Contents

Identification of Surface Leather Defects

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Abstract: *In this paper is discussing application of χ^2 - criteria for analysis of leathers based on image histograms. It is proposed a manner determining standard histograms and basic evaluation. It is designed an algorithm of leather defects identification for surfaces analysis.*

Key words: *χ^2 - criterion, distance, histogram, surface defects, leathers.*

INTRODUCTION

The visual inspection systems for textured surfaces have application in different areas for analysis of defects in textile, lumber, automobile paints, etc. Leather as a natural material with its variety of visual appearances – nonhomogeneous in color, thickness, brightness, wrinkledness, etc. is a complex object for control and analysis. The surface defects on leather affect the aesthetic appearance of leather goods and the amount of usable area. The presence of defects is critical factor for adjustment of the leather for manufacturing of particular good, because the existence of areas with leather defects may be considered as unusable or useful only for particular purposes. There are well known different methods for analysis of leathers surface defects and classifications.

Classification basic indexes of surface defects on leathers are the shape, size, area, depth, color, origin of the defect, etc. The proposed classifications are based only on part of these indexes because of which is obtained non-complete description of the defects.

A classification of defects depending of their depth and area is given in [3, 6] and there are defined four types where is indicated the importance of the particular types and their influence over the quality. The presented method for detection and classification of defects [4] for wet blue hides, depending on their shape and origin, defines eight kinds of defects - scars, mite nests, warts, open fissures, healed scars, holes, pin holes, folds. But the classification does not give an exact description of the shape and the size of the defects. The object of research in [8] is the surface defects on wet blue hides. The classification is detailed and is done depending on the shape and the area. There are defined seven types – thin spots, circular spots, thin lines, strips, holes, patterns and irregulars, but the importance of the particular defects is not pointed.

The detection of defects on the surface of natural materials is a difficult task, because of the great variety of shapes and textures, as well as in the quality areas and the defective areas. Different methods for detection of leather defects exist. Method and structure of system for visual inspection are proposed in [3, 6]. The method is based on statistical analysis of the image gray levels. As a result of it is built a histogram of the distribution of gray levels. This is a normal distribution and its last levels are defined as defects – all pixels having a gray level below defined limit are considered as belonging to defective area. The method for automatic grading of leather surfaces proposed in [4] is for analysis of local texture features of wet blue hides depending on seven characteristics that describe the distribution of image gray levels. The authors in [8] have proposed four semi-automatic methods for detection of defects on wet blue hides – contrast method, internal color level method, external color level method and fuzzy method. A method for detection of leather surface defects is considered in [2] using computation of orientation vector field for each image point. The direction of the vectors corresponds to the dominant local orientation of gradient and the length is proportional to its coherence. The described method for automatic inspection of surfaces in [7] uses Gabor filters.

The measurement of differences between images and parts of images is another group of methods for analysis of textures. They are based on the difference measurement in color histograms of some image parts and are used for classification of textures and ceramic tiles [1, 5]. The classification is based on criteria for accurately measure of similarity or dissimilarity of color histograms.

APPLICATION OF χ^2 CRITERIA FOR ANALYSIS OF LEATHER SURFACES

The usage histograms image analyse gives possibilities for invariability in case of rotation and scale, has weak influence from angle of view, provides fast information processing, etc. In this case the absence of information for spatial color distribution gives the possibility of making mistakes in the classification process.

There are many classification criteria – χ^2 test, histogram intersection, correlation coefficients, Kolmogorov-Smirnov's distance, divergence, etc. A comparison analysis for application of these criteria for dissimilarity measurement between histograms of comparative images and results evaluation is done in [1, 5].

In this paper is discussed the application of χ^2 - criteria for image analysis of leather surfaces and obtaining their standard histograms.

One of the most applicable criteria for the large image sizes is χ^2 – criteria

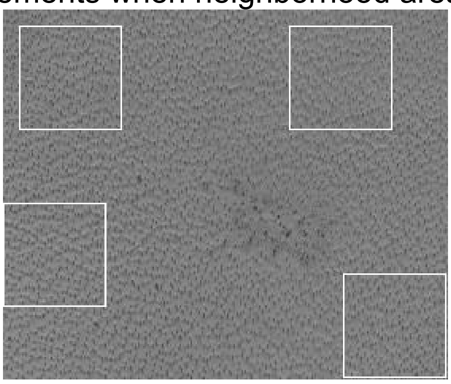
$$\chi^2 = \sum_i \frac{(R_i - S_i)^2}{R_i + S_i}, \qquad (1)$$

where R_i and S_i are the count of pixels for the i – gray level respectively for standard and for studied histogram. The criteria have not got a big processing complexity [1, 5]. The proposed method is based on the computing of the difference (the distance) between gray level histogram of standard image and research image areas. The basic problem is the standard histogram determination.

In this work is suggested the standard histogram calculation as an average value from the test set histograms. This set consists of non-defect areas with the same size which are selected from the processing image. The average of histograms allows receiving:

- Independence of standard histogram from the surface view, i.e. from the difference between texture elements as separate image parts as between separate patterns;
- Decreasing the influence of brightness irregularity of the object surface as a result of which is possible to obtain big difference between the histograms of non-defect image areas which could be classified as defect areas. That situation can arise when using only one standard area because it is almost impossible to obtain complete regular brightness of whole object surface;
- Defining relative limit of quality area – non-defect parts will have approximately the same (changing in exact space) distance in comparison with the standard area. In this way is given a basic value (basis) compared to which it is possible to make conclusions for defects presence or absence on processing surface.

Good results of analysis accuracy are obtained with medium computational requirements when neighborhood area size for every image point of 65x65 pixels [5, 7].



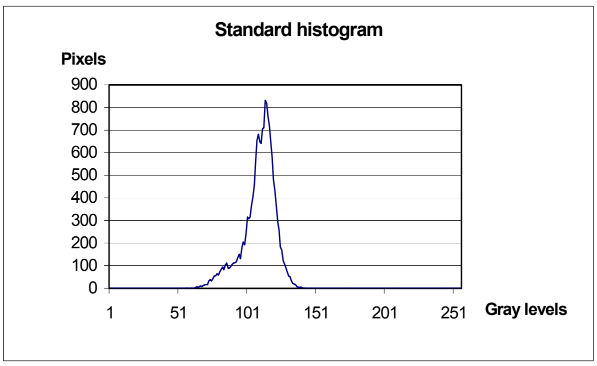


Fig. 1

On fig. 1 is given a pattern with standard test set, assigned by the indicated above requirements and the computed average histogram. The distances are obtained of test set in comparison with average value which allows defining relative limits – the basis regarding to which will be done quality evaluation. The researches supposed next analysis of factors that have influence on evaluation basis as texture kind, count of the test set elements and the possible value of the defect characteristics.

The obtained results show the existence of a range of values which defines from the basis. Parts from controlled patterns can be evaluated as defective when exceeding the indicated range.

In table 1 are given the results from distances evaluation of the test set by fig. 1 in relation with standard average histogram using χ^2 – criteria.

Table 1

Distance	D_1	D_2	D_3	D_4
	57	113	147	65

The basis could be computed as using the maximum standard distance in relation with average value. Using the maximum value is reported on the fact that the standards belong to non-defective areas. It must be taken in account at basis definition that the standard test set is limited which forces the usage of basis tolerance. The next researches may define the factors which influence on the basis tolerance.

After basis determination it has been made distance computation between the standard histogram and the histograms for each image point, which have neighborhood identical with this of the standard area. It is obligatory the requirement for pixel count equality which is used for histogram building since it is import computation error by difference in this indicator. The distance for the peripheral points do not compute, because the filter will extend outside the image boundaries and the requirement above will not be fulfil. The comparison is made with sliding window (the standard area). In this way is determining the degree of difference. As a result is obtained a map which contains the values of the computed distances. On fig. 2 is given a general appearance of the image analysis algorithm.

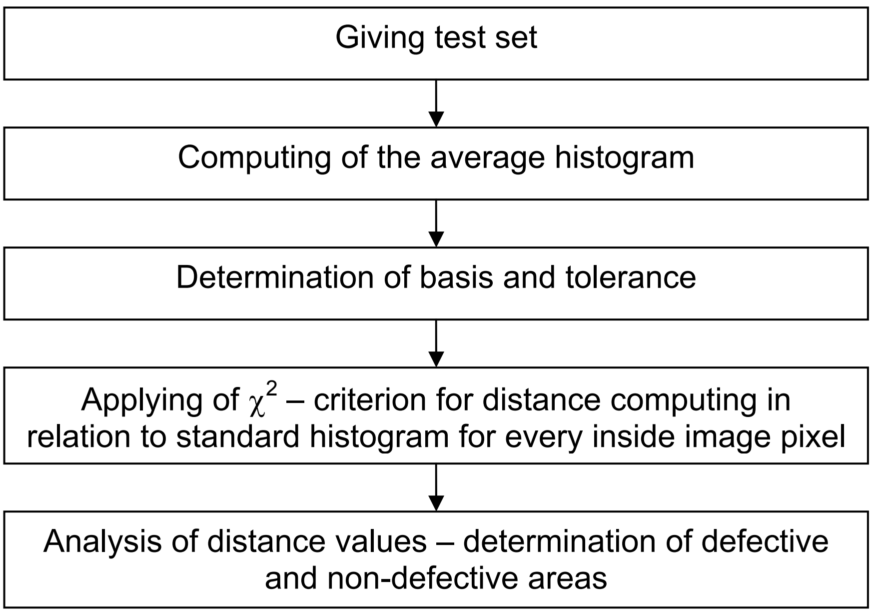


Fig. 2

These distances will be in the frames of previous defined basis and tolerance for the non-defective parts. Areas containing defects have more large value of distance. This is due to the fact that the defect has such color distribution which is different from the distribution of the standard area.

In fig. 3 is shown segmented image of distances via equal intervals (5% for good visualization) in relation with the basis.

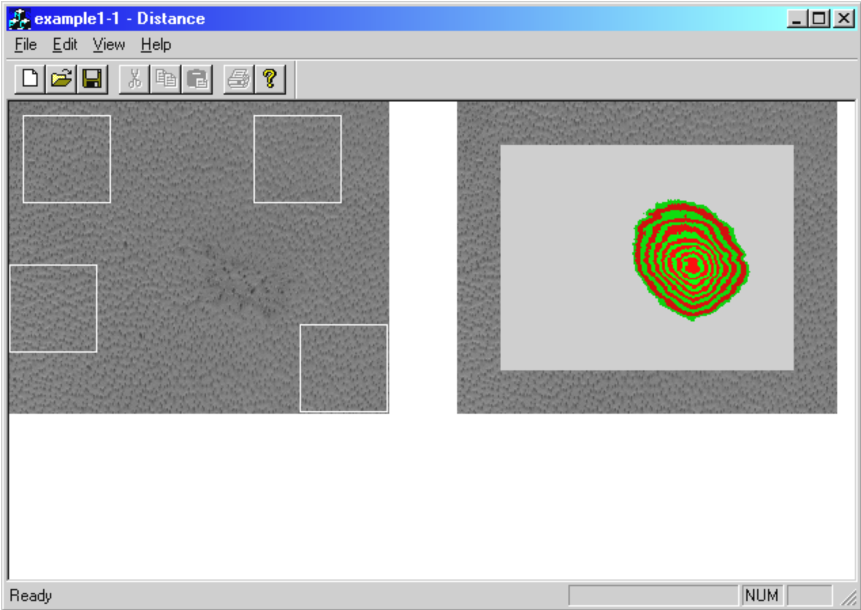


Fig. 3

CONCLUSIONS AND FUTURE WORK

In the present work is considered application of χ^2 – criteria for quality determination of leather patterns. The following conclusions could be made:

- It has been made a choice of test set, which ensures standards independence from their situation and the look of texture elements on surface of separate patterns and decreases the influence of irregular object brightness;
- It has been proposed a manner for determination of standard histogram, basis and tolerance for surfaces evaluation;
- It has been done research for determination the relative limits of quality area;
- The interval of distance modification is influenced by the leather texture, the kind and the defect characteristics – their color, shape, size, area, etc.

It is necessary to research the basis dependence from the texture kind, the element account in test set and permissible value of defect characteristics as well as the influence of color image model over the results. Using this manner it is possible to detect defective areas on leather surface but the exact contour determination of the defect is a task for next researches.

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