Studies on Selective Defect Identification of Crust Leathers for Computer-aided Grading

by

S. Nithiyanantha Vasagam,[1] B. Madhan,[2] B. Chandrasekaran[2] and J. Raghava Rao[3]*

[1]*Council of Scientific and Industrial Research - Central Leather Research Institute, Economics Research,* Adyar, Chennai - 600020, India

[2]*Council of Scientific and Industrial Research - Central Leather Research Institute, Center for Human and Organizational Resources Development,* Adyar, Chennai - 600020, India

[3]*Council of Scientific and Industrial Research - Central Leather Research Institute, Chemical Laboratory,* Adyar, Chennai - 600020, India

Abstract

Grading of leathers is a sensitive and vital process in leather trade. Conventional grading methodology deals with visual inspection of the leathers. This practice is purely based on experience of the person (sortor) grading leathers and has no defined frame work. The current grading process is highly subjective, varying from one person to another. In order to overcome these problems and to have better objectivity in the grading process, it is proposed to design a Computer Aided Grading (CAG) system for leather grading. The principle of image recognition and detection of pixels of the scanned image of leathers will be used for the CAG system.

Resumen

La clasificación de las pieles es un proceso sensible y vital en el comercio del cuero. La metodología convencional de la clasificación se entiende como la inspección visual de los cueros. Esta práctica se basa puramente en la experiencia de la persona (clasificador) seleccionando cueros y no tiene un marco definido. Este actual proceso de calificación es altamente subjetivo, variando de una persona a otra. Con el fin de superar estos problemas y tener una mejor objetividad en el proceso de clasificación, se propone el diseño de un sistema de Evaluación Asistida por Ordenador (CAG, en sus siglas en inglés) para la clasificación de cuero. El principio de reconocimiento de imágenes y la detección de píxeles de la imagen escaneada de cueros fue utilizado para el sistema de Evaluación Asistida por Ordenador CAG.

*Corresponding author e-mail: jrrao@clri.res.in; Tel: + 91 44 2441 1630, Fax: + 91 44 2491 1589

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INTRODUCTION

Global sales of leather and leather products are currently at US $120 billion. Totally, about 19.3 billion square feet of light leather is produced worldwide by the leather industry in a year, which comes to a total estimated value of about US$ 16.9 billion. Over 60% of the world's leather production is from the developing countries.[1] Leather commodity connects the rural farmer to the fashion world. Leather is manufactured from raw hides and skins, which is primarily a by-product of meat industry. Moreover animals vary for many reasons such as breed, sex, age, diet, husbandry, etc.[2-7] Since, the raw materials are from natural biological source it is subjected to significant variations depending on the species, origin and the environmental condition of rearing.[8,9] Hence leather suffers from a serious problem with reference to the quality due to varied raw material gradation.

Utility of the leather is based on the quality of leathers only. Higher grade of leather goes for shoe uppers while lower grades go for lining leathers, in general. Grades, in present industrial scenario vary from 8 to 10 types. The variation in grading is due to various defects in the raw material.[10,11] Grading is carried out at several stages of leather manufacture including assortment of raw material. Grading of material in its raw stage is very challenging as the presence of hair camouflages the grain surface defects.[12] Hence in the leather manufacture industry the grading carried out at intermittent semi processed stage is more reliable. However, even such grading technique practiced currently in the industry is highly subjective and has no clearly defined procedure for its practice. Due to the qualitative leather grading, disputes between buyers and sellers of leather happens, as the value of leather varies significantly depending upon the grading of the leather. Technologies, at present in the world are crossing its borders and make the impossible to be possible. The Technologies for some of the studies like statistical textures, surface inspection and defect detection for steel, apple, leather fabric and leather surface were also tried.[13-17]

In this paper, we are presenting our efforts in making the complex grading of leathers objective using computer aided grading (CAG) methodology. In the present study crust leathers from skins have been chosen for the objective assessment methodology development. Crust leathers are those post tanned for improving the compaction and softness of the leather and at these stages leathers can be graded before deciding the final finishing of leather and offers the possibility on further upgradation of leathers. This newer methodology is likely to make the objective assessment of leather a reality.

MATERIALS AND METHODS

Identification of Various Defects (Crust Leather)

In general, the defects in leather are classified as ante-mortem and post-mortem defects.[18,19] Ante-mortem defects refers to defects caused in hides/skins before the death of animal and post-mortem defects refers to defects caused after death of the animal i.e., during handling of hides and skins. The common defects found in crust leathers are, tick marks, white spots, pox marks, drawn grain, pin holes, scratches, short hairs, wounds, putrefaction, flay cuts, brand marks, warts, sores, small pox and warble fly marks.[20,21]

Parameters Considered for Grading Based on Defects

Grading of leathers is done by subjective parameters.[22] In a paradigm towards grading of leathers objectively, it is first necessary to document the existing pattern of grading and obtain highly reliable grading standards. Various parameters like type, extent, position and distribution of the defects need to be considered. Pre-mortem, ante-mortem and processing defects (type of defects) will influence the leather grading. The area of the leather surface can be subdivided mainly into main cutting area (position of defects) i.e. from butt to beneath neck (C) and less cutting area i.e. Neck and Belly (N and B). Extent of a defect can be known by its length (L) or area (A) or depth (D) depending on the particular defect. Defects can be closely distributed as clusters (Cl) or scattered (S). Physical parameters like thickness and uniformity in substance cannot be visually analyzed. All the parameters considered for grading can be measured. Length and breadth can be in mm. Area can be referred in mm^2. Distribution of the defects can be related to the number of defects in the defined area.[23] An attempt has been made based on these parameters to identify the defect and objectively analyze the defect using software based technique for fixing the grades of the final leather.

Objective Methodology

In the present work, the four parameters (type, position, extent and distribution) are considered and 10 different types of defects have been identified for the study. The market data are obtained from experienced personnel carrying out grading of wet blue (chrome tanned leather), crust and finished leathers. The data is analyzed and an objective method is proposed to grade leathers. The defects in the main cutting area are dealt seriously while other areas are comparatively less serious. Table I shows methodology to define or calculate the position of the defects, extent of the defects (low, medium or high) and the distribution of defects in a leather sample. Only the technology may give a solution for the age old conventional assorting methods based on which this project was started. The Algorithm designed for the grading of leather samples may provide a solution to this technological drawback. In order to achieve this, the first step is to study the parameters

involved in the present grading system and identify and digitize the leather defects. Secondly, interlace these data into the software to enable easy identification of the leather defects.

Software System

The Identification of color values, Row & Column ID and position will have the multiple steps, which has been shown in software system flow diagram (Figure 1).

Crust leather

Post tanned leathers processed from chrome tanned goat skins with different colors are used for tuning the database.

Image scanning

The Hardware HP Scan Jet 3570c has been used to scan the crust leather samples of size 11" x 8" with optimum resolution of 200 dpi (dots per inch).

Loading the image

The scanned image is then loaded into the software tool after cut down into 200 x 200 pixels[24,25] for the analyzing which has been shown in Figure 2.

Cutting range finding

Figure 2 shows the determination of cutting area in a given sample of leather. In any given sample of leather lower 2/3rd length and middle 3/5th breadth is taken as the cutting area.

TABLE I
Methodology to calculate the position of defects, extent of defects (low, medium or high) and the distribution of defects in leather sample.

Position				Extent			Distribution		
Side	**Total Area**	**Main Cutting Area**	**Less Cutting Area**	**Defects**	**Extent**	**Area (mm^2)**	**Defects**	**Distribution**	**No. of Defects/ mm^2**
Lengthwise	100%	67% (2/3rd)	33% (1/3rd)	White spots	Low	<3	White spots	S	1
Breadth wise	100%	60% (3/5th)	40% (2/5th)		Medium	3-6		Cl	< 2/16
					High	>6	Scratches	S	1
								Cl	< 2/16

S: Scatter/Loosely distributed; Cl: Cluster/Closely distributed

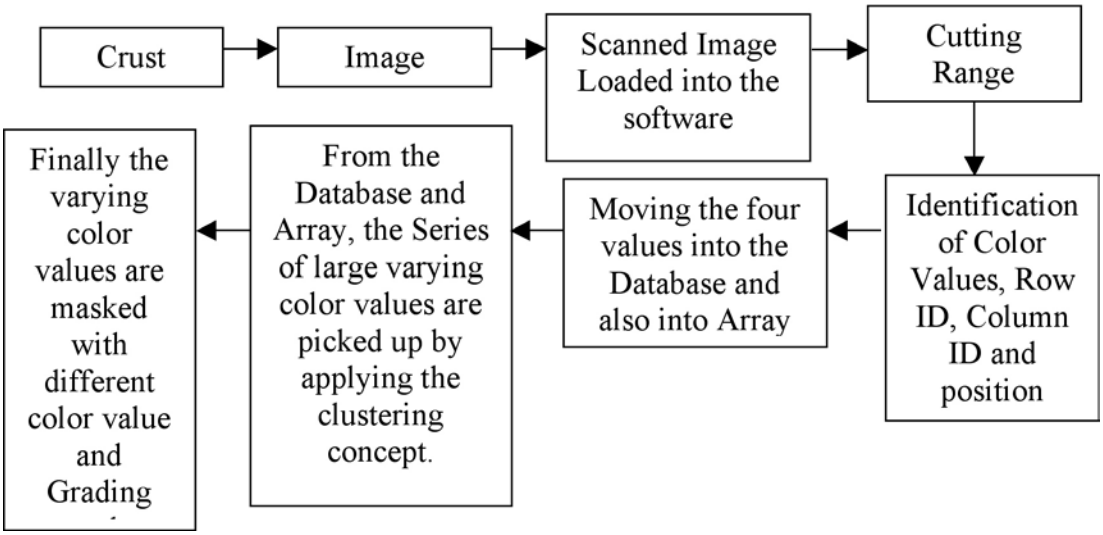

Figure 1. Flow diagram of software system.

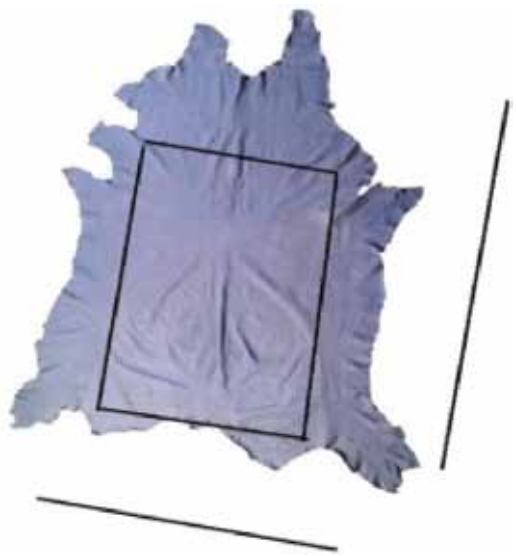

Figure 2. Picture of crust leather showing the area with better cutting value.

This is determined by a scaling process taken from different samples. To fix/draw the outer line on the image in the Algorithm the variables used are left side row, left side col, right side row, right side col, top side row, top side col, bottom side row, bottom side col, etc.,

Identification of color values, row ID, column ID and position

The color values are identified by using get pixel method and the RGB format in Visual Basic.[26,27] Moreover the co-ordinates of the row and column of the particular pixel also identified by using the above step.

Data storage

The software has been designed in such a way to store the coordinates and their corresponding pixel color values of the crust leather sample image into the database. Before that the crust leather samples are taken and scanned in a HP scanner with an optimum resolution which has been loaded in to the software to analyze the corresponding coordinates which has been stored in the database (MS ACCESS).[28] This is can be achieved by creating a component by using Visual Basic 6.0 to make comfortableness for the Data Manipulation Language (DML) using SQL coding.[29,30] The COM will be first created and through the SQL coding the data from the Visual Basic is transferred into the database.[31]

Analysis of color

Database is the most efficient storage hub through which the entities can be accessed and any number of actions can be performed. The utility here is through the color values stored in the database the series of large varying color values are picked up. The scanned image will be analyzed by getting its color values and position by using get pixel method, and also the RGB format in Visual Basic. By using the picture point method the row id and col id are identified. The series of varying color values are picked up and it has been changed to red.

Grading

By using the parameters like Position, Extent and Distribution the defects and its Grade has been defined. The NBC are the values for Position meanwhile S & C is the values for the Distribution. Mostly the distribution of the defects like loosely and closely will influence the Grading accuracy.

RESULTS AND DISCUSSION

In order to attain an objective methodology for grading, firstly logic or a table of data must be framed, which forms the basic bench mark for any grading purpose. Using the parameters mentioned in the methodology viz., position (P), extent (E) and distribution (D) for each defect, a logical table has been framed, which is presented in Table II. This matrix shows the parameterization for grading of different leathers. The combinations of the every single parameter as stated in Table II amounts to the grading and grade of the sample. Each defect has three parameters assigned, which are rated based on the location as N (Neck), B (Belly), C (Centre) for position; LOW, MEDIUM, HIGH for extent and S (scattered) and Cl (clustered) for distribution. The Table III gives the percentile cutting area or the usable area of the leather sample. This forms the basis for the objective grading methodology.

As mentioned in the software system, the output from the image contains series of varying color values in RGB format and get pixel format. The get pixel format consists of seven digit value and the RGB values are picked up by using the seven digit value. As mentioned in the Table IV, the color values are being used for the finding. The crust leather samples are taken and scanned in a HP scanner with optimum resolution of 200 dpi (dots per inch). The scanned image is cut to 200 x 200 pixel dimensions in the coding software. The scanned image is then loaded in to the computer and analyzed using the software. Based on Table IV and as outlined above, a software system has been developed for counting the selective defects and selective defect identification.

Three (black, blue and sandal coloured) dyed crust leather samples have been taken for the study. Figure 3a shows the image of black dyed crust leather and Figure 3b shows the image of the black crust leathers after analyzing it with the input parameters using the software. The defects identified are shown as red dots on the scanned image. However, the color values are being stored in RGB format and clustering them by using the software code as shown in the Figure 4. The series of large varying color values are changed into red. Similarly, the images of blue and sandal color dyed crust leathers are shown in Figure 5 and 6, respectively.

TABLE II
Logical table for objective grading technique (P- Position; E- Extent; D- Distribution).

Defects/ Grades		1	2	3	4	5	6	7	8	9	10A	10B	R
Tick Marks	P	*	*	*	*	*	*	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C
	E	*	*	*	*	*	*	L	L	M	M	H	H
	D	*	*	*	*	*	*	S-1	S-1	C	C	C	C
White Spots	P	*	*	*	N,B	N,B	N,B	N,B	N,B	N,B	N,B	N,B	N,B
	E	*	*	*	L	L	L	L	L	M	M	H	H
	D	*	*	*	S-1	S-1	S-1	S-1	S-1	C	C	C	C
Pox Marks	P	*	*	*	*	*	*	*	*	*	*	*	N,B,C
	E	*	*	*	*	*	*	*	*	*	*	*	H
	D	*	*	*	*	*	*	*	*	*	*	*	C
Drawn Grain	P	*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
	E	*	L	L	L	L	L	L	L	L	L	M	H
	D	*	C	C	C	C	C	C	C	C	C	C	C
Pin Holes	P	*	*	*	*	B,N	B,N	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C
	E	*	*	*	*	L	L	L	L	M	M	H	H
	D	*	*	*	*	S-1	S-1	S-1	S-1	C	C	C	C
Scratches	P	*	*	*	*	*	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C
	E	*	*	*	*	*	L	L	L	M	M	H	H
	D	*	*	*	*	*	S-1	S-1	S-1	S-2	S-2	C	C
Short Hairs	P	*	*	*	*	*	B	B,C	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C
	E	*	*	*	*	*	L	L	L	M	M	H	H
	D	*	*	*	*	*	S-1	S-2	C	C	C	C	C
Wounds	P	*	*	*	*	*	*	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C
	E	*	*	*	*	*	*	L	L	M	M	H	H
	D	*	*	*	*	*	*	S-1	S-1	S-2	C	C	C
Putrefaction	P	*	*	*	*	*	*	*	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C
	E	*	*	*	*	*	*	*	L	L	M	H	H
	D	*	*	*	*	*	*	*	C	C	C	C	C

Table II continued on the following page.

Table II continued.

Flay Cuts	**P**	*	*	*	*	*	*	N,B	N,B,C	N,B,C	N,B,C	N,B,C	N,B,C
	E	*	*	*	*	*	*	L	L	M	M	H	H
	D	*	*	*	*	*	*	S-1	S-1	S-2	C	C	C

(N- Neck; B - Belly; C – Cutting Area; S – Loosely Distributed; C – Closely Distributed; L-Low; M-Medium; H-High)

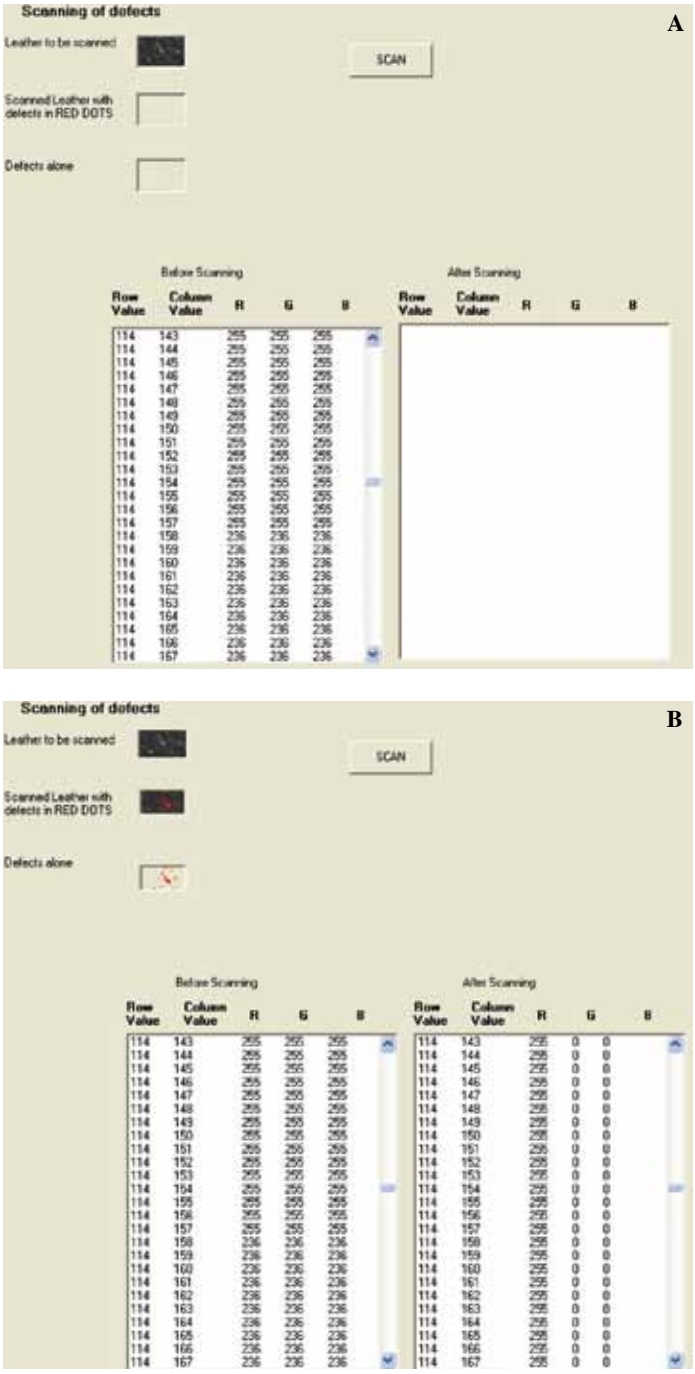

Figure 3. Output in the software for Black crust leather a) before scanning and b) after scanning of defects.

TABLE III
Grading table.

Grade	Cutting Area (%)
1, 2, 3, 4, 5, 6	100
7	95
8	90
9	85
10A	80
10B	70
R	<70

TABLE IV
Color values.

Position		RGB	Get pixel
Row	Column		
472	310	95-95-95	6250335
487	310	49-49-49	3223857
494	310	73-73-73	4802889

Defects Count

As a first step, the scanned image from the picture object is moved into another picture object, during this time the total size of the scanned images and the cutting range will be determined. In the following step, the cutting range image is moved into another picture object, during this time the color value, row id and column id will be moved into the database and also into the array as well. Then the series of different pixel range values are analyzed and the defects in the leathers are being counted. Figure 7 shows the result of the defects

cagno	rowactual	colactual	rowcurrent	colcurrent	tempcolor	colorofpicture	R	G	B
163	266	400	31	163	4539717	4539717	69	69	69
164	266	401	31	164	4539717	4539717	69	69	69
165	266	402	31	165	4539717	4539717	69	69	69
166	266	403	31	166	4539717	4539717	69	69	69
167	266	404	31	167	4539717	4539717	69	69	69
168	266	405	31	168	4539717	4539717	69	69	69
169	266	406	31	169	4539717	4539717	69	69	69
170	266	407	31	170	4539717	4539717	69	69	69
171	266	408	31	171	4539717	4539717	69	69	69
172	266	409	31	172	4539717	4539717	69	69	69
173	266	410	31	173	4539717	4539717	69	69	69
174	266	411	31	174	4539717	4539717	69	69	69
175	266	412	31	175	4539717	4539717	69	69	69
176	266	413	31	176	255	255	255	0	0
177	266	414	31	177	255	255	255	0	0
178	266	415	31	178	255	255	255	0	0
179	266	416	31	179	255	255	255	0	0
180	266	417	31	180	255	255	255	0	0
181	266	418	31	181	255	255	255	0	0
182	266	419	31	182	255	255	255	0	0
183	266	420	31	183	255	255	255	0	0
184	266	421	31	184	255	255	255	0	0
185	266	422	31	185	255	255	255	0	0
186	266	423	31	186	255	255	255	0	0
187	266	424	31	187	255	255	255	0	0
188	266	425	31	188	255	255	255	0	0
189	266	426	31	189	255	255	255	0	0
190	266	427	31	190	255	255	255	0	0
191	266	428	31	191	3223857	3223857	49	49	49
192	266	429	31	192	3223857	3223857	49	49	49
193	266	430	31	193	3223857	3223857	49	49	49
194	266	431	31	194	3223857	3223857	49	49	49
195	266	432	31	195	3223857	3223857	49	49	49
196	266	433	31	196	3223857	3223857	49	49	49

Figure 4. Varying color values and R-G-B values.

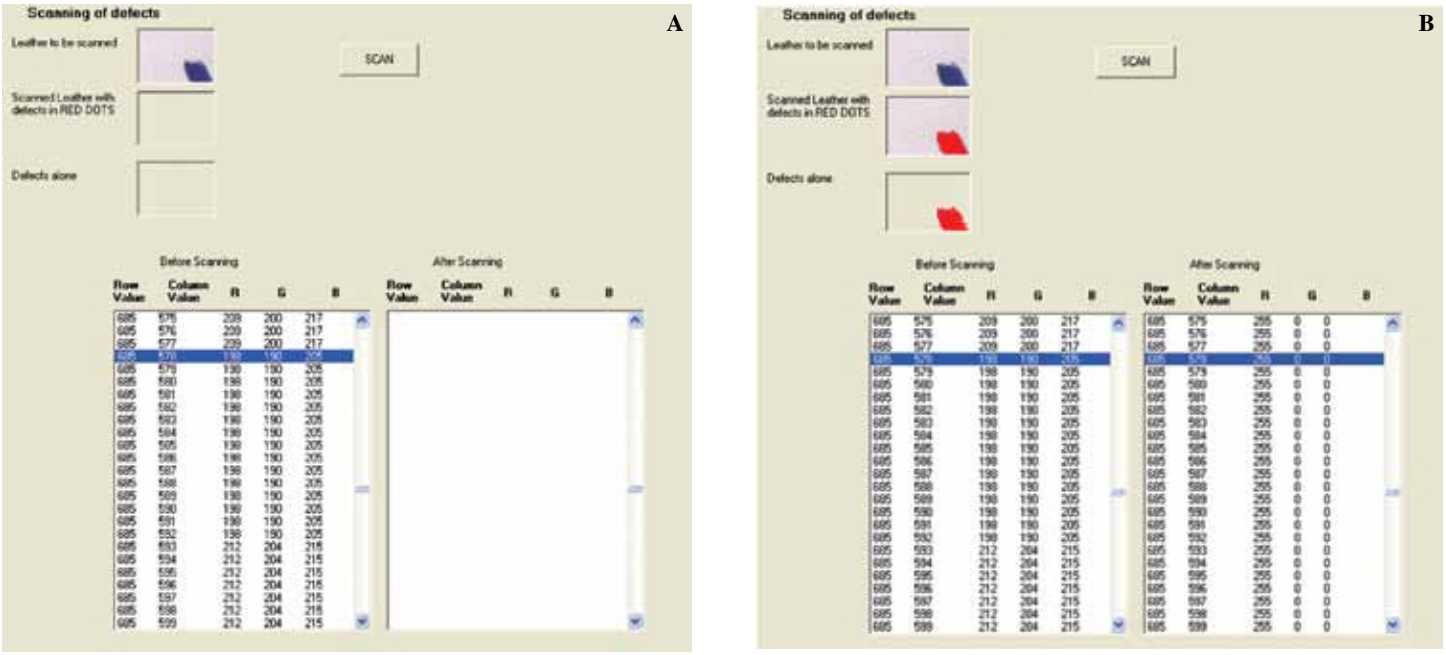

Figure 5. Output in the software for blue crust leather a) before scanning and b) after scanning of defects.

count on black crust leather, and Figure 8 shows the result of the defects count on sandal crust leather. From the figure it can be seen that the software provides the details such as the total number of defects, defects in main cutting area and the defects in non-cutting area. Any leather sample can be scanned for defects and the software can provide data on the intensity of the defects as shown from Figures 5 to 8 and also the data can also be stored for future reference. Thus we have clearly demonstrated that the defects can be quantified objectively using the developed software.

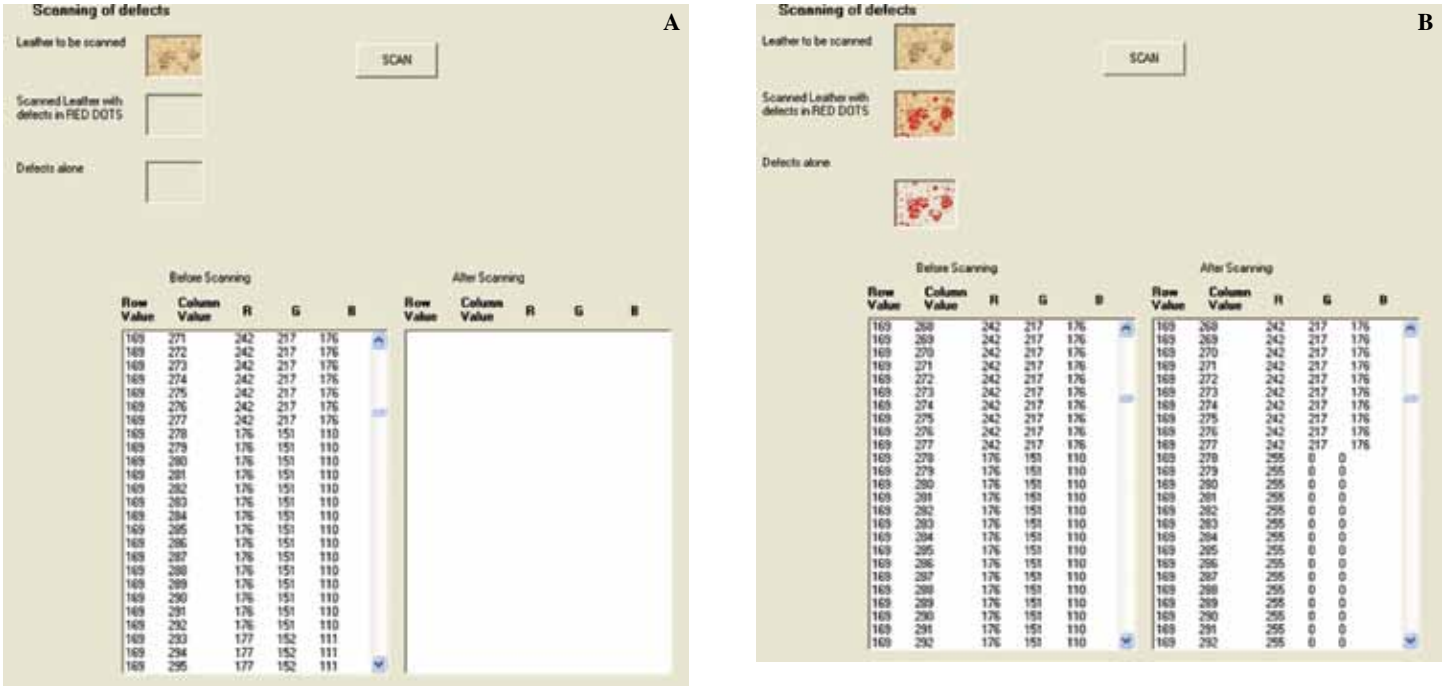

Figure 6. Output in the software for sandal crust leather a) before scanning and b) after scanning of defects.

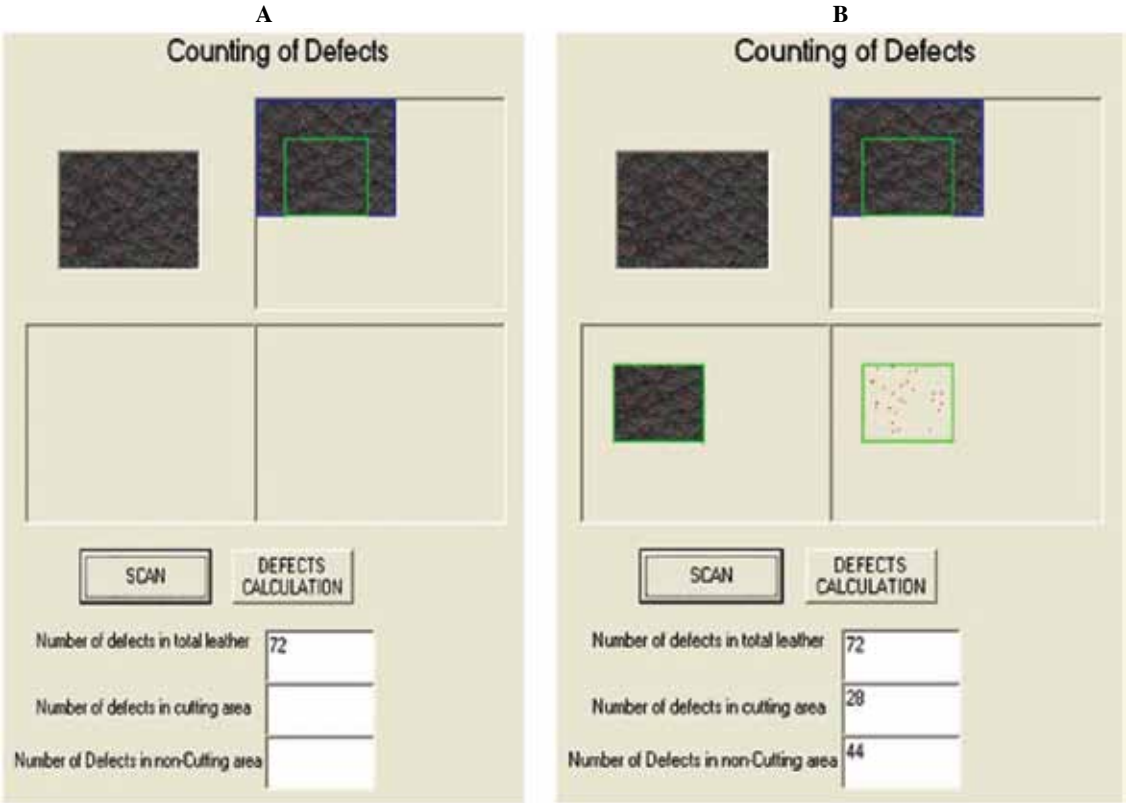

Figure 7. Output in the software for black crust leather a) before scanning and b) after scanning of defects.

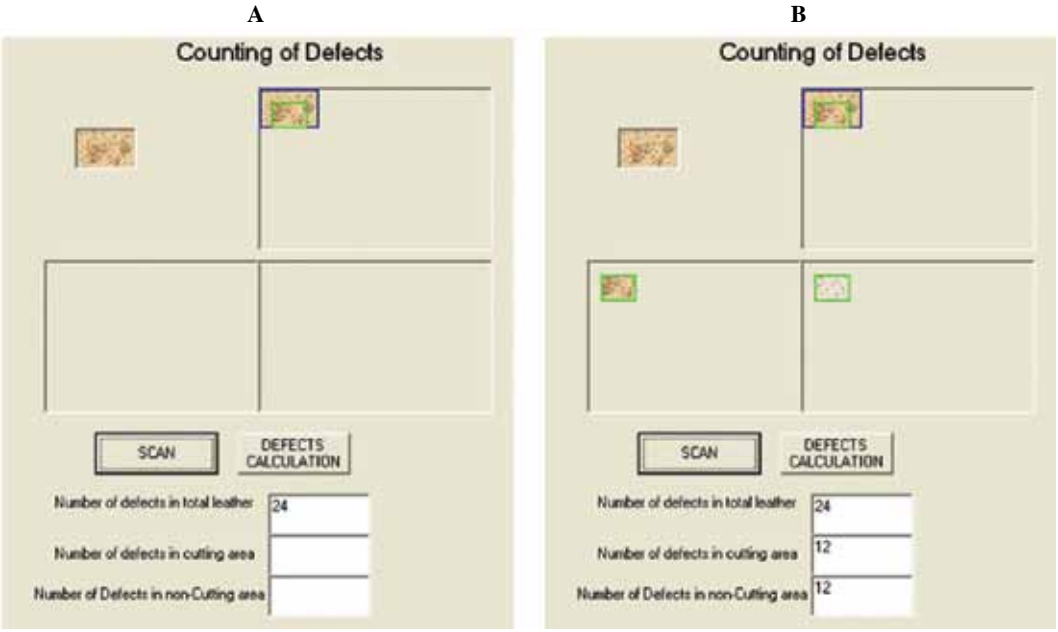

Figure 8. Output in the software for sandal crust leather a) before and b) after counting of defects.

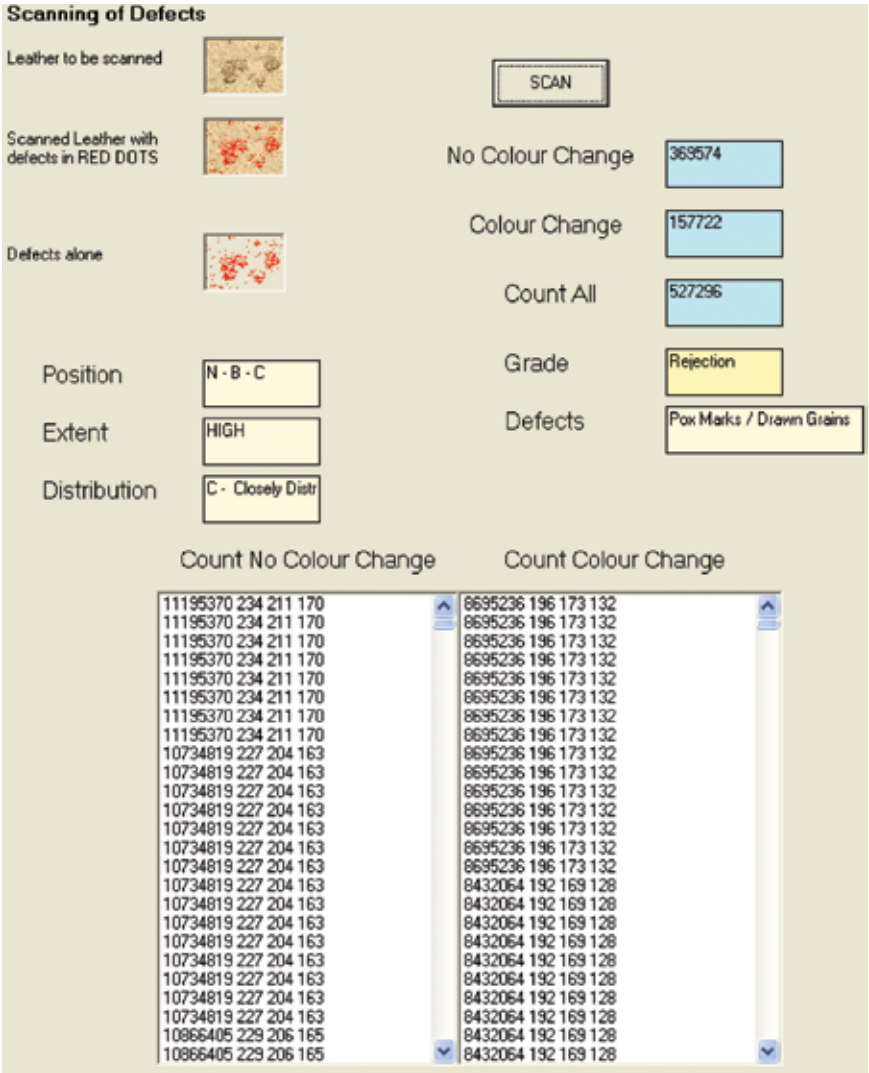

Figure 9. Output in the software after identification of defects and grading crust leather.

Defect Identification and Grade Value

The software output with defect identification and grading for one of the leather sample is shown in Figure 9. The PED are identified with the total pixel values. Finally the leather sample's Grade and defects are identified. In the case of the sample leather, the grade identified is observed to be rejected grade and the defects identified are Pox Marks / Drawn Grains. Similarly identification of other defects can be carried out using this methodology.

CONCLUSION

In the present study, an attempt has been made to study the techniques for the image processing for the crust leathers. The results clearly demonstrate the realization of objective grading of leathers. This study of objective grading of leathers reveals that the leather image processing has huge potential for further research.

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