

FINAL REPORT

of Olena Mul

FCT Postdoctoral fellowship SFRH/BPD/14946/2004

My Postdoctoral fellowship in the University of Aveiro began at July 1, 2004.

The reports about the first two years of my fellowship were already presented and approved by FCT. During the third year of my Postdoctoral fellowship, from 01/07/2006 till 30/06/2007, I continued my investigations in the field of dynamical systems analysis, according to the research plan, approved by FCT.

I have studied a class of hybrid dynamical systems, whose functioning in industry was not enough investigated and sometimes was unsatisfactory. Therefore, I have considered a very important problem, which was the existing controlled elastic system dynamics, including the widespread case of vibration processes. For that, I took into account both system continuous parameters and discrete ones, that greatly complicated the investigations. I reduced the study of vibrations of different types, such as longitudinal, transverse and torsional ones, to solving the partial differential equations with variable coefficients. I searched for the corresponding boundary problem solutions, satisfying not only classical boundary conditions but also some additional system of conjugation conditions, which characterized system discrete peculiarities. Such complex boundary problems described hybrid systems with many different applications in heavy, manufacturing and extractive industry. For the investigations, I adapted the known numerical and approximate analytical methods to the boundary problems of the considered type. I made analysis of the changes of system dynamical characteristics depending on different system parameters and in this way I found some possibilities of system functioning optimization. The obtained results may be applied for design of more reliable technical systems both in industry and in transport.

Below there are presented all the scientific activities, which took place during the third year of my FCT Postdoctoral fellowship in the University of Aveiro.

I published the results of my work in **4 papers in International scientific journals**

1) Mul, O.V., Torres, D.F.M., Kravchenko, V.P.: **Dynamics of Controlled Hybrid Systems of Aerial Cable-Ways**, in: *Nonlinear Analysis: Hybrid Systems*, Vol. 1, 2007 (in press). Available as *Reports math.NA/0607200* and *CM06/I-16*, Dep. Mathematics, Univ. Aveiro, Portugal, <http://www.pisharp.org/dspace/bitstream/2052/131/1/pam00131.pdf> (the copy of the paper is enclosed, see Appendix 1);

2) Tydnjuk, V.Z., Kravchenko, V.P., Mul, O.V.: **Naturally Controlled Processes and Theory of Relativity**, *International Scientific Journal of Computing*, Vol 6, Issue 1, 2007, pp. 6-14. **Prepublication:** *Cadernos de Matemática*, CM 05/I-33, Dep. Mathematics, Univ. Aveiro, Portugal, <http://www.pisharp.org/dspace/handle/2052/84> (the contents of the corresponding journal issue and the copy of the paper are enclosed, see Appendix 2);

3) Mul, O.V.: **Analysis of Vibrations in Discrete Parameter Machine Units**, in: *International Journal of Applied Mathematics & Statistics*, Vol. 6, No. D06, December 2006, pp. 56-69, <http://www.ceser.res.in/ijamas/cont/ams-d06-cont.html>. **Prepublication:** *Cadernos de Matemática*, CM 05/I-14, Dep. Mathematics, Univ. Aveiro, Portugal, <http://www.pisharp.org/dspace/handle/2052/62> (the copy of the paper is enclosed, see Appendix 3);

4) Mul, O.V., Torres, D.F.M.: **Some Applications of the Method of Normal Fundamental Functions to Oscillation Problems**, in: *Proceedings of MTNS 2006 (the 17th International Symposium on Mathematical Theory of Networks and Systems)*, Kyoto, Japan, July 24-28, 2006, pp. 2078-2082. Also available as *Reports math.NA/0607203* and *CM06/I-17*, Dep. Mathematics, Univ. Aveiro, Portugal, <http://www.pisharp.org/dspace/handle/2052/132> (the copy of the paper is enclosed, see Appendix 4);

and also the next **2 papers** are at the moment **under reviewing for publication in International scientific journals:**

5) Moulay Rchid Sidi Ammi, Olena Mul: **Error Estimates for the Chernoff Scheme to Approximate a Nonlocal Parabolic Problem**, submitted for publication in *the Journal of the Proceedings of the Estonian Academy of Sciences: Physics. Mathematics* (the copy of the paper is enclosed, see Appendix 5);

6) Tydnjuk, V.Z., Kravchenko, V.P., Mul, O.V.: **Natural Control of Energy Material Processes and Theory of Relativity**, submitted for publication in the Journal *Infinite Dimensional Analysis, Quantum Probability and Related Topics (IDAQP)*. **Prepublication**: Cadernos de Matemática, CM 05/I-40, Dep. Mathematics, Univ. Aveiro, Portugal, <http://www.pisharp.org/dspace/handle/2052/92> (the copy of the paper is enclosed, see Appendix 6).

The next 4 presentations were made at **International Scientific Conferences and Seminars**:

1) **"Some Applications of the Method of Normal Fundamental Functions to Oscillation Problems"**, *Invited Session "Computational Methods for Vibration Control and Model Updating in Structural Dynamics"*, the 17th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2006), Kyoto, Japan, July 24-28, 2006, <http://www-ics.acs.i.kyoto-u.ac.jp/~mtns2006/> (the copy of the presentation is enclosed, see Appendix 7).

2) **"Some Applications of Partial Differential Equations for Analysis and Control of Hybrid Oscillation Systems"**, *the Conference "Advances in Control of Partial Differential Equations" in Honor of Thomas I. Seidman*, Department of Mathematics and Statistics, University of Maryland, Baltimore County, USA, October 28-29, 2006, <http://www.umbc.edu/seidman> (the copy of the presentation is enclosed, see Appendix 8);

3) **"Perturbation Theory Method for Analysis of Vibrations in Some Transmission Pipeline Systems"**, *The Conference "Symmetry and Perturbation Theory" (SPT2007)*, Otranto, Italy, June 2-9, 2007, <http://www.sptspt.it/spt2007.html> (the copy of the done presentation is enclosed, see Appendix 9);

4) **"Application of a Perturbation Theory Method for Vibration Analysis of Transmission Pipeline Systems"**, *A Talk at the School of Aeronautics*, Politechnic University of Madrid, Madrid, Spain, June 12, 2007 (the copy of the invitation letter and the done presentation are enclosed, see Appendix 10).

Besides, I attended the regular *seminars of the R&D unit CEOC* (Centre for Research in Optimization and Control).

Also, I was a **Referee** for the *International Journal of Applied Mathematics & Statistics (IJAMAS)*, Roorkee, India, <http://www.ceser.res.in/ijamas.html>.

I am very grateful to FCT and to the University of Aveiro and the Control Theory Group of the Centre for Research in Optimization and Control for the hospitality and the perfect working conditions.

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