SECTOR 2

Sector of Digital Optics

Head of Sector – Dr. Victor Karnaukhov
Tel.: (095) 209-28-83; E-mail: victor.karnaukhov@iitp.ru

The leading researchers of the laboratory include:

Dr.Sc. (Math.)	L. Yaroslavsky
Dr.	T. Belikova
Dr.Sc.	V. Kober
Dr.	V. Lashin
Dr.	M. Mozerov

DIRECTIONS OF ACTIVITY:

- development of relative databases and DBMS;
- adaptive methods of image processing and pattern recognition;
- synthesis of two-dimensional digital filters;
- digital image enhancement;
- medical image analysis and classification;
- motion estimation;
- dynamic image analysis;
- multimedia;
- three-dimensional scene reconstruction;
- digital holography.

MAIN RESULTS

New adaptive correlation filters based on synthetic discriminant functions (SDF) were proposed to improve recognition of a partially-occluded target embedded into a known cluttered background. The performance of pattern recognition with various popular correlation filters and the proposed adaptive SDF filters in terms of discrimination capability was compared. The computer simulation results have shown the superiority of the proposed filters comparing with the matched filter, the phase-inly filter, and the filter yielding the minimum of anomalous errors.

Local adaptive color image processing using sliding discrete transforms such as the cosine, Fourier, Hartley, and sine transforms was proposed. Fast forward and inverse algorithms for computing discrete transforms in a sliding window were designed. The computational complexity of the algorithms was compared with that of known fast discrete transforms and running recursive algorithms. New techniques for restoring and enhancing color images degraded by non-homogeniuos distortions and noise were suggested. The techniques utilize the sliding discrete cosine transform. Extensive testing has shown that a background noise can be significantly reduced as well as local contrast enhanced by proper choice of algorithms parameters.

Within the framework of the INTAS project the joint researches on development of an information network resource for support of manuscripts and incunabula researches were carried out. The population of the developed information network resource was begun. The current version of the developed information network resource contains more than 6000 basic records. A software system for work with the

created information network resource on chronological identification of manuscripts, incunabula, and other historical documents is developed and created. The developed resource and software system are focused on the decision of problems of the historical-cultural researches connected to dating of historical documents.

A concept of robust methods for computing precise estimates of the motion vector field of the moving objects from a sequence of images is developed. A new algorithm for tracking of moving object in a sequence of images on the base of the developed methods is presented. The proposed method is a fusion of block-matching motion estimation and global optimization technique. The proposed concept allows avoiding some contradictions between global optimization techniques and piecewise smoothing values of sought motion vectors. Computer simulation and experimental results demonstrate a good performance of the method in terms of dynamic motion analysis.

Researches on development and creation of a multilevel information resource "History of Russian science in portraits" are continued on the basis of funds of the Archive of the Russian Academy of Science. The basic attention was given to population of the created database and bank of images logically connected to them by using personal funds and collections of Archive of the Russian Academy of Science. The total amount of the entered data has exceeded 10 Gbyte.

The complex of methods for the precise detection and segmentation of the low-contrast objects, located on the complex (heterogeneous and noisy) background has been developed. For detection and segmentation of objects is used the structural simulation of the object and the estimation of the belonging of image elements with the object according to the criterion of the maximum of posterior probability (MAV). For the suppression of the influence of complex background and increasing in the accuracy of segmentation optimum linear filtration and filtration of the details of small sizes have been applied. Three algorithms of the segmentations have been proposed, which differently extract the region of the object and have special feature in tracing the object margin. We carried out the estimation of the accuracy for the automatic segmentation of the object on the test and real medical images. The comparison of the results, obtained with the use of these algorithms showed that one algorithm gives the minimum level of false alarm and it makes it possible to accurately outline the region, occupied by the object. The second algorithm gives the minimum level of missing the elements of the object and extracts the area, where the object "grows" into the surrounding tissues, and also the shadows of the entering vessels. The third algorithm makes it possible to in a general manner outline the region, occupied by the object. Preprocessing images by optimum linear filtration and the filtration of the details of small size make it possible to improve the accuracy of the segmentation of objects quick algorithms for the realization of preprocessing images in the real time of user have been proposed, which can be useful in the conditions of the limited temporary resources. The developed complex of methods makes it possible to support analysis and classification of images by experts or in the automatic regime. It can increase the efficiency of the solution of screening, differential diagnostics and treatment problems.

GRANTS FROM:

- **INTAS (00-00081):** "A Distributed Database and Processing System for Watermarks" in cooperation with the Commission (Institute) for Scientific Visualization of the Austrian academy of sciences, the Commission (Institute) for Paleography and Codi-

cology of Medieval Manuscripts of the Austrian academy of sciences, and the Department of Special Collections of Koninklijke Bibliotheek (The Hague, The Netherlands).

- **Program of Fundamental Scientific Research of the DITCS RAS "New Physical and Structural Solutions in Infotelecommunications". Algorithms and Software for Infotelecommunication Nets:** "Static and Dynamic Images in Infotelecommunication Systems".
- **Russian Foundation of Basic Research (No. 03-07-90158):** "Development and creation of multilevel information resource «History of Russian science in portraits»" (in cooperation with the Archive of the Russian Academy of Sciences).
- **Russian Foundation of Basic Research (No. 04-07-90226):** "Development of the multimedia resource for computer-aided research of manuscripts, incunabula, and watermarks" (in cooperation with the State Historical Museum).

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