capture by using camera.
- 2) Apply pre-processing techniques such as enhancement etc.
- 3) Apply wavelet transform on that image.
- 4) Apply Binarization and Morphological Processing techniques.

- 5) Calculate density that is no. of warp and weft in that image.

$$D = \frac{\text{sum} * P * 10}{2.54 M (N)} \tag{1}$$

Where, P= is the resolution of CCD

D= is the density of warp and weft of woven fabrics
 M(N)= is the size of processed images.

ii)Weave Pattern Classification:-

Weaving is a method of textile production in which two distinct sets of yarns or threads are interlaced at right angles to form a fabric or cloth. The way the way filling threads interlace with each other is called the weave. The majority of woven products are created with one of three basic weaves: plain weave, satin weave, or twill.

There are three basic weave types of woven fabrics as shown in fig below:-

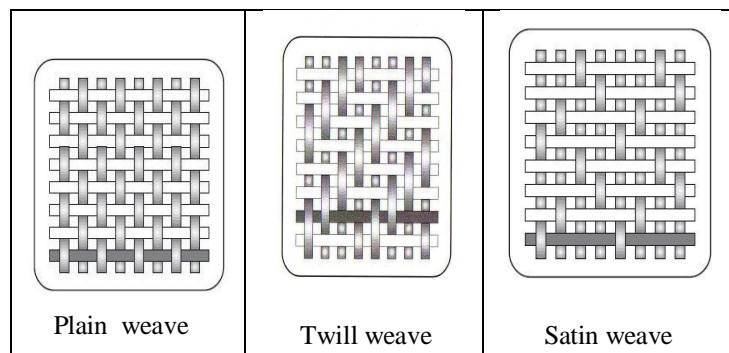


Figure 3.basic weave types of woven fabrics.

Plain Weave:-In plain weave, the warp and weft are aligned so they form a simple criss-cross pattern. Each weft thread crosses the warp threads by going over one, then under the next, and so on. The next weft thread goes under the warp threads that its neighbor went over, and vice versa.

Twill Weave:- Twill is a type of textile weave with a pattern of diagonal parallel ribs (in contrast with a satin and plain weave).

Satin Weave:- Satin is a weave that typically has a glossy surface and a dull back. The satin weave is characterized by four or more fill or weft yarns floating over a warp yarn or vice versa.The planning process for weave patten

classification is as follows:-

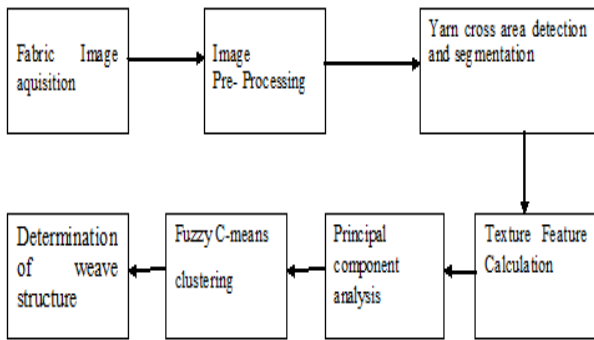


Figure 4. Block diagram for weave pattern classification.

Fabric image acquisition:- Fabric image is capture using camera. Then the captured RGB image are resized into M*N pixels and converted into gray images for improving processing speed.

Image pre-processing:- In order to improve the visual effect and facilitate people as well as machines to analyze and understand the images, image enhancement and media filter are use to reduce noisy and make fabric texture more outstanding.

Yarn cross area detection and segmentation:- To detect the interlacing area where weft yarn and warp yarn are crossed over each other, we apply a spatial domain integral projection approach. Interstices between yarns display darkness, therefore, the pixels around them have relative lower grey levels. [5] Looking for the local minima of the horizontal and vertical integral projections, we can locate the positions of interstices among yarns. Suppose $I(x, y)$ be an $M \times N$ gray scale image. The horizontal and vertical projection of the entire image is defined respectively as $H(y)$ and $V(x)$, thus, we have:

$$H(y) = \sum_{x=1}^N I(x, y) \quad (2)$$

$$V(x) = \sum_{y=1}^N I(x, y) \quad (3)$$

Due to image complexity and noise, there are some small waves through in the projection curve, which interfere actual local minima location detections. Therefore, we use moving average filter to smooth the curves. The enhancement of smoothing is shown in Fig.2. The upper panel depicts the integral projection curves without smoothing. Undesired local minima, which are highlighted by circle, are detected. These errors are removed after smoothing in lower panel.

Texture feature calculation:- The texture of an image is represented by the change of image gray levels. The grey level occurrence matrix (GLCM) of an image shows the statistic characteristics of grey level or grey level gradient under the condition of a certain spatial position. [5] The features

extracted from GLCM are related to the density of fiber and the orientation of yarn on a cross area. In this work, we use GLCM based texture features to discriminate the different cross area states. GLCM is computed based on two parameters, which are the distance between the pixel pair d and their angular relation θ . θ is quantized in four directions ($0^\circ, 45^\circ, 90^\circ$ and 135°). For rectangular $M \times N$ image segment $I(x, y)$, gray levels i and j , the non-normalized GLCM P_{ij} are defined by:

$$P_{ij, \theta} = \sum_{x=1}^N \sum_{y=1}^N C \{ (I(x, y) = i) \wedge (I(x \pm d\theta_0, y \mp d\theta_1) = j) \} \quad (4)$$

Principal component analysis:-

A feature vector has 192 elements. By definitions GLCM features are interrelated. Moreover, the diversity of the fabric samples also makes the measured feature vectors become confusing. The measured feature vector sets appear clouded, and may be redundant. It obstructs the accuracy of the next classification. As a standard tool in modern data analysis, principal component analysis (PCA) applies to large areas from image processing to bioscience. The goal of PCA is to extract relevant information from data sets consisting of a large number of interrelated variables [14]. Therefore, PCA is the optimal method to solve our above problems. We can state that our goals for using PCA are (i) to minimize redundancy in our feature vector sets and (ii) maximize the signal which expressed by our feature vectors. The basic idea of PCA is to identify the most meaningful basis to re-express the data set. In our studies, we assume that each fabric image has m detected image cells and each cell is expressed by a feature vector with 192 elements [5]. The feature data set for a fabric image is a $192 \times m$ matrix X . By using PCA, we aim at finding a new basis P which will reveal an optimal representation Y of the original data set X . The row vectors of P will become the principal components of X . Geometrically, P is a linear transform which rotates and stretches X into Y : $PX = Y$

Fuzzy c-means clustering:- the optimized texture features are analyzed by fuzzy c-means clustering for classifying the different cross area states by using algorithm shown below:-

Algorithm for weave pattern classification:-

Step 1:- Initialization (iteration 0):-

Randomly choose the centers of clusters v_i .

Step 2:- compute the membership function $u_{i,k}$ using:-

If $\|x_k - v_i\| = 0$ then set $u_{i,k} = 0$ (for $i \neq k$)

If $\|x_k - v_i\| \neq 0$ then

$$u_{i,k} = \left(\sum_{j=1}^c \left(\frac{\|x_k - v_i\|}{\|x_k - v_j\|} \right)^{2/m-1} \right)^{-1} \quad (5)$$

Where v_i is the center of the i^{th} cluster.

The norm $\|x_k - v_i\|$ is the distance between the sample x_k and the centers of classes v_i .

Step 3:- Update the positions of the centers v_i .

$$v_i = \frac{\sum_{k=1}^n u_{i,k}^m x_k}{\sum_{k=1}^n u_{i,k}^m} \quad (6)$$

Step 4:-Termination Test:- If $\| U^{(t+1)} - U^{(t)} \| > \epsilon$, then increment the iteration t.and back to the step 2.otherwise stop the algorithm. ϵ is the termination criterion.

Conclusion

Applying the wavelet transform to analysis the structure of woven fabrics could detect the yarns density of woven fabric perfectly, which requires woven fabrics with high quality. In other words, the whole algorithm is processed under the condition of warp being completely vertical and weft being horizontal. Nevertheless, being hard to avoid the affect by external interference in the process of actual image captured,the images of fabric weaves will be skew to a certain degree.Under the circumstances, the density detection would not be precise. Hence, it is the next target that skewing detection and rectification should be disposed for woven fabrics images to make the fabric density more accuracy.

In this paper, we have developed a novel automatic method for woven fabric structure identification. This method is based on digital image analysis techniques. It allows automatic weft yarn and warp yarn cross area segmentation through a spatial domain integral projection approach. Secondly, by applying unsupervised fuzzy c-means clustering to extracted texture features based on grey level co-occurrence matrix and principal component analysis, we can classify detected segments into two clusters. Then using a fuzzy rule based analysis on texture orientation features, the cross area states are automatically determined. To verify the validity of this method, a number of fabric images are used. The samples have different weave types, different fiber appearances and yarn counts. The recognition results match the actual structure of tested samples.

References

- [1] Junfeng Jing*,Shan Liu, PengfeiLi,QiLi,Suimei Liu, MengJiang,"Automatic Density Detection of woven Fabrics via Wavelet Transform" Journal of Information and Computational Science 11:8(2014) 2559-2568.
- [2] Junfengjing,MengmengXu*,PengfeiLi,QiLi,SuimeiLiu," Automatic Classification of woven Fabric structures Based on Texture Feature and PNN",Fibers and Polymers 2014,vol.15,No.5,1092-1098
- [3] JayantaK.Chandra,MadhumantiMajumdar,SourishSarkar, "Feature Extraction and classification of woven fabric using optimized HaralickParameters:a rough Set Based approach"2016,second International Conference on control,Instrumentation,energy&Communication(CIEC)
- [4] BaoXiaomin,NiXiaoqing,WangYaming,ZhouYanjiang," Recognition of fabric structures based on Improved Olfactory Neural Network"2010 International conference on Artificial Intelligence and computational Intelligence.
- [5] XinWang,NicolasD.Georganas,and Emil M.Petriu,"Automatic Woven Fabric Structure Identification by Using Principal Component Analysis and Fuzzy Clustering"2010,Distributed and collaborative Virtual Environments Research Laboratory(DISCOVER).
- [6] XingxingTu,BinjieXin "A novel method of intelligent analysis of weave pattern based on image processing technology"2011,4th International Congress on image and signal Processing.
- [7] DorianSchneider,YvesSimonGloy,andDoritMerhof"Vis n-Based On-Loom Measurement of Yarn Densities in Woven Fabrics"IEEE Transactions on instrumentation and measurement,VOL.64,NO.4,APRIL2015.
- [8] Dorian Schneider,DoritMerhof"High precision on-loom yarn density measurement in woven fabrics" Instrumentation and Measurement Technology Conference (I2MTC) Proceedings, 2014 IEEE International.
- [9] ZHANG Xiaochao,LIPing,JINFujiang,"The Study of Detect the Density of Knitted Fabric online Based on the Image"Control and Decision Conference (CCDC), 2015 27th Chinese2015 IEEE Transaction.
- [10]P.F. Li, J. Wang*, H.H. Zhang, J.F. Jing"Automatic woven fabric Classification based on Support vector machine."Automatic Control and Artificial Intelligence (ACAI 2012), International Conference
- [11]X.Wang,X.Li,Recognition of fabric density with quadratic local extremum[J],International Journal of Clothing Science and Technology,24(5),2012,328-338
- [12]Y.Qin,F.Xu,analysis and research of the fabric density based on wavelet transform [C],2012 fifth International Symposium on computational Intelligence and Design(ISCID),IEEE,1,2012,197-200
- [13]X. M. Zhao,Z.m.Deng,Y.T. Ran The automatic detection technology of woven fabric density based on wavelet transform[J],Progress in Textile Science & Technology 5,2011,45-47
- [14]Tejwant Singh,M. M. (2014). Performance comparison of Fuzzy C means with Respect to other clustering Algorithm.International Journal of Advanced Research in Computer Science and Software Engineering,89-83.

- [15] D. Napoleon, S. Pavalkodi. A New Method for dimensionality Reduction using K means clustering Algorithm for High Dimensional Data Set, International Journal of Computer Applications, Volume 13, No.7(2011), pp.41-46
- [16] Ananthi Sheshasayee1 ,P. Sharmila,"Comparative Study of Fuzzy C Means and K Means Algorithm for Requirements Clustering", Indian Journal of Science and Technology, 2014, Vol. 7, No. 6, pp. 853-857.
- [17] Soumi Ghosh, S.K. (2013). Comparative Analysis of K-means and Fuzzy C means Algorithm. International Journal of Advanced Computer Science and Applications, 35-39.