RESEARCH ARTICLE OPEN ACCESS

Surface Color Identification in Crust & Finished Leathers using K-Means Clustering Algorithm

M. Sornam*, S. Nithiyanantha Vasagam**
**(Department of Computer Science, University of Madras, Chennai, India*
*** (Department of Computer Science, University of Madras & PPBD, CSIR-CLRI, Chennai, India*
Corresponding Author: Dr. M. Sornam

ABSTRACT
In general, color identification on the surface level is carried out in the leather industry. Further, the leather is grouped by various parameters. Primarily it takes place through visual assessment only. This practice is a traditional one, and subsequently, the value is fixed depends on this grouping. Therefore, the surface level examination in a crust and finished leather has taken for study to understand the classification by using K-Means clustering. The proposed method offers reliable data on the cutting area by surface color identification.
Keywords - algorithm, clustering, crust leathers, k-means, leather surface

---

Date Of Submission:03-08-2018 Date Of Acceptance: 18-09-2018

I. INTRODUCTION

Entire leather and leather related industry depend on livestock since hides and skins are the raw materials, it is a by-product of the meat industry. "Leather Tanning" [1] is a process having various processing steps involved in converting animal hides/skins into finished leather. The value of the leather is arrived based on the various parameters like quality, mass, area, and types of leather through visual inspection [2] on the surface level. These groupings of the leathers are taking place predominantly based on the "visual inspection". It is also called conventional technique or methodology, and it is a sensitive process in the leather trade. Moreover, the value of the leather used to be arrived based on the grouping of them in evenly. Leather has assumed importance as an opportunity sector for social development, employment generation and export realization.

Image processing [3] is the field of signal processing [4] where both the input and output signals are images. Images can be thought of as two-dimensional signals via matrix representation, and image processing can be understood as applying standard one-dimensional signal processing techniques to two-dimensional signals.

The problem at hand concerns identification of defects in leather-based on an intelligent system. Traditionally, this has been tackled by manual intervention, which is understandably time-consuming and requires a lot of effort. Hence, it is necessary to improve the efficiency of the process led to the use of image processing tools to handle the problem, and accordingly, this paper focused primarily on the color segmentation [5].

1.1 Leather Defect

The quality of the raw material varies based on the species, origin and most importantly on the condition of rearing. Imperfections in the structure of a hide or skin resulting in an unsightly appearance and / or weakness of the resultant leather are called defects [6].

1.2 Pixel Indices

The quality. The most convenient method for expressing locations in an image is to use pixel [7] indices. The image is treated as a grid of discrete elements, ordered from top to bottom and left to right, as illustrated in the image matrix.
An image matrix (N x M):

$$A=\begin{pmatrix} A(0,0) & A(0,1) & A(0,2) & \dots & A(0, M-1) \\ A(1,0) & A(1,1) & A(1,2) & \dots & A(1, M-1) \\ . \\ . \\ . \\ A(N\text{-}1,0) & A(N\text{-},1) & A(N\text{-},2) & \dots & A(N\text{-}, M-1) \end{pmatrix} \Big\} \text{N rows}$$

1.3 Color Spaces

The colours seen and recognized by the human eye can be represented using a number of mathematical models, each with its limitations. Over the years many models have been developed, with each colour space model having its advantages and drawbacks. A few generic models are RGB [8], CMYK [9], LAB Space [10], Gray Scale [11], binary, etc. This paper employs the RGB, LAB

Space, Gray Scale and Binary Representations of colour.

Binary representation of an image essentially convert the images into binary images and classifies the entire colour as either black or white, zero for black and 1 for white in binary. A threshold value is to be specified for this classification.

Grayscale representation of an image, as the name suggests, represents the image in various shades of grey. This model is a two-dimensional model, with values ranging from (0,0) black to (255,255) white by default.

RGB colour representation works on the premise that most colours can be represented as a 3 Dimensional entity defined by independent colour components Red, Blue and Green. By varying the intensities of these components of a pixel, various colours can be represented, ranging from (0,0,0) black and (255,255,255) white. The RGB colour code is one of the most widely used representations. In this proposed work, we explored the k-means clustering along with Silhouette method.

1.4 K-Means Clustering Algorithm

K-means [12] clustering is a method of vector quantization, originally from signal processing, that is popular for cluster analysis in data mining. In addition to the K-means Clustering Algorithm, in this study Silhouette [13] function is also carried out to estimate [14] how similar a point is to the other points in its cluster.

II. MATERIALS AND METHODS

The A surface-level analysis of the scanned image for the given piece of leather within the cutting region, identified by clustering the defects and ultimately generate a suitable ranking.

Data Migration [15] - Importing data from the given database.

a. Consolidating the given data into a single image matrix (rows, columns, 3) – 3 for r, g and b components of a colour image.
b. Creating a 1-dimensional array [16] of size up to the maximum value. Each element of the array then represents the numerical frequency value of that index.
c. Converting this 1D array into a 2D array.
d. Regenerating the original image - Importing the corresponding RGB values into the current array. With the prior knowledge that the array is sorted according to frequency the top most element is taken, and with a tolerance of +/-40 of each R, G, B values, all the elements falling within the range are transported into a separate array, base (Extracting the base colour).

III. RESULTS AND DISCUSSION

In order to validate the color segmentation, a database is initially created by including the cutting area and remaining areas as shown in Fig. 1 through minimum variance quantization [17] by associating pixels into groups based on the variance between the pixel values.

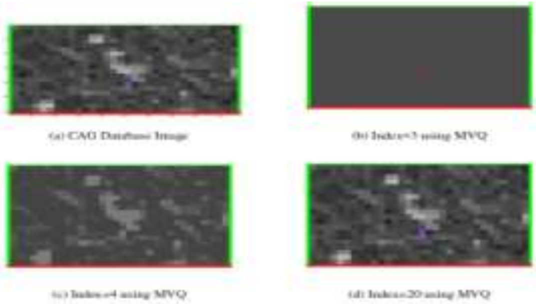
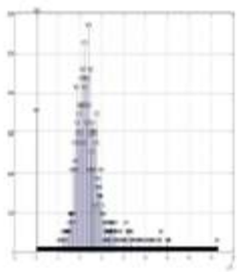


Figure 1. Scanned image and database conversion (MVQ - Minimum Variance Quantisation).

Histogram [18] is a clustering method which is used to plot individual frequencies of the various colours in the image. Basically it acts as a graphical representation of the tonal distribution in a digital image. Here, the default color-code, is used, for ease, as it is a unique code for each color consolidated in a single array, unlike the RGB values. Histogram obtained for the image is given in Fig. 2, Fig. 3 and Fig. 4.



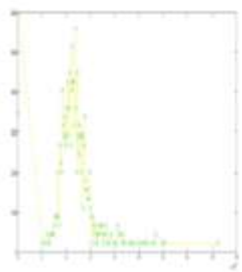


Figure2:Histogram of Color Code (True Color)
Figure 3.Histogram after array conversion

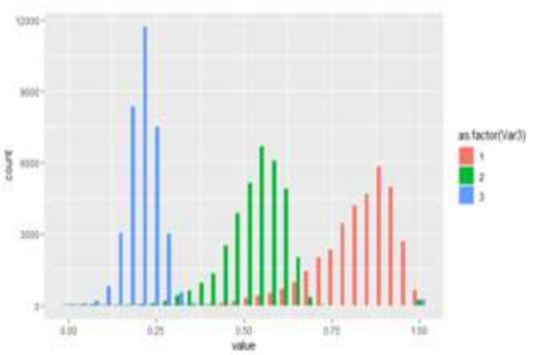


Figure 4.Histogram of the sample

A sample image (test) has been created with the size is of 300x300 to study the image color segmentation by extracting the base colour with a tolerance of +/- 40 of each R,G,B values and the main colors as against shown in Fig. 5

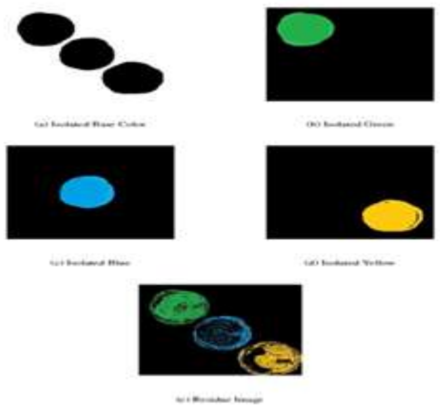


Figure5: Isolated Image

All the points have been clustered by using the K-means algorithm into many groups in which, the homogeneous [19] points are grouped together will form an identical group to make the comparison with similar points in any other groups. This is basically a cluster regarding color based clustering.

Using the above, test image Fig. 5 has been converted into a 3-D array such that each index corresponds to a unique RGB value, covering the entire spectrum, or the part of the spectrum which is required to represent the image.

The array of unique color is clustered as shown in the Fig. 6 by using the silhouette function and the corresponding values of k as shown in the below Table I.

Table I. Values of K in Silhouette Function Values

Values of K	4	5	6	7	8	9	10	11
Values	0.5523	0.5489	0.5542	0.5421	0.5523	0.5135	0.5231	0.5310

The same has carried out using K-Means Clustering for the Fig. 6 and the corresponding values of k as shown in the below Table II.

Table I. Values of K-Means Clustering

Values of K	2	3	4	5	6
Values	0.885	0.566	0.864	0.822	0.966

It is clearly understood that the exact values may vary from cluster to cluster by estimating the optimal k value. But the relative positioning is the same. Six always has the highest value indicating the ideal number of clusters as indicated in the Fig. 7 since greater the K value has more appropriate the clustering of that point.

Figure 6 Leather Sample for Testing

Figure 7. Image labeled by Cluster Index

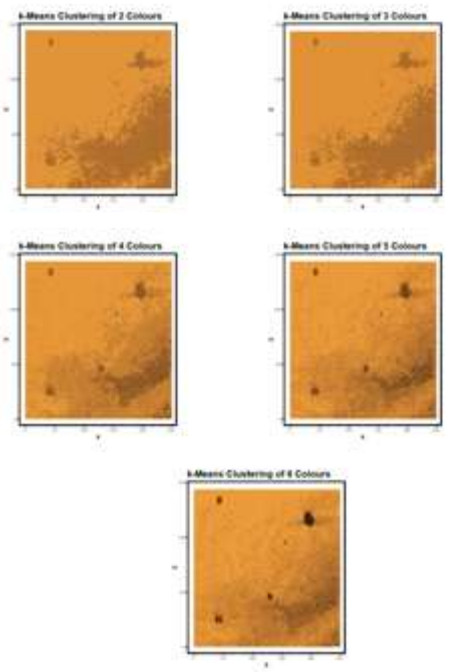


Figure 8. The same has been repeated as in the Fig. 8 and Fig. 9

Figure 9. Different Clusters of the Sample Leather

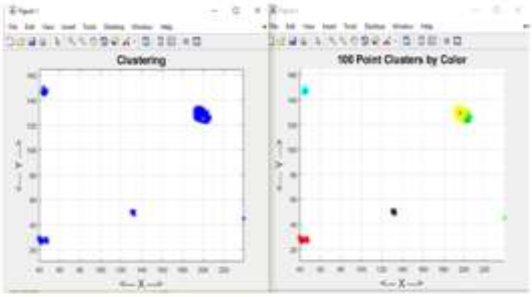


Figure 10. Through K – Means

The trials were carried out for the defect identification for the sample leather pieces with area, perimeter as indicated in the below Table III and the same was shown in Fig.10 and Fig.11.

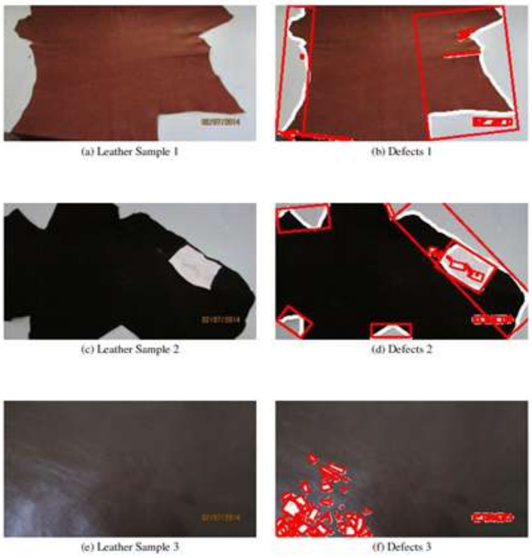


Figure 11. Defects in the Leather Samples Set 1

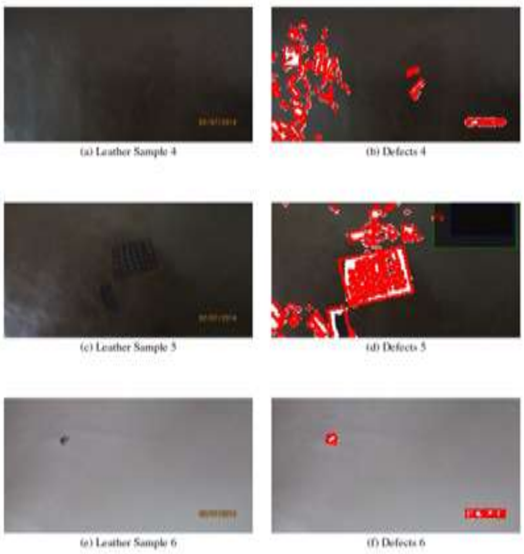


Figure 12. Defects in the Leather Samples Set 2

Table Iii Defect Outputs

Sample	**Area occupied**	**Perimeter**	**Area of Defects in %**	**Perimeter of Defects in %**
Leather Sample 1	380	1817.40	0.75	1.94
Leather Sample 2	366	1991.03	0.73	2.13
Leather Sample 3	334	2328.37	0.66	2.49
Leather Sample 4	398	2590.00	0.79	2.77
Leather Sample 5	1534	5487.85	3.04	5.86
Leather Sample 6	165	427.30	0.33	0.46

IV. CONCLUSION AND FUTURE WORK

This paper primarily attempted by using color segmentation by which a database is generated for defects. During the various trials for the defect identification based on the sample leather pieces, the area occupied, perimeter were noticed with respect to percentage of affected area. There is significant scope for further study concerning the type of defect, positioning of the defect in the cutting area.

ACKNOWLEDGEMENTS

The authors are thankful to University of Madras, Chennai and CSIR-Central Leather Research Institute (CSIR-CLRI), Chennai. The authors also acknowledge the CSIR-CLRI Communication No. 1238.

REFERENCES

This heading is not assigned a number.

[1]. Subramani Saravanabhavan, Palanisamy Thanikaivelan, Jonnalagadda Raghava Rao, Balachandran Unni Nair and Thirumalachari Ramasami; "Natural Leathers from Natural Materials: Progressing toward a New Arena in Leather Processing"; Environ. Sci. Technol., 38 (3), pp 871–879, 2004

[2]. Varsha S Kota, Shailaja R, Sri Vani K and Kamatchi Sundari V; "A Survey on The Approaches Used for Detection of Defects on Leather Surfaces Using Image Processing"; International Journal of Computer Science and

Intelligent Computing, Vol 3(3), pp: 374-379, 2017

[3]. R. Fisher, K Dawson-Howe, A. Fitzgibbon, C. Robertson, E. Trucco;. dictionary of computer vision and image processing (John Wiley; 2005)

[4]. Van De Vegte, Joyce, fundamentals of digital signal processing (Prentice Hall, 2001.)

[5]. A Charade, S.K. Katiyar; “Color Based Image Segmentation Using K-Means Clustering”; International Journal of Engineering Science and Technology; Vol. 2(10): pp.5319-5325, 2010.

[6]. S. Nithiyanantha Vasagam, B. Madhan, B. Chandrasekaran, J.Raghava Rao; “Studies on Selective Defect Identification of Crust Leathers for Computer-Aided Grading”; American Leather Chemists Association, Vol. 108: pp.210-220, 2013.

[7]. Foley, J. D.; Van Dam, A; Fundamentals of Interactive Computer Graphics. Reading, MA (Addison-Wesley, 1982.)

[8]. P. Sebastian, Y. V. Voon and R. Comley; “The effect Industrial Electronics and Applications”, Singapore, pp.2512-2516, 2008.

[9]. Galer, Mark; Horvat, Les; digital imaging: essential skills (Focal Press, p. 74; ISBN 978-0-240-51913-5, 2003.)

[10]. Hunter, Richard Sewall; “Accuracy, Precision, and Stability of New Photo-electric Color-Difference Meter”, JOSA. 38 (12): 1094, 1948 (Proceedings of the Thirty-Third Annual Meeting of the Optical Society of America)

[11]. Stephen Johnson, Digital Photography (O'Reilly; ISBN 0-596-52370-X, 2006.)

[12]. Peter J. Rousseeuw, Silhouettes, “Graphical Aid to the Interpretation and Validation of Cluster Analysis”, Computational and Applied Mathematics. 20: 53–65, 1987.

[13]. Van Der Hoeven, Jeffrey, Bram Lohman, Remco Verdegem; “Emulation for Digital Preservation in Practice: The Results". The International Journal of Digital Curation. 2 (2): 123–132, 2007.

[14]. S. Nithiyanantha Vasagam and M. Sornam; Selective Surface Colour Identification in Crust Leathers Using K-Means Clustering Algorithm; 08, 2017. (Proceedings of the 3rd International Conference on Computing Paradigms)

[15]. Simanta Shekhar Sarmah, Data Migration, Science and Technology, Vol. 8 No. 1, 2018, pp. 1-10. doi: 10.5923/j.scit.20180801.01.

[16]. Arghya Dutta, Raymond A. Wong, Woonghyeon Park, Keisuke Yamanaka, Toshiaki Ohta, Yousung Jung & Hye Ryung Byon , P, “Nanostructuring one-dimensional and amorphous lithium peroxide for high round-trip efficiency in lithium-oxygen batteries”, Nature Communications, 680, 2018

[17]. Gregg, W. David, Analog & Digital Communication (John Wiley, 1977.)

[18]. Meng, X., Li, H. & Cui, J.; “Studies on Selective Defect Identification of Crust Leathers for Computer-Aided Grading”; J. Commun. Inf. Netw,, Vol.2 (3): pp.68-77, 2017.

[19]. Edgar Chavolla, Arturo Valdivia, Primitivo Diaz, Daniel Zaldivar, Erik Cuevas, and Marco A. Perez, “Improved Unsupervised Color Segmentation Using a Modified Color Model and a Bagging Procedure in -Means++ Algorithm,” Mathematical Problems in Engineering, vol. 2018, Article ID 2786952, 23pages,2018. https://doi.org/10.1155/2018/2786952.

Dr. M. Sornam "Surface Color Identification in Crust & Finished Leathers using K-Means Clustering Algorithm "International Journal of Engineering Research and Applications (IJERA) , vol. 8, no.9, 2018, pp 12-16