Russian Academy of Sciences
Program Systems Institute

Research Center Control Processes

Director: Doctor of Sciences, Professor V.I. Gurman

Directions of research:

theoretical :

- Extension principle in control theory
- Geometric control theory
- Control of oscillations
- Algorithms and program systems for modeling and control

applied:

- System analysis of regional development strategies
- Innovation processes control
- Optimization of aircrafts maneuvers

Extension principle and degenerate control problems

On the basis of the extension principle, a series of new non-traditional optimal control methods were elaborated and effectively applied to theoretically complicated degenerate problems with turnpike solutions. Results are presented in books (Gurman, 1997; Gurman, 1998; Gurman, Ukhin, 2005).

Geometric control theory

Geometric methods are fruitfully applied to many controllability and optimal control problems. In particular, complete controllability conditions for bilinear systems and invariant control systems were obtained. Results are systematically presented in books (Agrachev, Sachkov, 2004; Agrachev, Sachkov, 2005).

Control of oscillations

Control problems for the wave equation with boundary conditions of the first, second, third kind, and of mixed type, are extensively studied. There was also stated and studied the problem on oscillations control for multi-chain elastic system with a bounded control resource oriented towards applications to large constructions in the space. Results are presented in the monograph (Znamenskaya, 2004).

Algorithms and program systems for modeling and control

New first-order and second-order iteration methods for the search and locally optimal synthesis of control are developed. The methods are based on sufficient local optimality conditions and local description of attain-able sets, and on sequential improvement of the model with wide possibilities of adaptation to external conditions. There are elaborated new methods of approximate synthesis of optimal control on the basis of polynomial approximation of solutions of Bellman equation and trajectory recovery of Bellman-Krotov function.

The concept and experimental version of the Intelligent System for Control Optimization is developed and equipped with a complex of programs and tutorial supporting multi-method procedures of search of op-timal control.

The web page describing the project and containing description of the multi-method intelligent system, al-gorithms, and test problems, was created (http://www.botik.ru/~cprc/ISOU/). Results are de-scribed in book (Gurman, Ukhin, 2004).

Research on regional problems (with the example of Pereslavl region)

- Analysis of innovative activity at large enterprises of the region, including innovations of ecological and management direction. Investigations on the effect of innovations on economics and environment.
- Development of mathematical socio-ecological-economical model of region with account of innovation processes and the study of optimal strate-gies and scenarios of sustainable development.

Results are presented in monograph: (Gurman, Ryumina, 2001, 2003).

Main publications

Every year researchers of the Center publish more than 20 scientific works. Seven monographs are published:

- Gurman V.I. The extension principle in control problems. Moscow: Nauka. Fizmatlit. 1997.
- Gurman V.I. The extension principle in control problems. General theory and learning examples. Moscow: Nauka. Fizmatlit. 1998.
- Gurman V.I., Ukhin M.Yu. The extension principle in control problems. Constructive methods and applied problems. Moscow: Fizmatlit. 2005.
- Agrachev A.A. Sachkov Yu.L. Control theory from the geometric viewpoint. Berlin Heidelberg New York Tokyo. Springer-Verlag. 2004.
- Agrachev A.A. Sachkov Yu.L. Geometric control theory. Moscow: Fizmatlit. 2005.
- Modeling of socio-ecological-economical system of a region. Eds. Gurman V.I., Ryumina E.V., Moscow: Nauka, 2001, 2003.
- Znamenskaya L.N., Control of elastic oscillations. Moscow: Nauka, 2004.

International scientific conferences and symposia

GENEZALIZED SOLUTIONS IN CONTROL PROBLEMS, International workshop (September 24-26, 2004)

GENEZALIZED SOLUTIONS IN CONTROL PROBLEMS, International workshop (August 27-31, 2002)

COMPUTATIONAL MECHANICS AND MODERN APPLIED PROGRAM SYSTEMS, The tenth jubilee international conference (June 7-12, 1999)

DIFFERENTIAL INCLUSIONS AND CONTROL (DIC'98), The third international workshop (September 7-11, 1998)

NEW COMPUTER TECHNOLOGIES IN CONTROL SYSTEMS, The third international workshop (July 29 - August 2, 1996)

ROLE OF INFORMATICS IN REGIONAL DEVELOPMENT, International workshop (October 26-29, 1996)

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