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Hybrid Method for Automated Leather Grading System using Image processing techniques

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Abstract

This paper describes the automation of leather grading for increasing the productivity with a reduced human workloads. The sorting/grading of leather is an important quality control tool that are carried out at different stages of leather processing such as post tanning, crust, finishing etc., whereas this manual defect inspection and analysis of leather grading becomes tedious and inaccurate attributed to the fact that leather is a natural product exhibiting natural imperfections. The visual imperfections caused due to manual inspections conducive to an erratic result as the defect perceptions and diagnosis varies from person to person. As a consequence, the grading of leather becomes ambiguous that affects the quality control clearance of global trading. Furthermore, such human imperfected diagnosis slows down the marketing and becomes labour intensive. This becomes a vital bottleneck in the entire production process. Thus, this necessitated computerized diagnostics through image processing, segmentation and modeling. Nevertheless, many such research [1-5] has been carried out over the recent past on automated inspection of metal surfaces, wood and textile fabrics, while relatively little work has been done in detecting leather defects.

Alternatively, this paper presents a novel hybrid method of neural networks and image processing techniques for automatic detection and diagnosis, which will be synchronized with grading software. This result to detect defects and grade leather automatically and thus solving the problems of such misjudgment and thereby high costs, etc., caused by manual inspectors. Many image processing techniques are in practice by global researchers. However, the preprocessing techniques based on statistical analysis for de-noising followed by filtering for extracting the property attribute from the defective regions fed to Multi-Layer Perceptron (MLP) neural network with back-propagation (BPN) algorithm found to be the most efficient system for evaluation of leather grading. Preprocessing techniques based on statistical analysis have shown improvement in image noise reduction. The effectiveness of the method is verified by experiments. The proposed innovative method can be used in leather industry for grading the leather thereby reducing the human workloads and labor costs while increasing throughput. Eventually, it is expected to achieve higher accuracy by eliminating human error due to fatigue.

INTRODUCTION

Reliably and effectively detecting leather surface defects and grading the leather are of great importance to both the tanneries and industries that use leather as a main raw material such as leather goods and footwear. Sorting and grading of leathers is a very significant operation in the manufacturing of the leather as it will finally decide the value of the finished product. It is vitally important to the profitability of the tannery that this operation is carefully monitored and controlled.

Visual inspection and classification of leather surface defects are the main factors in leather grading process. The experienced assorters do grading physically, and they sort the final leathers into four grades namely second, thirds, fourth and fifth. Physical sorting is done based on color of the tannage, scores, blemishes on the grain according to the number of defects they may have such as scarring, tick marks, barb wire marks and holes. etc and feel of the leather are mainly taken into consideration. The assorters tend to miss considerably number of defects because human beings are basically inconsistent and inappropriate for such simple and repetitive tasks. Furthermore, subjective human-expert assessments are slow and labor-intensive tasks, they can become a vital bottleneck in the entire production process. Hence grading of leather has always been the critical aspect for business in the leather industry.

In fact, much research has been carried out on automated inspection of metal surfaces, wood and textile fabrics, while relatively little work has been done in detecting leather defects [6-12]. Leather being a natural product exhibit natural imperfections and are difficult to analyze defects. Moreover the texture features present a high variation, even among a single texture leather sample.

Automated defect inspection and grading system can reduce human workloads and labor costs while increasing throughput. More importantly, higher accuracy can be achieved by eliminating human error due to fatigue.

MATERIALS AND METHODS

Dataset includes, images from different leathers showing different defect types. The images have been taken using a five megapixel digital camera during visits to tanneries located in Tamil Nadu, India. In total, 30 pictures from different tanneries were used to construct the training and testing dataset.

IMAGE PROCESSING

Image processing is any form of signal processing for which the input is an image, such as photographs, or frames of video; the output of image processing can be either an image or set of characteristics or parameters related to the image. Image processing usually refers to digital image processing, but optical and analog image processing are also possible. In this paper, the acquisition of images is referred to as imaging. Image processing techniques for identifying leather defects were developed MATLAB version 7.0.

The first step in the image processing is image acquisition. The next step is the pre-processing step where the image is improved being fed as an input to the other processes. Preprocessing typically deals with enhancing, removing noise, isolating regions, etc., Image enhancement operations are applied to the leather image to improve the quality of the image. The leather image's contrast and brightness characteristics are improved using the image enhancement technique. Image enhancement technique also reduces the noise content and sharpen the leather image details. The preprocessing technique enhances the leather image and reveals the same information in more understandable image at the same time does not add any information to it.

SEGMENTATION

Segmentation partitions the leather image into its constituents parts or objects. The output of segmentation is raw pixel data, which consists of the boundary of the pixels in the region themselves.

Thresholding is used in this present investigation for image segmentation. From the greyscale image, thresholding is used to create binary images. During the thresholding process, individual pixels in an image are marked as "object" pixels when their value is greater than the threshold value and as "background" pixels otherwise. This convention is known as *threshold above* and is automatically calculated using MATLAB. Variants such as threshold below, threshold inside and threshold outide are also calculated using MATLAB.

NOISE FILTERING

Digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. Adaptive filtering method produced better results than linear filtering. The adaptive filter is more selective than the linear filter, preserving edges and other high-frequency parts of an image. MATLAB handles all preliminary computations and implements the filter for the input leather image. However, this method requires more computation time than linear filtering.

NEURAL NETWORK TECHNIQUE

The Neural Network Toolbox for MATLAB was used to build the ANN (Artificial Neural Netwrok) models. During training, the ANNs were presented with binary output data. An output value of zero was assigned to non-defective area and one was assigned to defective area. Thirty images of different types of leather defects were used to train the ANNs. Testing was done with 5 other leather images. During the training procedure of the ANNs, the maximum acceptable sum-squared error was empirically set as $1x10^{-5}$. The training process was carried out with fast back-propagation, until a maximum of 2000 epochs (cycles) or the maximum acceptable sum-squared error was reached.

CALCULATION OF GRADING

The grading of leather is calculated based on the defected value. In this present investigation, the leathers were classified into three grades namely Grade A, Grade B and Grade C. When the defected value $D < 500$ the leathers were graded as A, when the defected value is between $500 < D < 1000$ the leathers were graded as B and finally when the defected value is between $1000 < D < 1500$, the leathers were graded as C.

RESULTS AND DISCUSSION

The main steps of the methodology for leather grading are shown in Figure 1. Figure 2 illustrates the experimental results in identifying the leather defects. The classification performance of the defects of leather surface depends on the quality of the image. In order to detect defects and suppress the unwanted noise and uneven lighting condition, the original image was preprocessed with a smoothing filter and a local enhancement filter. Leather images which are not considered for training were taken for testing which includes defect free leathers as well.

Multi-Layer Perceptron (MLP) neural network with back-propagation (BPN) algorithm found to be the most efficient system for identifying the leather defects. Thirty defective leather images were used for training the neural network. After training phase, the unknown leather images in the test data set were run through the system for the classification test. The defected value was calculated for each leather in the testing phase and is tabulated in Table 1. The grading program calculates the grade based on the defected value. From table 1, it can be observed that detected value for two leathers

were more and are graded as B and C and is in concurrence with the human assorters. A classification accuracy of 85.67% was achieved by using neural networks in identifying the leather defects.

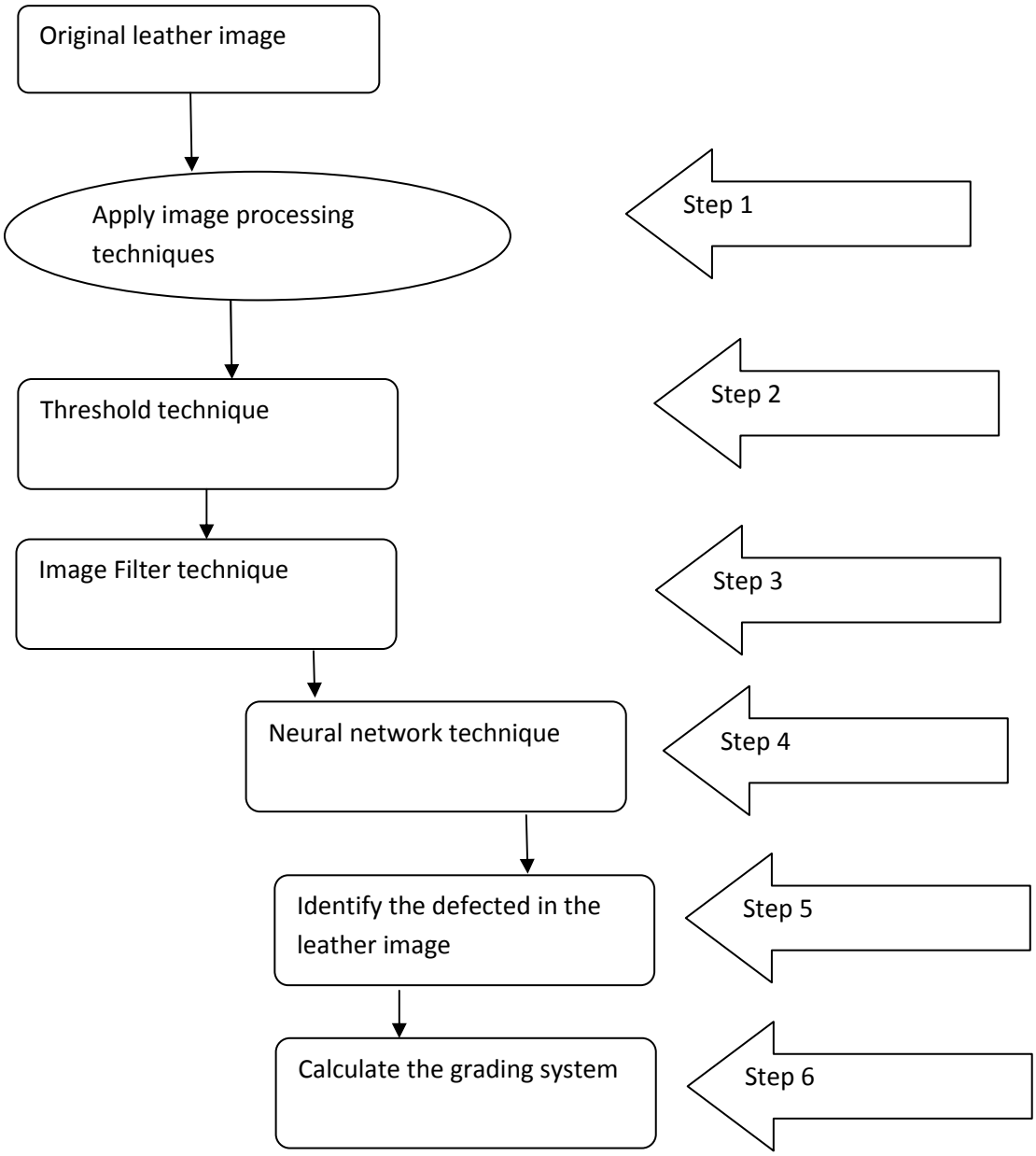

Figure 1. Leather defect identification and grading methodology

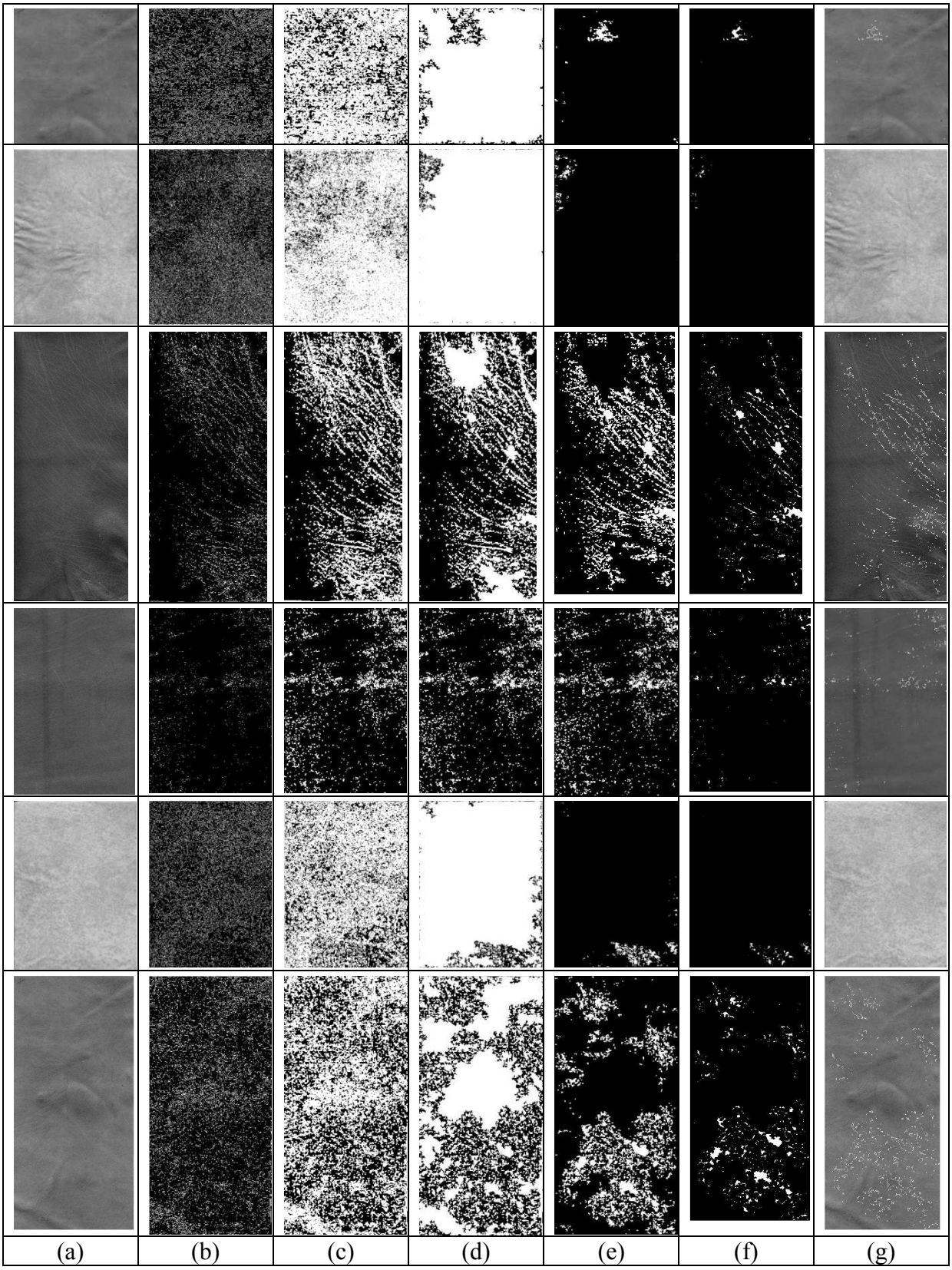

Figure 2. Experimental results for identifying leather defect process, (a) original leather images , (b) step 1 (c) step 2, (d) step 3 , (e) step 4, (f) step 5, (g) final defected lather images.

Table 1. Leather Grading System

Sl.no	Lather image name	Defected region value (D)	Grade
1	Leather 101	243	A
2	Leather 102	811	B
3	Leather 103	169	A
4	Leather 104	481	A
5	Leather 105	1943	C

CONCLUSIONS

The paper describes the development of an automated grading system using image processing techniques to identify leather defects and calculate the grading based on the defected value. Image enhancement followed by thresholding and noise removal by image filtering method showed good pre-processing imaging techniques. The overall accuracy of the classification using neural networks on testing set was 85.67%. This Hybrid Method for Automated Leather Grading System using Image processing techniques has shown satisfactory performance. Automated defect inspection and classification are very important because increased throughput and greater classification accuracy can be achieved. Also, human inspectors can be removed from this kind of tedious task in the long run.

References

1.	Hoang K. A. Nachimuthu, Machine Vision and Applications, 9, pp. 119-129, 1996.
2.	Krastev K., L. Georgieva, N. Angelov. RU Annual Scientific Session, 2004.
3.	Kwak C., J. Ventura, K. Tofang-Sazi., Intelligent Data Analysis, 5, pp. 357-370, 2001
4.	Serafim A., Proceedings of the 11th International Conference on Pattern Recognition (IAPR 1992), pp. 41-44, 1992.
5.	Yeh C., D.B. Perng, The International Journal of Advanced Manufacturing Technology, Online First 2004.
6.	Stefanie Peters, Andreas Koenig, 2007. HIS 2007. 7th International Conference on Hybrid Intelligent Systems, Digital Object Identifier: 10.1109/HIS.2007.18, Pg 326 – 331, 2007.
7.	Stefanie Peters, Andreas Koenig, , 2006. HIS '06. Sixth International Conference on Hybrid Intelligent Systems, Digital Object Identifier: 10.1109/HIS.2006.264902, pg 19, 2006.
8.	Kaloyan Krastev, Lidiya Georgieva International Conference on Computer Systems and Technologies - CompSysTech'06
9.	Kaloyan Krastev, Lidiya Georgieva International Conference on Computer Systems and Technologies - CompSysTech' 2005
10.	A.Branca, M.Tafuri, G.Attolico, A.Distante, E-Mail: Electrotechnical Conference, MELECON '96., 8th Mediterranean Volume: 2 Digital Object Identifier: 10.1109/MELCON.1996.551304, 1996.
11.	A.Branca, M.Tafuri, G.Attolico, A.Distante, Proceedings of the 13th International Conference on Pattern Recognition, 2, pg 830 – 834, 1996.
12.	F.P. Lovergine A. Branca G. Attolico A. Distante, Proceedings International Conference On Image Processing, 2, pg. 669 – 671, 1997 .