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TEXTURE SEGMENTATION OF IMAGES OF WEAR ZONES OF CUTTING TOOLS BY AMPLITUDE RECTIFYING METHOD

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Abstract: *The amplitude rectifying method of the texture segmentation of the image of wear zone of cutting tools with tracks of the fragile destruction is developed. The mathematical model of the image of wear zone of cutting tools with tracks of the fragile destruction as a spectral-statistical model of the texture image with the amplitude modulation of intensity is proposed.*

Keywords: *image texture segmentation, spectral and statistical texture, model of image of cutting tool wear zones.*

The sudden break down of cutting tools (CT) results in the considerable outages of equipment and losses of the quality of the precision treatment of details. The forced changing of instrument causes a rise in the prices of production. It is therefore necessary to conduct the control and diagnostic of CT in the process of the treatment, that reduces a production cost. The perspective direction of the control and diagnostic of CT are methods realized by the image processing. As a result of work of television video sensor the images of wear zone of CT are got. One of the images is resulted on a fig. 1.

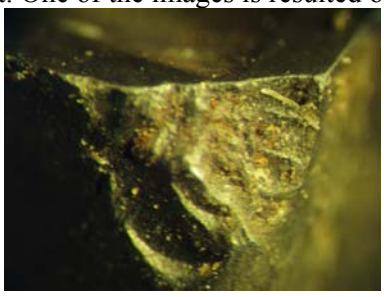

Fig. 1 – Image of wear zone of CT

The defect of CT with a fig. 1 is a crack of the cutting part. The sharp verges of this defect are caused with the fragile character of destruction beginning of which is cracks. Existent methods for visual control and diagnostic of CT do not provide necessary probability of the correct diagnostic. It is related to the specific of the generation of wear zone images of CT with tracks of the fragile destruction, consisting in that the corresponding image is a texture. A noise level on such image is high, that is a reason of the image oversegmentation if the methods [1] used at the last time are applied. They result in a lot of false bounds of segments. Therefore the aim of the paper is development of the method of the texture segmentation of images of wear zone of CT with tracks of the fragile destruction for the increase of the noise stability of segmentation. For achievement of the put purpose the mathematical model of image of wear zone of CT with tracks of the fragile destruction is elaborated.

The image of wear zone of CT can be described as texture image. Random quickly flowing processes at the treatment of materials by cutting are represented on a detail as roughnesses and shallow cracking. Such wear zone images are presented by a statistical texture. Slowly flowing processes in the system of cutting and processes of the middle duration are a reason of the fragile destruction of the instrument. The images of zone of such defect can be modeled as a spectral texture. Thus the segmentation of images of wear zone of CT at diagnostic of tracks of the fragile destruction is expedient to process both on spectral and statistical texture features. In this case a texture is described by a hybrid spectral-statistical model, allowing to segment of images of wear zone of CT on the features of both types. The mathematical model of image of wear zone of CT is formulated as follows. Let x=1, …, N; y=1, ..., M, are spatial coordinates. We will present the values of intensity of the line of the texture image as partition on sequence non-overlapping segments

$$I(x, y_m) = \bigcup_{i=1}^{k} \{c_i(x, y_m) + N_i(x, y_m) +$$

$$+ \sum_{j=1}^{n} A_{ij}(x, y_m) \cos\left(\omega_m^j x + \varphi_m^j\right),\ x \in [q_{i-1}, q_i]\},$$

where $c_i(x, y_m)$ is a background on the segment *i* of the line *m* of the image, $A_{ij}(x, y_m)$, ω_m^j, φ_m^j accordingly the amplitude, frequency and phase of the amplitude modulated component *j* on the segment *i* of the line *m* of the image, $N_i(x, y_m)$ is white Gaussian noise with the zero mean and the σ_i^2 variance, $q = (q_0, ..., q_{k+1})$ is a vector of bounds of texture regions of the line *m* of the image, thus q_0=1, q_{k+1}=*N*+1, where *N* is a number of pixels in the image line.

Suppose that $A_{ij}(x, y_m)$ is the slowly changing function of spatial coordinate x as compared to the harmonic of frequency ω_m^j. Therefore the intensity values of image of wear zone of CT is represented with a sum of the amplitude modulated signals which is modelling a spectral texture. A white Gaussian noise with changing variance corresponds to a statistical texture of image.

On the bound of texture regions the intensity of the image background, a variance of noise, and amplitudes of the modulated signals can jumped. At the analysis of the image of wear zone of CT the bound of the homogeneous texture regions allow to localize the bound of defect which carry out the most substantial information for CT diagnostic. Then for the diagnostic of the fragile character of destruction of CT of precision treatment it is necessary to detect the bounds of homogeneous texture regions of the image of wear zone. For decision of this task the amplitude rectifying method [2] of texture segmentation are developed for the images of wear zone of CT as follows.

The intensity values of every line of the image of wear zone of CT are localized in the Fourier space. For this the intensity values of every line of image examined as realization of random process. The trend of this process is approximated by the polynomial of 5th order and is deleted from every line of the image.

The amplitude rectifying of intensity values of every line of image of wear zone of CT is utilized. This procedure includes the two half period straightening and the band pass filtering.

The image which got as a result of the amplitude rectifying is transformed to a binary image. A threshold for a binary image gets out by the analysis of histogram of image. In our case the histogram of the image of wear zone of CT contains two modes, corresponding to the zone of threadbare back surface and zone of unthreadbare back surface. On a valley between modes a threshold for a binary image is set.

The morphological processing of the binary image is applied (fig. 2, a). For filling the gaps of the binary image and smoothing of the salient features of the bounds the closing is used (fig. 2, b). After that it is necessary to delete unimportant on sizes details by application to the image the operation of erosion on the primitive of less sizes, what objects which we wish to save. Then the opening and the deleting of small regions is applied (fig. 3).

a **b**

Fig. 2 – Binary image after amplitude rectifying (a), result of closing of the image with a fig. 2, a (b)

a **b**

Fig. 3 – Result of the texture segmentation before the bound detection (a), after the bound detection (b).

The developed amplitude rectifying method of the texture segmentation of image of wear zone of CT with tracks of the fragile destruction provides the high-quality detection of bounds of defect unlike the edge detection methods [1] which oversegmented an image. The elaborated method of image texture segmentation get a low time consuming (55,8 seconds on the Intel (R) Celeron (TM) CRU 1000MHz 128 RAM for the images 960x1280 pixels), high noise stability and low enough error (linear error of defect area is 27 – 40 pixels, i. e. 4,8 – 7,2 % from linear size of defect at image signal-noise ratio 19 – 27 on power).

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