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On some Problems of Signal and Image Processind, Analysing and Protection

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Establishing the Computing Center of the National Academy of Armenia and Yerevan State University in fifties of the last century initiated the deployment of intensive scientific investigations in the area of computer science and information technologies in Armenia. Now it can be stated that the institute is an important component of E-infrastructure of Armenia, providing high level of scientific investigations and supplying numerous organizations of the republic with highly qualified specialists in the specified area.

The research area of the institute includes all basic fields of computer science and information technologies. In this report we consider briefly three subjects of research and technologies, related to the signal and image processing, digital analysis and protection, carried out in the institute for last decades.

1. Structural analyzing and recovering of signal and image. This subject includes following problems:

a. *Determination of signal change-points.* Some versions of this problem named "change-point estimation of a random sequence" were stated and solved in sixties of last century [1]. In what follows these methods were developed by other scientists of the institute and now they are in the developing process.

b. *Edge detection in an image.* There are many approaches to solving this problem, proposed in the scientific literature, which are based on using the algorithms in the spatial or frequency domain. Recently a new approach named "Continuous Extension of DCT" was proposed by J. Patera and A. Atoyan [2-3], which allows considering the discrete image as a continuous one. It was shown that usage of this method decreases the spectrum aliasing. We propose a new method for image edge detection [4], which also has some advantages against those of other methods.

c. *Segmentation and simplification of an image.* Segmentation is an important task at an image analysis. It has a huge amount of applications to various problems in the image processing area. We have proposed a hierarchical coherent segmentation algorithm, as well as a software tool to solve many standard problems, which can arise during image analysis and interpretation [5]. Particularly, the problem of image "simplification" (piecewise-linear approximation) is solved quite effectively. Stop-rule is proposed to estimate the quality of segmentation at any step of hierarchical segmentation, which helps to make adequate decisions.

d. *Restoration of a damaged or distorted image.* The complex of algorithm and software tools mentioned in the previous section allows effectively restoring the damaged or distorted images. We suppose that distortion of an image has a local character (i.e. the damaged part is a segment). A special additional tool allows the transfer of the content of any segment to any other

segment. In such manner we "recover" the image. As examples of important application of this complex we consider the restoration of distorted images from the ancient manuscripts, distorted artworks, photos etc. [6].

2. Audio and image watermarking. The history of developing of methods to protect a digital content from an unauthorized access, usage and tampering numbers accounts about two decades. We have proposed and investigated a few new algorithms, which have some advantages against the other methods described in the literature. Particularly, we have proposed the following algorithms.

a. *Audio watermarking algorithms.* These audio watermarking algorithms are based on the properties of the human auditory system, so they have enough robustness to various attacks of well known types [7]. The algorithm is applied to the protecting of musical compositions.

b. *Watermarking algorithms based on embedding a binary image into a host image.* These algorithms are based on human visual system, so they have enough robustness to various attacks of well known types [8]. An analytical method for the quality assessment of watermarking procedure is proposed.

c. *High payload watermarking algorithms.* A class of combined watermarking algorithms using both spatial and spectral methods is proposed and investigated [9]. It is shown that the payload of the watermarking procedure can be significantly larger than that of the host image size with keeping other parameters of the procedure quality on the acceptable level.

c. *Watermarking algorithm using wavelet analysis.* This algorithm heightened robustness to various types of attack [10].

3. New method for image quality assessment and applications. It is well known that the results of the evaluation of image quality by widely used criteria based on the mean square discrepancy of images, often does not match the quality assessment in visual manner. Therefore a new philosophy based on conception that the human visual system retrieves mainly the structural information from the images, is developing last decades. In accordance with this concept, a series of papers were published in the scientific literature, in which the authors proposed criteria, which are in some sense adapted to the structure of the image.

We have proposed an approach based on acceptance as structural information of the distribution of gradient of the image. An image quality measure which is invariant to the size and rotation of images is proposed [11].

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