Surface Defect Identification and Grouping of Intermittent Leather Images using Linear Discriminant Model

S. NithiyananthaVasagam, M. Sornam

Abstract*: *Scrutiny of intermittent leather is accepted through visual analysis on the natural material by an experienced individual based on many parameters which includes surface defects as a parameter. Such results comprising of base color, other than base color, share of regions, share of cutting area, share of cutting value, position wise length and position wise breadth will determine the value of the leather and surprisingly the result will vary form one experienced person to another. Hence, a new method for grouping of intermittent leather is proposed for a better or suitable decision making. Feature extraction technique, Grey Level Co-occurrence Matrix (GLCM) has been implemented to understand the features of color and area by extracting the texture features like Entropy, Energy, Contrast, Variance, Mean, Dissimilarity, Correlation and Homogeneity. A total of 428 intermittent leather imagesare used to understand the classification. The classifiers, Linear Discriminant Analysis (LDA) model and Support Vector Machine (SVM) are used to find out the accuracy. Further, linear discriminant model confirms 92% of accuracy over the support vector machine which is confirms 89.65% of accuracy. The proposed LDA model clearly shows that the approach is successful in classifying the variations among the defects and non-defects in intermittent leather images.

Keywords* :*Grey Level Co-occurrence Matrix, Intermittent leather,Linear Discriminant Analysis and Support Vector Machine

I. INTRODUCTION

The value of the leather used to be arrived based on grouping of them in an evenly distribution order. Leather has assumed importance as an opportunity sector for social development, employment generation and export realization. Indian leather sector processes about 700,000 tons of rawhides and skins from around 2300 units across the country per year, which results in the production of about 3 billion sq. ft of leather that amounts to about 12.9% share of the global import. The export of leather and leather products from India is about US$ 5.74 billion (2017-18). The leather and leather product sectors provide employment to about 4 million people. India is the second largest producer of footwear and leather garment and fifth largest exporter of leather products and accessories.

At the same time, it was observed that examination of leathers has been practiced for detecting defects by grouping manual intervention and this practice is considered as a traditional one which is understandably time-consuming and requires a lot of effort. But still, it varies between expert to expert or visual inspector to another inspector. The problem at hand concerns identification of defects in leather based on an intelligent system.

Texture analysis is generally a complex source of visual information [1] and it is representing the characteristics of textures, so that it can be used for classification and segmentation of objects [2]. Texture refers to surface characteristics and appearance of an object given by the size, shape, density, arrangement and proportion of its elementary part. In Image processing and pattern recognition [3], feature extraction is a vital step. A basic stage to collect such features through texture analysis [4] process is called as texture feature extraction. The Grey Level Co-occurrence Matrix (GLCM) [5] method is a way of extracting second order statistical texture features and this approach has been used in a number of applications.

Hence, it is necessary to improve the efficiency of the process led to the use of image processing tools to handle the problem that can achieve uniformity and accordingly this work focused primarily based on the GLCM [6] features. Linear discriminant analysis (LDA) [7] is used as a classifier to understand the relationship of the features. LDA is also related to the analysis of variance and regression. Moreover, Support Vector Machine (SVM) is employed to cross validation of the performance with LDA. The structure of paper comprises Material & Approach, Results & Discussion and Conclusion is respectively given in the section II, III and IV.

II. Material and approach

The proposed work was conducted in five steps namely, pre-processing, segmentation, feature extraction, feature selection and classification as shown in the Fig 1. Initially the original image, Fig.2 is picked to eliminate noises and marks. Afterwards an improved image is then segmented using Contour without edge (CWE) [8].

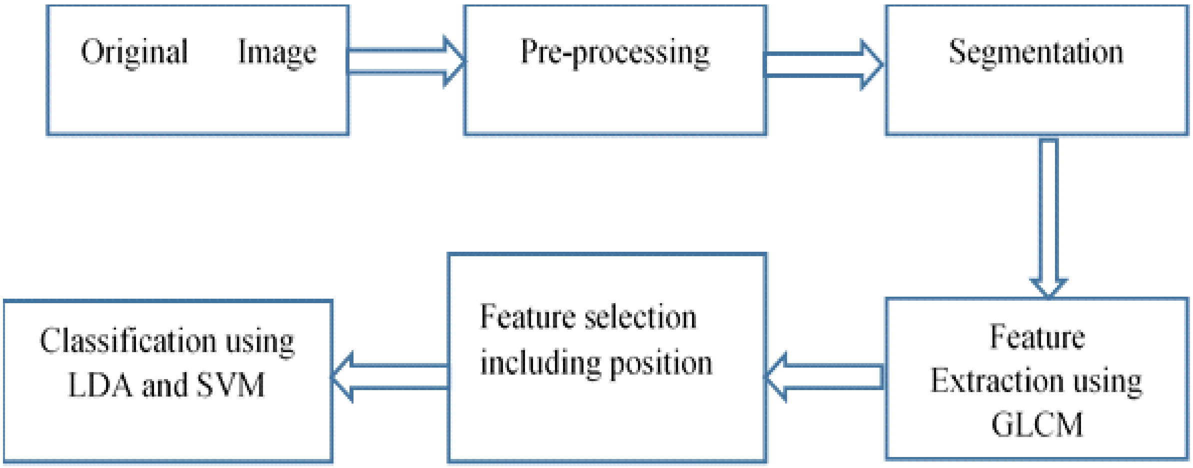

Fig. 1. Process Flow

- **Image Collection and Database**

Primarily, a total of 428 leather images consisting of training data of 384 and test data of 44are taken from Nikon DX 5100 camera in 32-bit format. In order to understand the classification, all the images were converted into 300 x 300 size.

Fig. 2. Intermittent leather with defect

- **Pre-processing and Segmentation**

By doing Pre-processing, it would improve the contrast in the background. Further the image is filtered by erosion and dilation for shrinking and expansion operation respectively. Further, the image is segmented [10] by active contour without edge for making difference between defects and non-defects area in region wise. Each region [11] is partitioned based on certain texture characteristic and proper-ties in homogeneously. Using Homogeneity, the measures of closeness of the distribution could be obtained to determine whether the image is textured or non-textured. Basically, Energy measures the uniformity of an image and the value of the image will be large if pixels are very similar.

- **Feature Extraction, Selection and Classification**

The image is extracted using Gray Level Co-occurrence Matrix (GLCM) method to calculate the spatial distance of gray levels in the image [12]. GLCM represents the relationship between reference pixel (i) and neighboring pixel (j) in the angle 0. The initial value of GLCM (i, j) is zero. The value of each element is getting updates as per the co-occurrence of pixels. In this paper, eleven texture features [13] are extracted from the images, three features namely base color, other color, share of cutting value, position length and position breadth from visual inspectors and through histogram [14]. The remaining eight features are extracted using GLCM which are Variance (1), Entropy (2), Contrast (3), Dissimilarity (4), Energy (5), Mean (6), Correlation (7) and Homogeneity (8). The formulas are given below:

Variance = $\sum_i\sum_j(i-\mu)^2p_{ij}$ (1)

Entropy = $-\sum_i\sum_j P_{ij}\log_2 p_{ij}$ (2)

Contrast = $\sum_i\sum_j(i-j)^2p_{ij}$ (3)

Dissimilarity = $\sum_i\sum_j|i-j|^2p_{ij}$ (4)

Energy = $\sum_i\sum_j p_{ij}^2$ (5)

Mean = $\sum p/n$ (6)

Correlation = $\sum_i\sum_j p_{ij}\text{-}\mu_x\mu_{x/xx}$ (7)

Homogeneity = $\sum_i\sum_j p_{ij}/1+ij^2$ (8)

Basecolorshare = (nPBC/nP) - u (9)

Othercolorshare = nP–(nPBC/nP)-u (10)

Shareofcuttingvalue = (((nPBC/nP)-u) *(2/3)) (11)

The classifier, linear discriminant analysis (LDA) finds a set of prediction equations based on independent variables that are used to classify individuals into groups. In general, DA used for interpreting the predictive equations to better understand the relationships that may exist among variables. The following formula as shown in equation (12) is to workout discriminate score (Y_i, i = 1,2,...n is dependent variable) whereas LA is constant and LB is discriminant co-efficient and (X_i, i = 1,2,...n) is the independent variables.

$$Y_i = LA + LB_1X_1 + LB_2X_2 + \ldots + LB_nX_n \quad (12)$$

III. RESULTS AND DISCUSSION

In this work, Grey Level Co-occurrence Matrix (GLCM) method is used for feature extraction. The intermittent leather image (Fig 2) is segmented and the Grey Level Co-Occurrence Matrix (GLCM) for the same is calculated. Among the features, interestingly, the texture features which classifying the image between Defect leather images (Fig 3) and normal leather (Fig 4) are Variance, Contrast, Entropy, Energy and Homogeneity. The features base color as shown in equation (9) and other color as shown in equation (10) are used to be inverse each other.

Table I: Texture analysis using GLCM

Features	***Non-Defect / Normal***	***With Defect***
Mean	0.899	0.902
Variance	909.7204	961.7435
Correlation	0.9	0.9
Entropy	2.19	2.19
Homogenity	1.0	1.0
Contrast	62.3333	122
Dissimilairty	7.4444	10.0
Energy	1.0	1.0

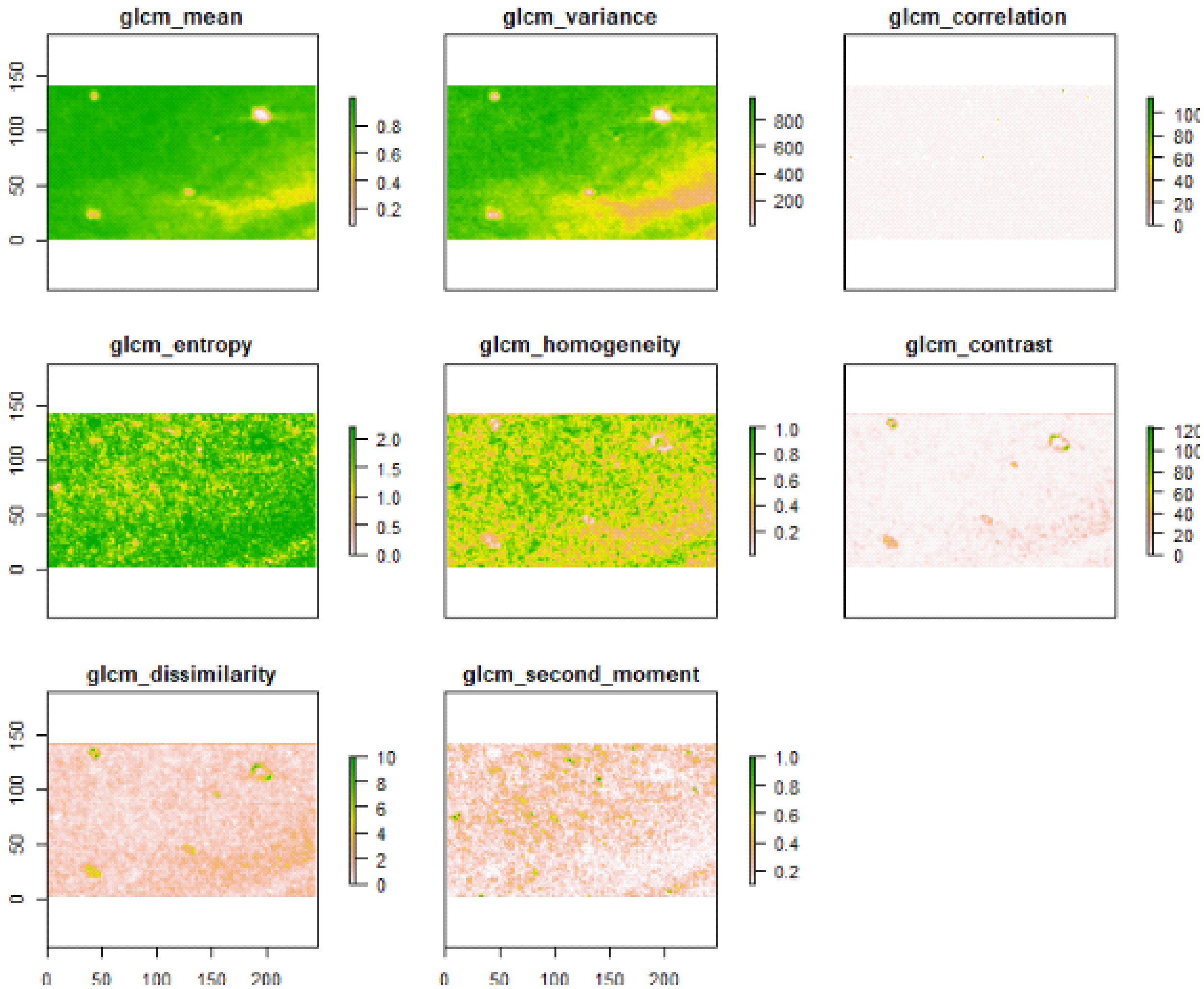

Fig. 3. GLCM features of defect Intermittent leather

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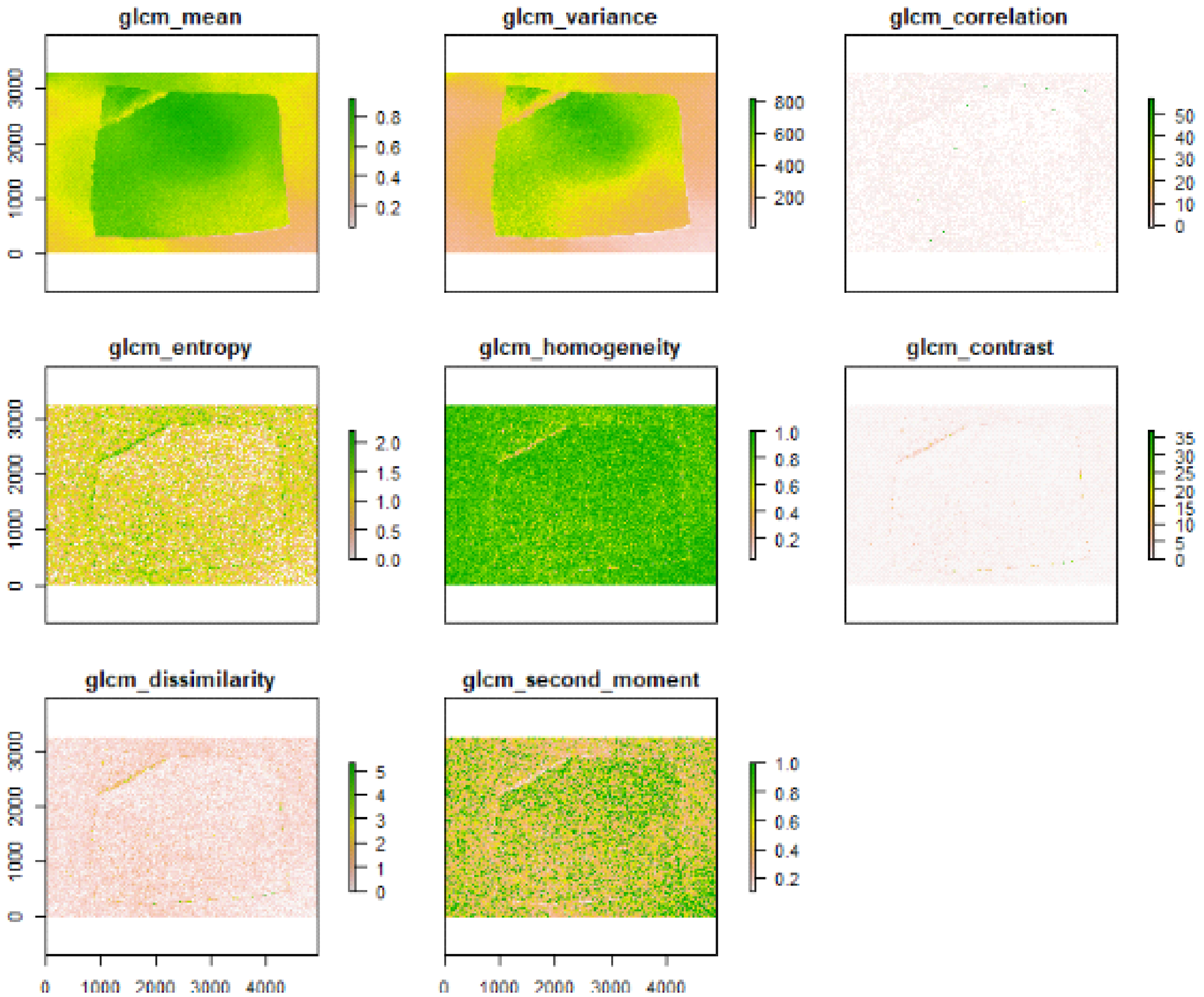

Fig. 4. **GLCM features of non-defect Intermittent leather**

The value of the relevant texture features is extracted after GLCM is computed and the feature values are obtained from the images with defect and without defect as shown in Table I.

It is clearly understood from the above table I, that the features of Mean, Variance, Contrast, Dissimilarity are showing variances in the value when compared with the remaining features like Correlation, Entropy, Homogeneity and Energy. According to the above, the proposed work has confirmed that there is a significant difference that could identify between Normal and Defect leathers through GLCM features and though, features like Homogeneity, Energy are positively significant.

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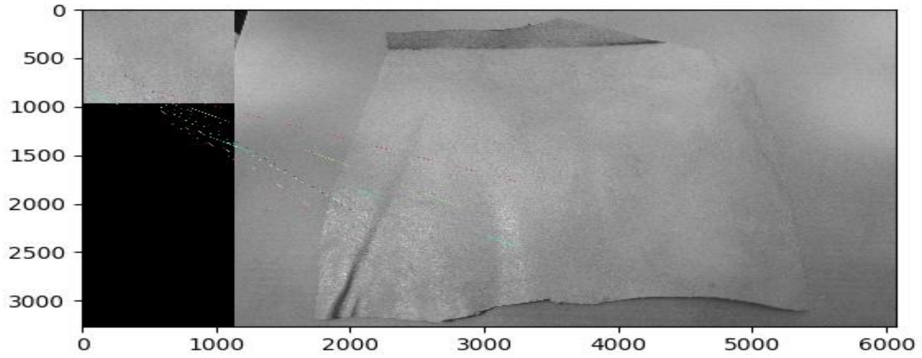

Fig. 5. Feature mapped intermittent Leather with the pixels of corresponding row as x axis and column as y axis

Moreover, feature mapping was carried out to point out the selected regions with the pixel value of row and column (Fig 5)

Table II: Additional Features

Features	*Non-Defect / Normal*	*With Defect*
Base color share	90%	Below 30%
Other colorshare	10%	Above 40%
Position Lengthwise	67%	33%
Position Breadth wise	60%	40%
shareofcuttingvalue	50 % and above	Below 50%

It is observed from the table II, the share of basecolor value 90% which impacts in the share of cutting value of corresponding position by length.

For data analysis, statistical software SPSS V20 has been used.To understand the relationship between data of basecolor and shareofcuttingvalue as shown in equation (11), correlation is applied. There is a strong positive correlation of 0.985 between basecolor and shareofcuttingvalue. Moreover, the shape of the intermittent normal leather material (without defect) is determined a minimum of by the position with length is 67% and breadth is 60%.

Discriminant analysis results of Wilks' Lambda value is 0.282 which shows model is significant because the significant value is less than 0.05. Also, the prediction accuracy is 92% for the discriminant model. The unstandardized regression equation is

Presence of defects (y) = -13.867 + 0.225 base colour (x_1) - 0.064shareofcuttingvalue (x_2) (13)

Here the base color and shareofcuttingvalue are independent variables and presence of defects is dependent variable as shown in equation (13).

Table III: Functions at Group Centroids

Presence of Defects	*Function*
Non-Defects	2.084
Defects	-1.172
Unstandardized canonical discriminant functions evaluated at group means	

The function of group centroid value has been used to predict the presence of defects. It is observed from table III, If Y value is closer to 2.084, then there are no defects whereas if Y value is closer to -1.172, it shows presence of defects.

Table IV: Observation from classifiers

Parameter	*SVM*	*LDA*
Accuracy	89	92

It is observed from the table IV, the classifiers values with respect to the accuracy.

In addition to the above classification, the Support Vector Machine is employed and it is confirming 89.65% of accuracy.

IV. CONCLUSION

The value of the intermittent leather is determined based on the presence of defects. In this study, 428 number of various intermittent leather images were used. The problem at hand concerned on identification of defects in leather by manual intervention, the accuracy of the result is varying from one assortor to another assortor. The proposed, lineardiscriminant model classifies 92% of accuracy over the classifier Support Vector Machine which is confirms 89.65% of accuracy. Hence, this study clearly shows that the proposed approach of linear discriminantmodel is successful in classifying the variations among the defects and non-defects in intermittent leather images.

Present study gives hopes for future work with respect to additional features such as position wise availability, cutting area and segregation of distribution of defects in intermittent leather.

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