Nikolay Pogodaev

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Personal

Born	November 7, 1982
Citizenship	Russian Federation
Marital status	Married, one son

Education

2009	**PhD in Mathematics**; Institute for System Dynamics and Control Theory (Irkutsk, Russia)
2005	**Specialist Degree in Mathematics**; Irkutsk State University (Irkutsk, Russia)

Employment

2018-today	Senior research fellow (Institute for System Dynamics and Control Theory, Russia)
2012-2018	Research fellow (Institute for System Dynamics and Control Theory, Russia)
2011-2012	Postdoctoral fellow (Università degli studi di Brescia, Italy)
2009-2011	Junior research fellow (Institute for System Dynamics and Control Theory, Russia)

Scientific interests

Mathematical control theory, Nonlinear conservation laws, Dynamic systems in the space of probability measures, Partial differential equations

Papers in international journals

1. **Nonolocal parametric balance equations in the space of signed measures**. to be published in Sbornik: Mathematics (with M. Staritsyn)
2. **Feedback Maximum Principle for Ensemble Control of Local Continuity Equations: An Application to Supervised Machine Learning**. IEEE Control Syst. Lett., 6 (2021), pp. 1046-1051 (with M. Staritsyn, R. Chertovskih, F.L. Pereira)
3. **Modeling of crowds in regions with moving obstacles**. Discrete Contin. Dyn. Syst., 41 (2021), no. 14, pp. 5009 - 5036 (with N. Maltugueva)
4. **Impulsive control of nonlocal transport equations**. Journal of Differential Equations, 269 (2020), no. 4, pp. 3585-3623 (with M.V. Staritsyn)

5. **Program strategies for a dynamic game in the space of measures**. Optimization Letters. 13 (2019), no. 8. pp. 1913-1925.
6. **Bang-Bang Theorem for a Coupled ODE-PDE Control System**. Journal of Mathematical Sciences 23 (2019), no, 2. pp. 146-158.
7. **Estimates of the Domain of Dependence for Scalar Conservation Laws**. Journal of Differential Equations, 265 (2018), no. 4, pp. 1654-1677.
8. **On the regularity of the boundary of the integral funnel of a differential inclusion**. Differential Equations, 52 (2016), no. 8, pp. 987-999.
9. **Optimal control of continuity equations**. Nonlinear Differ. Equ. Appl. (2016) 23: 21.
10. **On the modeling of moving populations through set evolution equations**. Discrete Contin. Dyn. Syst., 35 (2015), no. 1, pp. 73-98 (with R.M. Colombo and T. Lorenz).
11. **The variational stability of an optimal control problem for Volterra-type equations**. Siberian Mathematical Journal, 55 (2014), no. 4, pp. 667-686 (with A. Tolstonogov).
12. **On the control of moving sets: positive and negative confinement results**. SIAM J. Control Optim., 51 (2013), no. 1, pp. 380-401 (with R.M. Colombo).
13. **Confinement strategies in a model for the interaction between individuals and a continuum**. SIAM J. Appl. Dyn. Syst., 11 (2012), no. 2, pp. 741-770 (with R.M. Colombo).
14. **Relaxation of the optimal control problem for Goursat-Darboux system**. Siberian Mathematical Journal, 52 (2011), no. 1, pp. 78-90.
15. **On solutions of the Goursat-Darboux inclusion with mixed boundary and distributed control constraints**. Siberian Journal of Industrial Mathematics, 11 (2008), no. 1, pp. 96-110 (in Russian).
16. **On the properties of solutions to the Goursat-Darboux problem with boundary and distributed controls**. Siberian Mathematical Journal, 48 (2007), no. 5, pp. 897-912.
17. **On solutions of the Goursat-Darboux system with boundary controls and distributed controls**. Differential Equations, 43 (2007), no. 8, pp. 1142-1152.

Conference papers

18. **Feedback Maximum Principle for a Class of Linear Continuity Equations Inspired by Optimal Impulsive Control**. Lecture Notes in Computer Science: 20th Intern. Conf. on Mathematical Optimization Theory and Operations Research, MOTOR 2021. 2021. vol. 12755. pp. 356-368 (with M. Staritsyn and E. Goncharova).
19. **Optimality Conditions and Numerical Algorithms for Hybrid Control Systems**. Lecture Notes in Computer Science: 19th Intern. Conf. on Mathematical Optimization Theory and Operations Research, MOTOR 2019. (2019), vol. 11548, pp. 474-488 (with N. Maltugueva and O. Samsonyuk).
20. **Impulsive Relaxation of Continuity Equations and Modeling of Colliding Ensembles**. Communications in Computer and Information Science: 9th Intern. Conf. on Optimization and Applications, OPTIMA 2018. (2019) , vol. 974. pp. 367-381 (with M.V. Staritsyn).
21. **Minimum time function of a non-autonomous control system**. IFAC-PapersOnLine, 51 (2018), no. 32, pp. 704-707 (with V.A. Voronov).
22. **On a Class of Impulsive Control Problems for Continuity Equations**. IFAC-PapersOnLine, 51 (2018), no. 32, pp. 468-473 (with M.V. Staritsyn).
23. **Numerical Algorithm for Optimal Control of Continuity Equations**. Proc. of 8th Intern. Conf. on Optimization and Applications, OPTIMA-2017, pp. 467-474.
24. **Conservation laws in the modeling of moving crowds**. AIMS Series on Applied Mathematics:

Proc. of the 14th International Conference "Hyperbolic Problems: Theory, Numerics, Applications (2014), vol. 8, pp. 467-474 (with R.M. Colombo, M. Garavello, M. Lecureux-Mercier).

Conferences and seminars

2006 International Conference on Control Theory and Mathematical Modeling dedicated to 75th anniversary of Udmurt state university (Izhevsk, Russia)

2007 International Conference on Differential equations, Theory of Functions and Applications (Novosibirsk, Russia)

2007 9th International Chetaev Conference on Analytical Mechanics, Stability and Motion Control (Irkutsk, Russia)

2008 International Conference on Differential Equations and Topology dedicated to the Centennial Anniversary of L.S. Pontryagin (Moscow, Russia).

2008 International School-Seminar on Nonlinear Analysis and Extremal Problems (Irkutsk, Russia)

2009 International Conference Kolmogorov Readings, General Control Problems and Their Applications (Tambov, Russia)

2011 International Conference on Differential Equations and Related Topics (Moscow, Russia)

2012 3rd International School-Seminar on Nonlinear analysis and extremal problems (Irkutsk, Russia)

2012 Seminar in Università degli Studi di Brescia (Brescia, Italy)

2012 Seminar in Università degli Studi di Padova (Padua, Italy)

2013 Seminar in Università Cattolica del Sacro Cuore (Brescia, Italy)

2013 2rd Russian Mongolian Conference for Young Scientists on Mathematical Modeling, Computing Technologies and Control (Irkutsk (Russia) - Khankh (Mongolia))

2013 International Conference Kolmogorov Readings, General Control Problems and Their Applications (Tambov, Russia)

2013 Mathematical Control in Trieste (Trieste, Italy)

2014 4rd International School-Seminar on Nonlinear analysis and extremal problems (Irkutsk, Russia)

2014 7th International Symposium “Generalized Statements and Solutions of Control Problems” (Gelendzhik, Russia)

2015 3rd Russian Mongolian Conference for Young Scientists on Mathematical Modeling, Computing Technologies and Control (Irkutsk (Russia) - Khankh (Mongolia))

2015	International Conference Kolmogorov Readings, General Control Problems and Their Applications (Tambov, Russia)
2016	5rd International School-Seminar on Nonlinear analysis and extremal problems (Irkutsk, Russia)
2016	Geometric Analysis and Control Theory (Novosibirsk, Russia)
2017	The VIII International conference “Optimization and Applications”
2018	6rd International School-Seminar on Nonlinear analysis and extremal problems (Irkutsk, Russia)
2018	The 14th Viennese Conference “Optimal Control and Dynamic Games” (Vienna, Austria)
2018	17th IFAC Workshop on Control Applications of Optimization (Yekaterinburg, Russia)
2019	International Youth School-Conference Modern problems in mathematics and its applications (Yekaterinburg, Russia)
2019	International conference “Crowds: models and control” (Marseille, France)

Grants

2014-2015	Russian Foundation for Basic Research No. 14-01-31254-mol_a (leader)
2016-2017	Russian Foundation for Basic Research No. 16-31-00184-mol_a (participant)
2017-2019	Russian Foundation for Basic Research No. 17-01-00733-a (participant)
2017-2019	Russian Science Foundation No. 17-11-01093 (participant)
2018-2019	Russian Foundation for Basic Research No. 18-31-00425-mol_a (participant)
2018-2021	Russian Foundation for Basic Research No. 18-01-00026-a (participant)

Teaching

2016	Lectures for the Bachelor course Optimization (Irkutsk State University)
2016	Lectures for the Bachelor course Linear programming (Irkutsk State University)
2016-2019	Exercise classes for the Bachelor course Linear programming (Irkutsk State University)
2017	Exercise classes for the Bachelor course Convex programming (Irkutsk State University)

Other skills

Languages	Russan (native), English (fluent), French (basic)

Programming C/C++, Python, Julia

Overview of my research

The papers [11,14-17] are related to my PhD thesis. They deal with **nonlinear Volterra operator equations**, a class of operator equations that provides a convenient framework for studying initial-boundary value problems for various PDEs: Goursat-Darboux systems, first order semilinear hyperbolic systems, nonlinear wave equation, etc. First, I studied various topological properties of the solution set of the Goursat-Darboux control system [15-17], then proved a Bogolyubov-type relaxation theorem [14]. In our joint paper with A.A. Tolstonogov [11], we proved that optimal control problems for a general nonlinear Volterra equation are stable (in the sense of Γ-convergence) under a wide range of perturbations.

Together with R.M. Colombo we studied control problems in some models of **agent-population interaction**. We started from a model based on differential inclusions and focused on the confinement problem: find an agents' strategy that holds the population inside a given set within a given period of time. We found confinement strategies under certain conditions related to the diameter of the set initially occupied by the population [13]. We proved that there is no confinement strategy if the area of the initial set is sufficiently large [12]. Finally, we generalized the model by developing the concept of set evolution equation [10].

The remaining papers are mostly devoted to controlling continuity equations. In [9] Pontryagin's maximum principle was derived for the case of linear continuity equation. Then in [23] it was used to construct a descent numerical method for solving the corresponding optimal control problem. A nonlocal continuity equation was considered in [4]. Since unbounded controls were admitted, we constructed an impulsive relaxation of the optimal control problem and derived a necessary optimality condition. Paper [7] can be considered as a bridge between models based on conservation laws and differential inclusions. It shows that the domain of dependence of a nonlinear scalar conservation law lies in the reachable set of a certain differential inclusion. A novel model of crowd motion in regions with moving obstacles is presented in [3]; we prove its well-posedness and discuss some applications to environment optimization.