„Politehnica“ University of Bucharest
Faculty of Automatic Control & Computers
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Scientific offer for Ph.D. studies

Prof. Dr. Eng. Dan ŞTEFĂNOIU
Ph.D. adviser in the field of **Systems Engineering** (since **2009**)
Doctoral School of Automatic Control and Computers
SPSI (sΨ) research group
(Signal Processing and System Identification)

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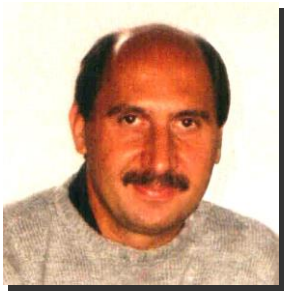


Research profile

- Signal Processing: time-frequency-scale methods, wavelets (discrete, parametric), speech and audio processing, filter banks, spectral estimation, vibration analysis.
- Data and signal compression (lossless and lossy).
- System Identification (linear and nonlinear): multi-model identification, time series prediction, fast algorithms (real-time, recursive).
- Metaheuristic optimization and evolutionary programming.
- Identification and control of highly nonlinear systems (such as: wind turbines, satellite launchers, academic installations).
- Functional Analysis: applications to Operators Theory to digital filtering.
- Artificial Intelligence: mathematical models of multi-agent systems based on the Theory of Fuzzy Sets and Measures.
- Robotic systems.

Scientific production

- 35 books and book chapters;
- about 180 scientific articles and communications;
- 4 patents granted by OSIM.

∗ The detailed publications list is included as an appendix into my CV.

Research grants

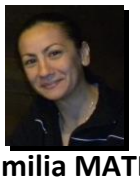
∗ The list of research grants is included into the publications list, as an appendix of my CV.

Complementary activity

- Administrative positions: vice-dean of FAC&C, in charge with international cooperation (2012-2020); member of Executive Board of FAC&C Doctoral school (2012-2020); member of PUB senate (2012-2016); member of Faculty Council at PUB-FEFL (2008-2012).
- Affiliations: member of American-Romanian Academy of Sciences and Arts – ARA (since 2002), of IFAC Technical Committee of System Identification (since 1995) and of Romanian Society of Automation and Technical Informatics – SRAIT (since 1990).

Completed Ph.D. theses

- **2010-2014**
  Advanced Control Strategies for Horizontal Axis Wind Turbines
  Abstract: http://acs.pub.ro/public/PhD_Abstract_REM_2014.pdf
  Thesis: http://acs.pub.ro/public/PhD_Thesis_REM_2014.pdf



Raluca Emilia MATEESCU

Undergoing Ph.D. theses

- **2011-20yy**
  Contributions to Developing of Modern Control Architectures and Strategies for Fault Tolerant Systems

Elena Margareta CIMPOESU

- **2011-20yy**
  Contributions to Predictive Control of Nonlinear Systems

Maria NICULA

- **2017-20yy**
  Contributions to Adaptive-Robust Control of Aeronautical Systems

Iulia Cristina RADULESCU

- **2017-20yy**
  Contributions to Analysis and Synthesis of Complex Automatic Systems

Cezar Stefan ISTRATESCU

- **2018-20yy**
  Applications of Artificial Intelligence to Systems Collaborative Control

Maria Giorgiana MACAU

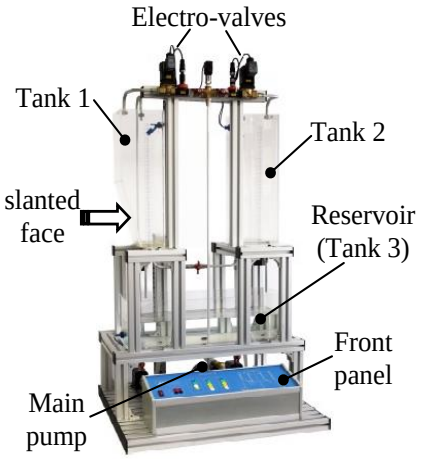
Proposed Ph.D. research topics

- ***Metaheuristic Automatic Control***
  The incredible increase of computing speed allows efficient implementation of metaheuristic optimization algorithms. In fact, such procedures shape a side of Artificial Intelligence. Consequently, several automatic control regulators, from the simplest ones (e.g. from PID class), to the complex ones (e.g. from LQR-LQG-LQI or MPC classes) can optimally be synthesized by means of popular metaheuristics such as Genetic Algorithms, Particle Swarm or Bees Colony. Up to **2 Ph.D. theses** can be developed within this framework.

- ***Satellite Launcher Control Techniques***
  This proposal is extracted from a larger project framework, where the SPSI group is collaborating with the Space Engineering Faculty, National Institute of Space Engineering (INCAS) and European Space Agency (ESA). The project goal is to design and implement a flight simulator for some standard ESA satellites launchers. The proposed research aims: to be involved into the design and implementation of flight simulator and to test some automatic control algorithms of interest for ESA (such as: μ-synthesis, $H\infty$, LQI with Kalman observer), in a multi-model approach, subject to some clear robustness, adaptivity and fault tolerant restrictions. Up to **2 Ph.D. theses** can be developed within this framework.

- ***Modelling, Simulation, Identification and Control of ASTANK2 plant***

The ASTANK2 installation/plant has been designed by SPSI group and built by ASTI Automation SRL company. The plant includes two parallelepiped interconnected water tanks, one of them exhibiting a slanted face (in order to add one more nonlinearity to the existing ones). The research group SPSI owns not only the ASTANK2 plant, but also a MATLAB-SIMULINK interface, based on a PLC Siemens type with Step7 and LOGO! Soft Comfort. Currently, the implemented automatic control (as hosted by the Master S7-1200 equipment) is rudimentary: on-off and PID. The proposed research aims: to design and implement a simulator of ASTANK2 plant (based on analytical models), to perform multi-model identification of ASTANK2 plant, to test (in simulation and through hardware-in-the-loop) some advanced automatic control techniques (such as RST, H∞, LQI with Kalman observer, MPC). For this research a project proposal exists and shall be re-submitted, to obtain financial support. Up to **3 Ph.D. theses** can be developed within this framework.



- ***Multi-Variable Prediction by Using Signal Models and Metaheuristic Optimization***

The SPSI group earned quite a rich experience in time series prediction, as a result of several successfully completed research grants. Yet, the number of unaddressed issues in the field of data prediction remains large. The proposed research aims to test various signal models associated to multi-dimension data blocks (such as: auto-regressive, nonlinear, time-frequency-scale), which can play the role of optimal predictors, with respect to prediction quality as cost function to be maximized by means of some metaheuristics. Up to **2 Ph.D. theses** can be developed within this framework.

- ***Optimal Data and Image Fusion Techniques through Time-Frequency-Scale Transforms***

An important issue of data acquisition refers to the huge volume of numerical values to store and their high redundancy. One can reduce both the volume and the redundancy by means of data fusion (although this is not the only possible approach). The proposed research aims to add to the existing data fusion techniques new procedures, based on time-frequency-scale signal analysis. Moreover, one seeks to perform data fusion optimally, with respect to criteria to be defined for each dataset, depending on its nature. **One Ph.D. thesis** can be developed within this framework.

- ***Image Processing and Compression through Orthogonal Transforms***

In Data Compression field (and especially in Image Compression), numerous applications have proven that the compression performance is sensibly better if an orthogonal transform was previously applied to the data stream than in case such a transform misses. Though this research direction has intensively been investigated in the literature, still unexplored ways remain. The proposed research aims to test new (still or video) image compression techniques, designed by using combinations of orthogonal transforms to be applied prior to effective advanced compression techniques. Up to **2 Ph.D. theses** can be developed within this framework.

- ***Nonlinear System Identification Algorithms***

The MATLAB-SIMULINK programming environment has reached high degree of sophistication, as modelling toolboxes for almost all human activities are implemented. Nevertheless, to the best of our knowledge, no toolbox including nonlinear identification techniques exists. The proposed research aims then to design and implement a MATLAB-SIMULINK toolbox devoted to nonlinear system identification algorithms, addressed to models like: Volterra, Hammerstein, Wiener-Hammerstein, variable parameter polynomials etc. The toolbox can soundly be tested in the framework of some applications, such as nonlinear identification of wind turbines, greenhouses, ASTANK2 plant (the last two being available in the SPSI laboratories). **One Ph.D. thesis** can be developed within this framework.

- ***Linear Identification and Control of a Wind Turbine***

This research has already been approached within two Ph.D. theses supervised by SPSI group members. Also, SPSI group succeeded to design and implement quite a realistic simulator for middle power wind turbines (400-600 kW) including one of the most complex available power generators, namely WINTUS. The simulator has been designed from the nonlinear analytical model of wind turbines. Since none of the two theses made use of WINTUS, in a recent M.S. thesis, three automatic control algorithms (RST, H∞, LQI) have

successfully been tested on the simulator. The proposed research aims then to extend the collection of automatic control laws to be tested on WINTUS (such as: MPC, *sliding mode*, *guardian maps*), but starting from linear identification models. **One Ph.D. thesis** can be developed within this framework.

- ***Nonlinear Identification and Robust Control of a Wind Turbine***

  The proposed research is quite similar to the previous one, in terms of framework. By difference from the previously proposed research, here, the WINTUS simulator is intended to be employed in order to provide nonlinear identification models of a wind turbine. With such models, nonlinear control techniques can be tested on WINTUS. The proposed research aims to test a number of nonlinear robust control techniques, by using nonlinear identification models and having WINTUS as testing platform. **One Ph.D. thesis** can be developed within this framework.

☝ ***Any other proposed research theme the Ph.D. candidate would make can be accepted, provided that the topic is consistent (it does not reduce to product design) and close enough to the fields of interest already mentioned in the beginning of this offer.***

Minimal personal requirements for Ph.D. candidates to be accepted in the doctoral program

- Minimum proficiency: **80%**.
- Good experience of professional programming in MATLAB and/or C++ and/or LabView.
- Affinity for applied mathematics topics.
- Initiative (self-activation), tenacity, endurance, flexibility, self-organizing, regularity, resistance to hard work, good communication skills, open mind, earnestness (but with good sense of humour ☺).
- Optional, but with a wildcard into the selecting procedure: intention to follow an academic career, by getting the offered position of teaching assistant at FAC&C, if admitted to the doctoral program.
- For the industry candidates: firm commitment (by a signed form) to the doctoral program and periodic meetings with the Ph.D. adviser and the SPSI group.
- **For the foreign candidates – see the Ph.D. admission requirements at:**

  http://acs.pub.ro/public/Incoming_students_at_FACC.pdf

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