

ARTIFICIAL VISION INSPECTION APPLIED TO LEATHER QUALITY CONTROL

F. Adamo, F. Attivissimo, G. Cavone, N. Giaquinto, A. M. L. Lanzolla

Laboratory for Electric and Electronic Measurements
Department of Electrics and Electronics (DEE) – Polytechnic of Bari
Via E. Orabona 4, 70125 Bari – Italy

Abstract: The paper deals with the problem of pointing out and mark the various kind of defects (mainly scars, wrinkles and fire brandings) of tanned calf leathers used in many industrial areas (e.g. household couches and car seats lining ones). In the first experiments here presented the authors try to use the same inspection method previously successfully applied to quality control of hands-made satin glasses, that is a two-dimensional wavelet-based de-noising technique of high resolution images of the leather under inspection; according to multiresolution analysis, this method produces a suitable number of decomposition levels of the image, then it carries out a thresholding operation on details and finally, using the threshold levels estimated considering the actual noise level, it assesses and mark the various kind of defects. The final aim of the work is the realization of an automatic and in-line computer vision system for leather analysis capable to accurately inspect and mark the defective areas of the analyzed leather specimens before they enter the production chain.

Keywords: Automatic optical inspection, quality control, leather

1. INTRODUCTION

Nowadays there is even an higher interest in building automatic processing and analysis systems using visual inspection techniques; there are already countless applications of artificial vision on various manufacturing industries. These techniques promise a great economic return and good levels of accuracy without human presence; it is therefore quite obvious to suppose that in the next years most of quality inspection tasks for industrial applications will be performed by means of computer vision systems.

Moreover, even though the automated inspection systems are successfully replacing the manual ones in many sectors, an enhancement of process accuracy is still necessary to reduce the rate of false positives (products classified as good when they are defective) and false negatives (products classified as defective when they are good) as well as reducing the processing time.

This work presents the first attempts to address the problems implied in the detection of imperfections of leathers used in various industry segments. In scientific literature there are only a discrete number of works which try to address these kind of problems; in [1] and [2], for example, the texture analysis is carried out by means of neural networks.

Truly this particular application of computer vision seems to be quite difficult; this is due mainly to the particular characteristics of some kind of defects that to be viewed require a mechanical stretching of the leather (e.g. “closed” scars); obviously with such kind of defects, the concrete risk is that they become evident only on the completed product. Moreover the colour of tanned leathers can vary from white to black and this poses problems on the choice of the correct light source to correctly illuminate the scene.

Nowadays a great amount of preliminary leather inspection work for defects pointing and classification must be done by skilled workmen; also the automated leather cutting phase must be assisted by a human operator to point out previously marked defects that are not seen by the artificial vision assisted cutting system.

The following photos show two typical “immediately evident” defects of leathers, that is defects that can also be viewed by a non-expert eye and without the need to stretch the leather:

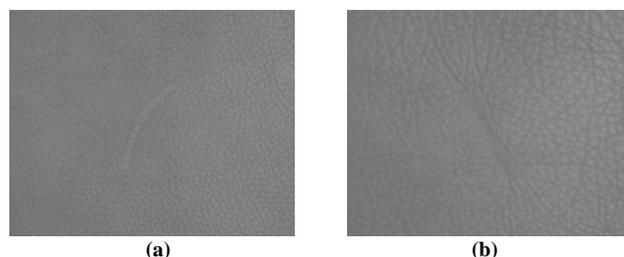


Fig. 1 – Two typical defects on a bright tanned calf leather: (a) an “open” scar and (b) a scarnification

In these preliminary studies, the authors try to apply the same approach already used for satin glasses defect detection; they postulate that the defects, if present, are perceived as irregularities with respect to a reference

image and they examine the possibility to use some suitable lighting systems and a wavelet-based de-noising technique to locate the main kind of defects.

2. THE PROPOSED TECHNIQUE

The main steps of the analysis technique are:

1. high resolution image acquisition;
2. image decomposition in approximations and details;
3. thresholding operation on details;
4. de-noised image reconstruction;
5. defect detection by means of a final thresholding phase.

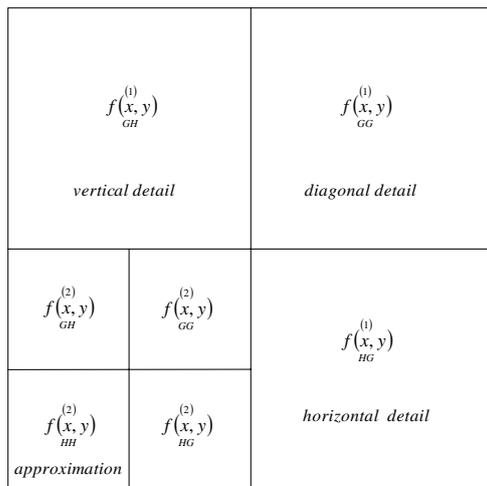


Fig. 2 – Image decomposition into details (horizontal, vertical and diagonal) and approximation

The first step applies a two-dimensional wavelet transform to a high resolution digital image of the leather specimen which produces a decomposition in approximations and details (Fig.2) by keeping unchanged the samples number; in this case, for each decomposition level it is necessary a double filtering (along the rows and the columns). In the very first attempts made on defected leather specimens, the authors used the same mother wavelet applied in the satin glasses analysis, that is the modified spline-biorthogonal; at first glance it seems to guarantee a good sensitivity to not completely closed scars, to fire brands and to some other typical defects that do not require a mechanical stretching of the leather.

The third step implements a soft-thresholding function:

$$\delta_{\lambda}(x) = \text{sgn}(x) \max(|x| - \lambda, 0)$$

which yields the threshold values λ_i for each detail with a low mean square error; finally, the fourth stage thresholds the image using the threshold values previously estimated

so that, a map of revealed defects can be obtained and, in final completely automated system, passed to the nesting and cutting phases.

3. SYSTEM DESCRIPTION

The authors made the first attempts here described using the following laboratory equipments:

- a) a PULNIX gray scale CCD camera type TM-6200;
- b) a National Instruments' image acquisition board type PXI-1409, installed in an external PXI chassis;
- c) a dark-field illumination system;
- d) a custom application software developed in MSVC++ to process the acquired images.

The main steps of the analysis are:

1. *reference image acquisition*: acquisition of an image known to be without defects; this step is to be executed only once for every glass type.
2. *setup stage*: acquisition of image under analysis, thresholds initialization or update + image thresholding;
3. *detection stage*: defects are located and classified.

The following figures show the results obtained analyzing the defects of Fig. 1; it seems that the algorithm guarantee a good sensitivity to those kind of defects.

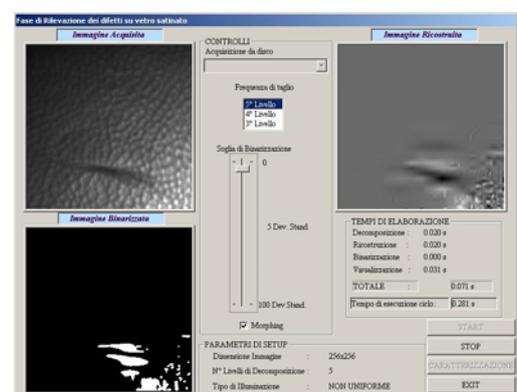
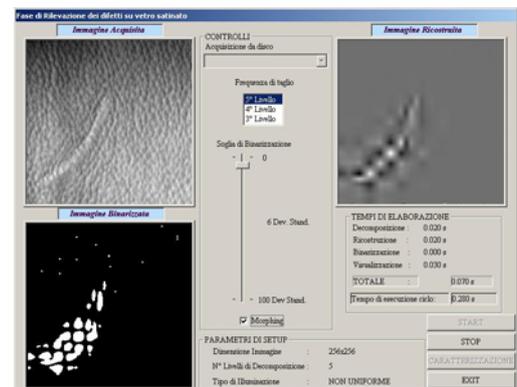


Fig. 3 – Dialog box of the detection phase: algorithm results relevant to defects represented in fig. 1

To make the proposed system working on a real-time basis three different problems must be solved: *i*) the choice of a correct illumination system, *ii*) the integration of a mechanical stretching system and, most important of all, *iii*) the reduction of image processing time (for example, the analysis of small images - 256 by 256 pixels - as that of the previous two figures require a processing time in the order of hundredth of a second). It is worth trying, in the author's opinion, to win this bet.

Another important matter is the reduction of cost of the image acquisition hardware; the authors are making attempts to use colour cameras with a IEEE1394 (FireWire) standard bus. The first successful experiments

were made using a Sony commercial camera model DCR-TRV33E.

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