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 theoretical investigation in optimal stochastic control and filtering for discrete-continuous stochastic systems described by differential equations with measures was continued. On the basis of stochastic discontinuous time transformation the new statement of stochastic maximum principle was obtained. This new optimality condition covers the already known cases and can be applied to a new class of problems with integral constraints.

The new optimality condition in the maximum principle form was obtained for discrete-continuous systems with active phase constraints. This condition was obtained on the basis of recently developed method of the singularity discovering for discrete-continuous systems. (B. M. Miller)

The control model in data transmission systems based on TCP/IP type protocol was investigated in the case of fluctuating communication channel. Hidden Markov Process drives the channel characteristics. The evolution equations for system of sufficient statistics were obtained and the separation principle was proved. The modeling software was developed as well. (B. Miller and K.V. Stepanyan)

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 algorithm of detection and lo-

calization of objects on series of variously scaled electron microscope images was developed. Modeling programs were developed and tested on the series of the images of quasi-regular objects. MicroSpec approved the results. (P. Chochia)

The reconstruction problem in optic-acoustic tomography (OAT) was studied. The method of reconstruction problem solution was developed in even-dimensional (2D) case. The mathematical model was created and modeling software was developed as well. (D. Sushko)

Investigation of effective algorithms in computational genomic. (Jointly with Sector 1.1). (L. Rubanov)

In the framework of RFBR Projects No. 03-07-90158 jointly with Sector 2 It was developed the methodology of classification and structural description big collections of halftone and colored images. The interface prototype for search in database of digital images was created. It was developed the methodology of classification and structural description big collections of halftone and colored images. The interface for search in database of digital images was created. (L. Rubanov)

The minimum energy methods in filtering and restoration of blurred images were investigated. (O. Milukova)

The bandwidth of stochastic radio-channels was investigated for various methods of diversity reception. (A. Prosin)

Conferences
1. 2nd IFAC Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control, Sevilla, April 3-5, 2003.
2. International Conference "Electronic Images and Visual Arts" (EVA'2003 Moscow).
3. 2nd International Conference "System Identification and Control Problems" (SICPRO'03), Moscow, 29-31 January, 2003.
4. 8th International Conference "System Analysis and Control", Evpatoria, 29 June – 06 July 2003.

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".

- **Cooperation program CNRS (France) – RAS (Russia). Project CNRS/RAS cooperation № PECO/NET 9570:** "Theory of singular control in stochastic systems".

- **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 2003

1.   Karnaukhov V.N., Aizenberg I.N., Butakoff C., Karnaukhov A.V., Merzlyakov N.S., Milukova O.P., Zhang Y.J. Neural network identification and restoration of blurred images // Proceedings of Second International Conference on Image and Graphics ICIG'2002. P. 303-310.

2.   Miller B., Bentsman J. The singularity opening approach to control of mechanical systems with constraints // Preprints of 2nd IFAC Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control, Sevilla, April 3-5, 2003, p. 293-298.

3.   Miller B., Stepanyan K. Observation Control for Discrete-Continuous (Hybrid) Stochastic Systems with the Estimate Dependent Noise // International Journal of Hybrid Systems. 2002. V. 2. P. 337-368.

4.   Miller B., Stepanyan K. The problem of observation control in systems with state-estimate dependent noise // Proceedings of II International Conference "System Identification and Control Problems – SICPRO'03". Moscow: Institute of Control Problems, 29-31 January 2003. P. 1238-1251.

5.   Miller B.M., Rubinovich E.Ya. Kalman filter for controlled hybrid systems // System & Control Letters. 2003. V. 50. P. 39-51.

6.   Stepanyan K. Application of discontinuous time transformation methods to the solution of the observation control problem in systems with state-estimate dependent noise // Proceedings of 8th International Conference "System Analysis and Control", Evpatoria, 29 June – 06 July 2003, 129-130.

7.   Bentsman J., Miller B. Dynamical Systems with Controlled Singularities: Physically-Based Representation and Control-Oriented Modeling // IEEE Trans. Automatic Control (submitted).

8.   Dufour F., Miller B. Singular stochastic control problems // SIAM J. Control and Optimization, in print (accepted).

9.   Emel'yanov D., Rubinovich E., Miller B. An information set-based guidance algorithm against a decelerating maneuvering target // IEEE Trans. Aerospace and Electronic Systems (submitted).

10.   Karnaukhov V., Kuznetsov N., Rubanov L. Development of multilevel information resource "History of Russian Science in Portraits" // Proceedings of Conference "Electronic Images and Visual Arts – EVA'2003". Moscow, 2003 (in print).