LABORATORY 2

Laboratory of Image Processing Models and Algorithms

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The leading researchers of the laboratory include:

Dr.	P. Chochia	Dr.	D. Sushko
Dr.	O. Milukova	Dr.	K. Stepanyan
Dr.	A. Prosin	Dr.	L. Rubanov

DIRECTIONS OF ACTIVITY:

- mathematical modeling of images and sequences of images;
- investigation of discrete-continuous and hybrid systems;
- control of stochastic and deterministic discrete-continuous systems;
- application of the theory of generalized optimization to problems of observation control and signal processing;
- systems of data transmission with fluctuating communication channels
- methods of regularization for inverse problems;
- image processing, filtering, enhancement, and compression;
- interpretation and scene analysis;
- recognition and identification of video data;
- investigations of man-machine interaction systems for finite object area.

MAIN RESULTS

The set of algorithms the image reconstruction in optic-acoustic tomography (OAT) was created (jointly with Institute of Physical-Chemical Biology). The quality of the algorithms is almost the same as in Radon tomography, which is considered usually as a standard of high level of the restitution. (D. Sushko)

The investigation of the flow control problem was performed. The problem is considered as a stochastic control problem with incomplete information, where the state of link is unknown and the observed counting process has an intensity depending on the current link state and control. The separation theorem was proved and the optimal control was derived. In comparison with the standard TCP the optimal control demonstrates more conservatism and stability with respect to random fluctuations. (B. Miller, K. Stepanyan)

In the singular control problem with affine dependence on control the optimality conditions were derived. Basing on the method of discontinuous time transformation on could obtain the optimality conditions in the form of generalized maximum principle. (B. Miller)

In the framework of the agreement between IITP and MicroSpec Technologies Ltd., Carl Zeiss Group, Israel "Investigation of the defect detection algorithms" the methods for black and white and colored images were investigated. The set of matching algorithms for quasi-regular periodic vertical/horizontal structures was investigated. It was created very effective algorithms of matching for images with this type of regularity. (P. Chochia)

The problem of the image restoration for linearly distorted images was investigated. It was shown that the phase of Fourier-transform rests unchanged under the wide variety of linear operators. It gives the opportunity to apply the recognition and classification procedures to the distorted images without preliminary restoration. (O. Milyukova)

The attenuation in radio lines including statistically non-uniform surfaces was investigated theoretically and with the aid of computer modeling. (A. Prosin)

The collection of high quality digital images of Russian and World Scientists includes now 9480 different halftone and colored images, photos and engraving. The volume of the archive is more than 17 Gb. The images are saved in the table space of DB Oracle 9i and provided by attributes permitting to realize the search and selection with the aid of SQL. The preliminary analysis of the variability with respect to statistical and information criteria was performed. (L. Rubanov)

Conferences:
– International Congress on Nonlinear Analysis, Florida, Orlando, USA, July 2004.
– 9-th International Conference ``System Analysis and Control", Evpatoria, June-July 2004.
– Network Optimization and Control, Workshop of EuroNgi Network of Excellence, October 2004, INRIA Sophia-Antipolis, France.

GRANTS FROM:

• **Russian Foundation of Basic Research (No 03-07-90158):** "Development and creation of multilevel information resource «History of Russian Science in Portraits»" (jointly with Sector of Digital Optics).

• **Russian Foundation of Basic Research (No. 02-01-00361):** "Robust methods of estimation and control for stochastic processes in hybrid functional dynamic systems".

• **US National Science Foundation Grant No. (CMS-0000458):** "Active Singularity Approach to Control of Nonsmooth Mechanical and Electromechanical Systems Using Wavelet-based and Impulsive Control Methods".

• **Program of basic research of Division of Informatics and Computing of RAS "New technologies in info telecommunications".** Item: Investigation of data transmission systems with fluctuating channels with the aid of the methods of stochastic control theory.

International Project:
Collaboration agreement between IITP and MicroSpec Technologies Ltd., Carl Zeiss Group (Israel): "Investigation of algorithms for the image defect detection".

PUBLICATIONS IN 2004

1. Aizenberg I., Butakov K., Milukova O. Recognition of images distorted by linear transformation, basing on the image spectrum // Accepted to Conference on Education and Information Systems: Technologies and Application .EISTA 2005.)

2. Bentsman J., Miller B., Rubinovich E. Ya. Modeling and Control of Dynamical Systems with Active Singularities and Sensing in a Singular Motion Phase // Accepted IFAC World Congress, Prague, 2005.

3. Dufour F., Miller B. Stochastic Maximum Principle for Singular Controls // Accepted IFAC World Congress, Prague, 2005.

4. Miller B., Avrachenkov K., Stepanyan K., Miller G. Flow Control as Stochastic Optimal Control Problem with Incomplete Information // INRIA Research report. 2004. No. 5239. P. 1-26. http://www.inria.fr/rrrt/rr-5239.html

5. Miller B., Avrachenkov K., Stepanyan K., Miller G. Flow Control as Stochastic Optimal Control Problem with Incomplete Information // Accepted to IEEE INFO-COM'05, Miami, 13-17 March, 24th Annual Conference.

6. Miller B., Avrachenkov K., Stepanyan K., Miller G. Hidden Markov model based flow control in TCP/IP networks // Accepted to SICPRO'05, Moscow Institute of Control Sciences, January 2005.

7. Miller B., Rubinovich E. Optimization of dynamic systems with impulsive controls. – Moscow: Nayka, 2005. 501 p. (In print).

8. Miller B., Stepanyan. K. Optimization of date flow in TCP/IP with the aid of stochastic control methods // Information processes. 2004. V. 4. No. 2. P. 133-140. http://www.jip.ru/2004/133-140.pdf

9. Miller B.M., Avrachenkov K., Stepanyan K., Miller G. Stochastic Control Approach to Flow Control // EuroNgi Workshop on Network Optimization and Control, (14-15 October 2004, INRIA Sophia Antipolis).

10. Popov D., Sushko D. Image restoration in opto-acoustic tomography // Problems of information transmission. 2004. No. 3. P. 81-107.

11. Stepanyan K. On application of stochastic control theory in systems described by piece-wise deterministic Markov processes for modeling of data transmission systems with fluctuating communication link // Collection of abstracts. 9-th International conference on System Analysis and Control, July 2004, Evpatoria, Ukraina.