Fabric Defect Detection Based on Fuzzy C-Mean Algorithms

Sheetal Thorave
M.E. (Second Year)
Siddhant College of Engineering, Pune, India.
sheetal.thorave2009@gmail.com

Prof. M.S.Biradar
(H.O.D of Electronics & Telecommunication)
Siddhant College of Engineering, Pune, India.
msbiradar2002@rediffmail.com

Abstract-There exist various computer based techniques researched available in fabric defect detection but in accuracy and various problem exists in this techniques. So in this paper we introduced, the new techniques for fabric defect detection using automatic visual analysis. In this paper the fabric defect is detected by using clustering algorithm. Clustering methods is also used for image segmentation. The main objective of this paper is to show the outcome of fuzzy c-mean technique in the fabric defect recognition. Also performance of fuzzy C-mean is spotlighted.

Key words- *Fabric defect detection, Preprocessing, Fuzzy C-mean algorithm, Thersholding.*

*****

I. INTRODUCTION

Image Recognition techniques are being increasingly used to automate the detection of fabric defects in recent years. The approaches of fabric feature extraction have been mainly classified into various categories. In this paper, we introduced fuzzy c-means algorithm. These technique are based on clustering .Clustering techniques are unsupervised learning methods of grouping similar from dissimilar data types. Therefore, these are popular for various data mining and pattern recognition purposes. Segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful easier to analyze. Clustering is one of the methods used for segmentation.

Cluster analysis is also recognized as an important technique for classifying data, finding clusters of a dataset based on similarities in the same cluster and dissimilarities between different clusters [4]. Putting each point of the dataset to exactly one cluster is the basic of the conventional clustering method where as clustering algorithm actually partitions unlabeled set of data into different groups according to the similarities. As such there are many algorithms that are proposed to improve the clustering performance. Clustering is basically considered as classification of similar objects or in other words, it is precisely partitioning of datasets into clusters so that data in each cluster shares some common trait.

In this research paper, we recognize the fabric defect detection using the Fuzzy C-Means clustering algorithms are analyzed based on their clustering efficiency.

II. PROPOSED METHODS

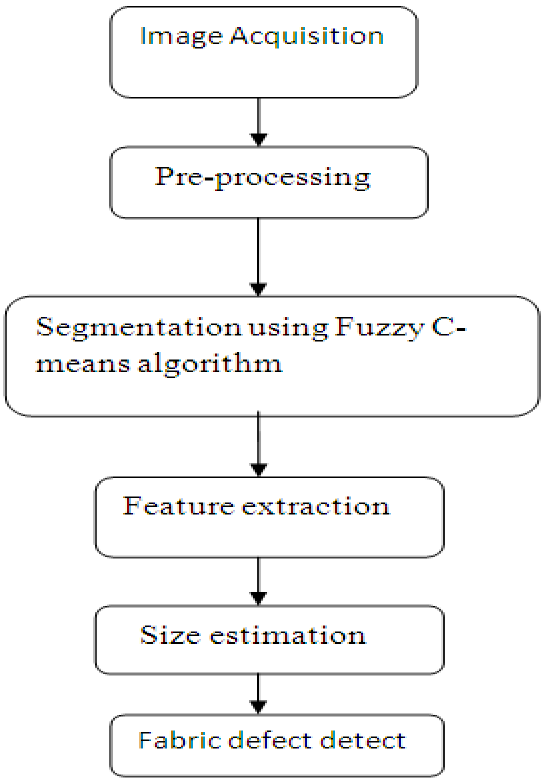

Fig.1 block diagram of proposed method

The above block diagram is proposed method to fabric defect detection. It uses the combination of two algorithms for image segmentation. The proposed method consists of main five modules. Each of module and its function will be explained below in details.

III.PRE-PROCESSING

According to the need of the next level is the pre processing step which convert the image. It performs filtering of noise and other artifacts in the image and sharpening the edges in the image. RGB to grey conversion and Reshaping also takes place in pre-processing. It also includes median filter for noise removal. It may arrive due to the thermal effect. The main aim of this paper is to detect the Defect in fabric. But for the complete system it needs the process of noise removal. For better understanding the function of median filter, we added the salt and pepper noise artificially and removing it using median filter.

3.1 Conversion RGB to Gray

A grayscale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information[1]. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. Grayscale images are distinct from one-bit bi-tonal black-and-white images, which in the context of computer imaging are images with only the two colors, black, and white (also called bit level or binary images). Grayscale images have many shades of gray in between.

3.2 Median filter

In image processing, it is often desirable to be able to perform some kind of noise reduction on an image. The median filter is a nonlinear digital filtering technique, often used to remove noise[2][3]. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

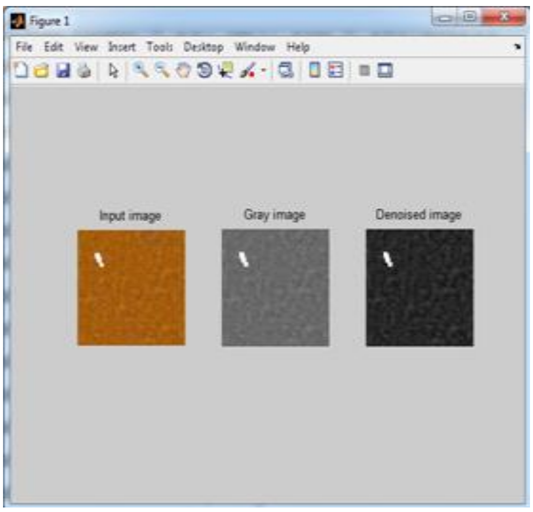

Fig.2.Result of preprocessing

IV. SEGMENTATION USING FUZZY C-MEANS

4.1 Fuzzy C-mean Clustering

The fuzzy logic is a way to processing the data by giving the partial membership value to each pixel in the image. The membership value of the fuzzy set is ranges logic that allows intermediate values i.e., member of one fuzzy set can also be member of other fuzzy sets in the same image.[3][7][8][9] There is no abrupt transition between full membership and non membership. The membership function defines the fuzziness of an image and also to define the information contained in the image. These are three main basic features involved in characterized by membership function. They are support, Boundary. The core is a fully member of the fuzzy set. The support is non membership value of the set and boundary is the intermediate or partial membership with value between 0 and 1

4.2. Mathematical Equation for Fuzzy C-mean

Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. This method (developed by Dunn in 1973 and improved by Bezdek in 1981) is frequently used in pattern recognition. It is based on minimization of the following objective function:

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^{m} \left\|x_i - c_j\right\|^2, \quad 1 \le m < \infty \quad -(1)$$

where m is any real number greater than 1, u_{ij} is the degree of membership of x_i in the cluster j, x_i is the i^{th} of d-dimensional measured data, c_j is the d-dimension center of the cluster, and ||*|| is any norm expressing the similarity between any measured data and the center. Fuzzy partitioning is carried out through an iterative optimization of the objective function shown above, with the update of membership u_{ij} and the cluster centers c_j by:

$$u_{ij} = \frac{1}{\sum_{k=1}^{c}\left(\frac{\left\|x_i - c_j\right\|}{\left\|x_i - c_k\right\|}\right)^{\frac{2}{m-1}}} \quad -(2)$$

$$C_j = \frac{\sum_{i=1}^{N} u_{ij}^{m} \cdot x_i}{\sum_{i=1}^{N} u_{ij}^{m}} \quad -(3)$$

This iteration will stop when $\max_{ij}\left\{\left|u_{ij}^{(k+1)} - u_{ij}^{(k)}\right|\right\} < \varepsilon$, where is a termination criterion between 0 and 1,where as *k*

ISSN: 2321-8169
367 – 371

are the iteration steps. This procedure converges to a local minimum or a saddle point of J_m.

4.3 Algorithm

1. Initialize $U=[U_{ij}]$ matrix, $U^{(0)}$.
2. At k-step: Calculate the centers vectors $C^{(k)}$.

$$C_j = \frac{\sum_{i=1}^{N} u_{ij}^{m} . x_i}{\sum_{i=1}^{N} u_{ij}^{m}} \qquad - (4)$$

3. Update $U^{(k)}$ and $U^{(k+1)}$.

$$u_{ij} = \frac{1}{\sum_{k=1}^{c}\left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|}\right)^{\frac{2}{m-1}}} \qquad - (5)$$

4. If $\|U^{(k+1)}-U^{(k)}\| < \delta$ Then STOP, Otherwise Return.

4.4 Flowchart of Fuzzy C-mean Algorithm

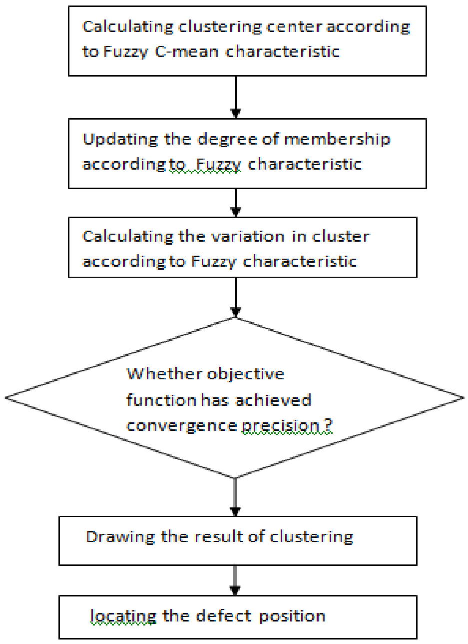

Fig.3 Representation of the Fuzzy c-means algorithm and its flow.

V. EXAMPLE DEMONSTRATION

Data are bound to each cluster by means of a Membership Function, which represents the fuzzy behavior of this algorithm.[5][6] To do that, we simply have to build an appropriate matrix named U whose factors are numbers between 0 and 1, and represent the degree of membership between data and centers of clusters. For a better understanding, we may consider this simple mono-dimensional example. Given a certain data set, suppose to represent it as distributed on an axis. The figure below shows this:

Fig.4 Data distributed on an axis.

Looking at the picture, we may identify two clusters in proximity of the two data concentrations. We will refer to them using 'A' and 'B'. In the first approach shown is the k-means algorithm – we associated each datum to a specific centroid; therefore, this membership function looked like this:

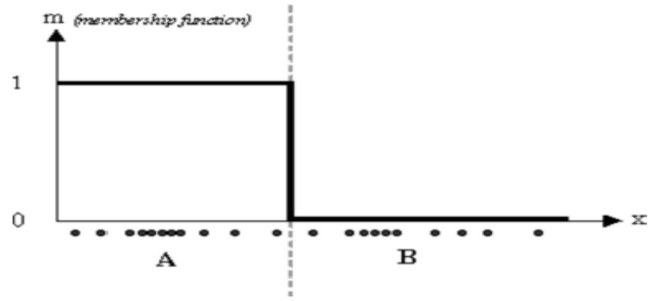

Fig.5 Membership function representation using K-mean

In the FCM approach, instead, the same given datum does not belong exclusively to a well defined cluster, but it can be placed in a middle way. In this case, the membership function follows a smoother line to indicate that every datum may belong to several clusters with different values of the membership coefficient.

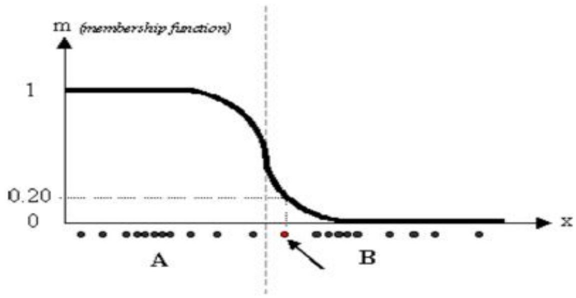

Fig.6 Membership function representation using fuzzy C-mean

In the figure above, the datum shown as a red marked spot belongs more to the B cluster rather than the A cluster. The value 0.2 of 'm' indicates the degree of membership to A for such datum. Now, instead of using a graphical representation, we introduce a matrix U whose factors are the ones taken from the membership functions:

$$U_{N*C} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 0 \\ .. & .. \\ 0 & 1 \end{bmatrix} \qquad U_{N*C} = \begin{bmatrix} 0.8 & 0.2 \\ 0.3 & 0.7 \\ 0.6 & 0.4 \\ .. & .. \\ 0.9 & 0.1 \end{bmatrix}$$

(a) (b)

ISSN: 2321-8169
367 – 371

The number of rows and columns depends on how many data and clusters we are considering. More exactly we have C = 2 columns (C = 2 clusters) and N rows, where C is the total number of clusters and N is the total number of data. The generic element is so indicated: u_{ij}. In the examples above we have considered the k-means (a) and FCM (b) cases. We can notice that in the first case (a) the coefficients are always unitary. It is so to indicate the fact that each datum can belong only to one cluster. Shown below is the expected outcome of the Fuzzy C-mean on defected image.

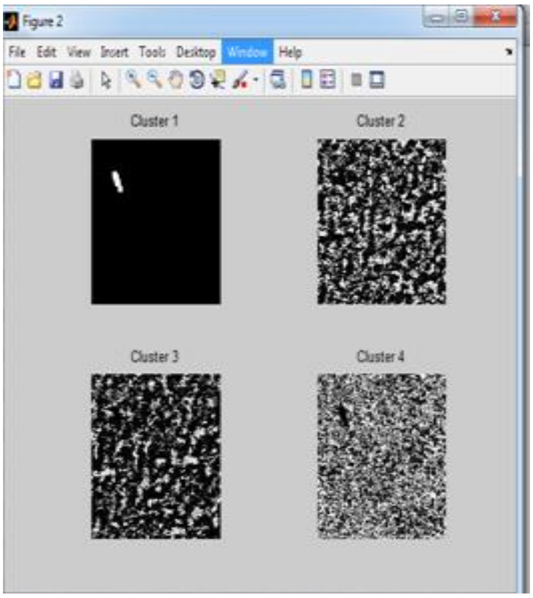

Fig.7 Experimental Result

VI. FEATURE EXTRACTION

The feature extraction is extracting the cluster which shows the predicted tumor at the FCM output.[5] The extracted cluster is given to the thresholding process. It applies binary mask over the entire image. It makes the dark pixel become darker and white become brighter. In threshold coding, each transform coefficient is compared with a threshold. If it is less than the threshold value then it is considered as zero. If it is larger than the threshold will be considered as one. The thresholding method is an adaptive method where only those coefficients whose magnitudes are above a threshold are retained within each block. Let us consider an image 'f that have the k gray level. An integer value of threshold T, which lies in the gray scale range of k. The thresholding process is a comparison. Each pixel in 'f 'is compared to T. Based on that, binary decision is made. That defines the value of the particular pixel in an output binary image 'g':

$$g(n) = \begin{cases} \text{'0' if } f(n) \geq T \\ \text{'1' if } f(n) < T \end{cases} \quad \text{-- (6)}$$

VII. APPROXIMATE REASONING

In the approximate reasoning is calculate the defected area is using the binarization method. That is the image having only two values either black or white (0 or 1). Here 256x256 jpeg image is a maximum image size.The binary image can be represented as a summation of total number of white and black pixels. Therefore image (I) is ,

$$I = \sum_{W}^{255} \sum_{H=0}^{255} [f(0) + f(1)] \qquad -(7)$$

Pixels = Width (W) X Height (H) = 256 X 256
f (0) = white pixel (digit 0)
f(l) = black pixel (digit 1)
No. of white pixel(P)-

$$P = \sum_{W}^{255} \sum_{H=0}^{255} f(0) \qquad -(8)$$

Where,
P = number of white pixels (width*height)
1 Pixel = 0.264 mm
The defect area calculation formula is

$$S = [(\sqrt{P})0.264]\,mm^2 \qquad \text{--(9)}$$

P= no-of white pixels; W=width; H=height.

VIII. CONCLUSION

In this paper, we have introduced a new computer-based fabric defect detection algorithm known as Fuzzy C-mean algorithm. The algorithm is developed in MATLAB for analysis and comparison. Fuzzy C-means clustering produces fairly high accuracy i.e. 96% then most of the existing techniques. Though Fuzzy C-mean requires more computation time, it provides more precise and accurate defect identification.

IX. REFERENCE

[1] Mark Grundland*, Neil A. Dodgson” Decolorize: fast, contrast enhancing,color to grayscale conversion”
[2] Raymond H. Chan, Chung-Wa Ho, and Mila Nikolova” Salt-and-Pepper Noise Removal by Median-Type Noise Detectors and Detail-Preserving Regularization”.
[3] Zhou Wang and David Zhang” Progressive Switching Median Filter for the Removal of Impulse Noise from Highly Corrupted Images

[4] Zhe LIU and Xiuchen WANG"Image Defect Recognition Based on "Super Fuzzy" Characteristic" JOURNAL OF MULTIMEDIA, VOL. 5, NO. 2, APRIL 2010.

[5] J.selvakumar, A.Lakshmi," Brain Tumor Segmentation and Its Area Calculation in Brain MR Images using K-Mean Clustering and Fuzzy C-Mean Algorithm" IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM -2012) March 30, 31, 2012.

[6] Soumi Ghosh, Sanjay Kumar Dubey," Comparative Analysis of K-Means and Fuzzy C-Means Algorithms"((IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 4, No.4, 2013

[7] JAMES C. BEZDEK," FCM: THE FUZZY c-MEANS CLUSTERING ALGORITHM

[8] Nikhil R. Pal, Kuhu Pal, James M. Keller, and James C. Bezdek" A Possibilistic Fuzzy c-Means Clustering Algorithm".

[9] MC Hung, DL Yang "The efficient fuzzy c-mean algorithm".

[10] "Digital Image Processing using MATALB" Rafael C.Gonzalez.

[11] www.wikipedia.com