

ALEXANDER V. TEREKHOV

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QUALIFICATION OVERVIEW

- Highly qualified Research Scientist with extensive experience in mathematical/computational modeling and data analysis in neuroscience and robotics.
- Strong mathematical background and problem formalization skills, supported by diploma from Russia's best graduate school of mathematics (the second best mathematical graduate school in the world according to the alumni score of Shanghai rating 2014).
- Extensive experience in mathematical modeling combined with good programming skills used for rapid computational implementation of mathematical models in Matlab/Python and their subsequent translation into C/C++.
- Hands-on experience in signal processing (model-free filters, spectral analysis, Kalman filter, particle filter, EM) and machine learning (RBMs, SOMs, K-means, SVMs, neural networks, Kolmogorov-Gabor polynomials, Gaussian MMs).
- Flexibility and demonstrated ability to enter new fields by rapidly acquiring necessary skills both in academic and industry.
- Experience recruiting, training and managing personnel.
- Good communication skills (oral and written), large scientific network, grantsmanship.

EDUCATION

Ph.D., Applied Mechanics and Control Theory <i>Moscow State University</i>	2007 <i>Moscow, Russia</i>
M.Sc. & B.Sc., Applied Mathematics and Mechanics, <i>magna cum laude</i> <i>Moscow State University</i>	2003 <i>Moscow, Russia</i>

PROFESSIONAL EXPERIENCE - FULL TIME EMPLOYMENT

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| Researcher
<i>Paris Descartes University (Paris 5)</i> | since Jan 2014
<i>Paris, France</i> |
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- Leader of one of five spearheads of a 5-year 2.5M euro project 'FEEL' (PI: J.K. O'Regan) at all stages: conception, application writing, personnel hiring, personnel management, results reporting.
 - Developed a formal approach for the analysis of abstract perceptual notions in humans and artificial (robotic) agents.
 - Gave preliminary constructive mathematical definitions of the notions of perceptual space; built algorithms through which a computational agent can construct the notion of space (see the talk: https://archive.org/details/Redwood_Center_2014_02_25_Alexander_Terekov).
 - Supervised one Ph.D. student, two postdocs, one research engineer.
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| Researcher
<i>Pierre and Marie Curie University (Paris 6)</i> | Jan 2011 - Dec 2013
<i>Paris, France</i> |
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- Discovered two phenomena in tactile perception having high potential for applications in touch-screens. One of them provides a low-cost solution for generating sensation of pressing a button; the illusion is submitted as a patent.
 - Developed a demonstration setup on which the button-pressing sensation was successfully generated in more than 200 users.

- Analyzed ~20,000 neuronal recordings and illustrated the feature extraction process performed at the first brain relay (cuneate nucleus).
- Developed a method for decomposing intracellular neural recordings into a combination of individual EPSPs.
- Developed a unified mathematical framework (Bayesian filter-based) for interpreting the contribution of different sources of haptic information to the percept of shape.
- Supervised a Ph.D. student, now successfully graduated.

Postdoctoral Researcher

Jul 2009 - Dec 2010

Pierre and Marie Curie University (Paris 6)

Paris, France

- Explored the use of stochastic algorithms in a highly dynamic task: the steering of a car robot when sliding. Combined three models of different complexity with execution on a physical robot in the stochastic optimization procedure.
- Developed an analytic model of a fast moving robotic car; the model was built using tools for symbolic mathematics, it counts 14 degrees of freedom, the formulas occupy more than 30,000 symbols.
- Incorporated the developed models into a simulation and visualization framework (OpenRave).

Chief Control Engineer

Sep 2008 - May 2009

Movicom LLC

Moscow, Russia

- Was responsible for the control algorithms and software for a cable system for areal displacement of a TV or cinema camera in large volumes (~100,000 m³), such as soccer stadiums. The system is being actively used, e.g. Olympics 2014. See demo: https://www.youtube.com/watch?v=3D0xspU_AWM
- Developed control algorithms which take into account the sag of the cables, solving in real time (100 Hz) the underlying optimization problem.
- Supervised two software developers implementing the algorithms and building the overall software solution.

Research Scholar

Sep 2007 - Aug 2008

Pennsylvania State University

University Park, PA, USA

- Formulated and mathematically proved a theorem giving conditions under which an unknown cost function can be determined unambiguously when provided the set of points where this cost function reaches its minima under linear constraints.
- Developed algorithms for estimating the cost function from experimental data.

PROFESSIONAL EXPERIENCE - CONSULTING

Consultant

Aug 2014 - Dec 2014

PriceLabs

Moscow, Russia

- Consulting for a company offering a system of automatic bidding control for internet auctions (Yandex.Market - analogue of Google Adwords), which has been recently purchased by Yandex (main competitor of Google on the Russian market).
- Suggested a way to approximate the expected click-through rate depending on the context in which the advertisement is displayed.

Consultant

since Jan 2010

NIH grant "Prehension Synergy" (PI: Zatsiorsky, Penn State)

University Park, PA, USA

- Consulting for the experimental design of 15-20 different studies of human movements with the purpose of determining the cost function used by the brain in motor control.
- Trained 10-15 Ph.D. students and postdocs to use inverse optimization methods.

Consultant*NormaSys Corporation*

Jan 2011 - Dec 2011

Paris, France

- Consultant on methods of data mining and visualization for the business intelligence tool 'Daat', which generated a revenue of at least 250K euro after my contribution (for 2012).
- Explored in Matlab the usefulness of various methods for unsupervised learning and dimension reduction (e.g. SOM, K-means, CCA, IsoMap) for the purpose of the project.

Consultant*Samsung R&D*

Dec 2004 - Feb 2005

Moscow, Russia

- Consulted on a device for the detection of drug abuse using the pupil light reflex.
- Developed a pupil model which increased the rate of correct classification.

TECHNICAL STRENGTHS

Programming

- Matlab: 12 years of daily usage (~10,000 hours); very efficient codes maximally exploiting built-in data manipulation functions.
- Python: 1 year of daily usage (~ 500 hours); hands-on experience with Theano & Deep Learning.
- C/C++: 18 years of experience (~7,000 hours); Eigen 3 (matrix manipulation), Open Dynamic Engine (physical simulation), Open Rave (integration), GNU Scientific Library (BLAS).
- Maxima/Mathematica: occasional usage (~500 hours);
- R: occasional usage (~500 hours); statistical analysis of the data (e.g. ANOVA, Kruskal-Wallis, Kolmogorov-Smirnov, etc), data manipulation (plyr), data visualization (ggplot2).
- SVN/Git: 1 year of experience with GitHub and BitBucket.

Reporting

- TeX/LaTeX: 12 years of daily usage (~2,000 hours), also in combination with Markdown.
- Inkscape/Illustrator: 9 years of experience: high-quality figures for scientific publications and slides.
- LibreOffice, MS Office, Google Documents: 20 years of experience; use for collaborative working offline (MS Office & LibreOffice) and online (Google Documents).

Other

- Linux: command line user for the last 7 years; Xenomai; wrote a kernel patch.
- Emacs: 6 years of daily usage; use as a working environment for Matlab & Python; use for programming (Matlab, C/C++, R, Maxima) and editing (LaTeX, Markdown, plain text).

GRANTS AND ACHIEVEMENTS

- Oct 2012: Contributed to writing an advanced European Research Council proposal 'FEEL'; PI: O'Regan; accepted.
- Apr 2012: Contributed to writing a NIH renewal proposal 'Prehension Synergy'; PI: Zatsiorsky; accepted.
- Oct 2008: Received individual purpose grant 'Development of gyrostabilized system for cinema and TV industry' from Foundation for Assistance to Small Innovative Enterprises.
- Oct 2004: Received individual purpose grant 'Participation in the foreign scientific conference Motor Control 2004' from Russian Foundation for Basic Research, 04-01-10786.
- 1999-2001, 2003-2004: Received increased state scholarship.
- Oct 2003: According to the score of the examination was accepted for a state-paid PhD-studentship.
- Mar 1998: According to the score of pre-examination was exempted from further exams and accepted for a state-paid studentship.

Sponsored invited talks

- Dec 2014: Motor Control Laboratory, Penn State, USA
- Feb 2014: Redwood Center for Theoretical Neuroscience, UC Berkeley, USA.
- Feb 2014: Brain Corporation, San Diego, USA.
- Apr 2013: 'Action Club', Penn State, USA.
- Nov 2012: Laboratory for Analysis and Architecture of Systems, CNRS, Toulouse, France.
- Oct 2012: Neuromorphic cognitive systems laboratory, Kurchatov Institute, Moscow, Russia.
- Oct 2012: 'Optimality principles and adaptation to humanoid robot control' workshop, IROS 2012, Portugal.
- Nov 2011: Research Center 'E. Piaggio', University of Pisa, Italy.
- Jul 2011: 'The Hand Embodied' meeting, University of Siena, Italy.
- Mar 2007: Motor Control Laboratory, Penn State, USA
- Dec 2004: Laboratory of Perception and Action, College de France, Paris, France.

Travel grants

- Feb 2013: 'Conceptual and Mathematical Foundations of Embodied Intelligence', Leipzig Germany.
- May 2007: 'European Workshop on Movement Science 2007', Amsterdam, Netherlands.
- Jun 2005: International Summer School 'Space Biology and Medicine', Moscow, 2005.
- Jun 2005: 'European Workshop on Movement Science 2005', Vienna, Austria.

Other

- Interview on haptic perception for 'Russia 2' federal channel (aired on December 2, 2013).
- Co-organizer of the workshop 'Hand synergies - how to tame the complexity of grasping' at ICRA 2013.
- Co-organizer of 'Haptic Illusion Workshop' within 'Joue le jeu' game exhibition at La Gaité Lyrique, Paris, 2012.
- Co-supervisor of four PhD student (three defended, one active), one specialist students (equivalent to MS), two post-docs.
- Reviewer at one PhD thesis defense and five specialist (equivalent to MS) thesis defenses.
- Reviewer for: Journal of Biomechanics, Neural Computation, Scientific Reports, IROS, EuroHaptics.
- Erdős number of 4.

PUBLICATIONS

Preprints and Submitted (2)

- A.V. Terekhov, J.K. O'Regan. Space as an invention of biological organisms. arXiv:1308.2124. [Link](#)
- Y. Xu, A.V. Terekhov, M.L. Latash, V.M. Zatsiorsky. Effects of arm posture on the force and moment production. Submitted to Experimental Brain Research.

Journal papers (14)

- A.V. Terekhov, V. Hayward. The brain uses extra-somatic information to estimate limb displacement. Proceedings of the Royal Society: B (in press).
- A. Laflaquiere, J.K. O'Regan, S. Argentieri, B. Gas, A.V. Terekhov. Learning agent's spatial configuration from sensorimotor invariants. (2015) Robotics and Autonomous Systems, 71: 49-59. [Link](#)
- H. Jorntell, F. Bengtsson, P. Geborek, A. Spanne, A.V. Terekhov, V. Hayward. Segregation of tactile input features in neurons of the cuneate nucleus. (2014) Neuron, 83(6), 1444-52. [Link](#)
- V. Hayward, A.V. Terekhov, S-C. Wong, P. Geborek, F. Bengtsson, H. Jorntell. Spatio-temporal skin strain distributions evoke low variability spike responses in cuneate neurons. (2014) Journal of the Royal Society Interface, 11(93). [Link](#)

- J.R. Martin, A.V. Terekhov, M.L. Latash, V.M. Zatsiorsky. Optimization and variability of motor behavior in multi-finger tasks: What variables does the brain use? (2013) *Journal of Motor Behavior*, 45(4), 289-305. [Link](#)
- J.R. Martin, A.V. Terekhov, M.L. Latash, V.M. Zatsiorsky. Comparison of inter-finger connection matrix computation techniques. (2013) *Journal of Applied Biomechanics*, 29(5):525-534. [Link](#)
- Y. Xu, A.V. Terekhov, M.L. Latash, V.M. Zatsiorsky. Forces and moments generated by the human arm: variability and control. (2012) *Experimental Brain Research*, 223(2), 159-175. [Link](#)
- X. Niu, A.V. Terekhov, M.L. Latash, V.M. Zatsiorsky. Reconstruction of the unknown optimization cost functions from experimental recordings during static multi-finger prehension. (2012) *Motor Control*, 16(2), 195-228. [Link](#)
- A.V. Terekhov, V. Hayward. Minimal adhesion surfaces in tangentially loaded digital contacts. (2011) *Journal of Biomechanics*, 44(13) 2508-2510. [Link](#)
- E.Yu. Shapkova, A.V. Terekhov, M.L. Latash. Arm motion coupling during locomotion-like actions: An experimental study and a dynamic model. (2011) *Motor Control*, 15(2): 206-220. [Link](#)
- A.V. Terekhov and V.M. Zatsiorsky. Analytical and numerical analysis of inverse optimization problems: conditions of uniqueness and computational methods. (2011) *Biological Cybernetics*, 104(1) 75-93. [Link](#)
- A.V. Terekhov, Y.B. Pesin, X. Niu, M.L. Latash, V.M. Zatsiorsky. An analytical approach to the problem of inverse optimization: An application to human prehension. (2010) *Journal of Mathematical Biology*, 61(3) 423-453. [Link](#)
- A.V. Terekhov, Yu.S. Levik, I.A. Solopova. Mechanisms of reference posture correction in the system of upright posture control. (2007) *Human Physiology*, 33(3) 289-295. [Link](#)
- H. Hicheur, A.V. Terekhov, A. Berthoz. Intersegmental coordination during human locomotion: does planar covariation of elevation angles really reflect central constraints? (2006) *Journal of Neurophysiology*, 96(3):1406-1419. [Link](#)

Papers in peer-reviewed conference proceedings (11)

- A.V. Terekhov, G. Montone, J.K. O'Regan. Knowledge transfer in deep block-modular neural networks. (2015) *Lecture Notes in Computer Science: Biomimetic and Biohybrid Systems*, 9222:268-279 Eds: S.P. Wilson, P. Verschure, A. Mura, T.J. Prescott. [Link](#)
- G. Montone, A.V. Terekhov, J.K. O'Regan. Unsupervised model-free camera calibration algorithm for robotic applications. *IEEE/RSJ International Conference on Intelligent Robots and Systems 2015* (in press).
- A.V. Terekhov, J.K. O'Regan. Learning abstract perceptual notions: example of space. (in press) *ICDL-EPIROB - IEEE International Conference on Development and Learning and on Epigenetic Robotics*. [Link](#)
- J. Hartcher-O'Brien, A.V. Terekhov, M. Auvray, V. Hayward. Haptic Shape Constancy Across Distance. (in press) *Haptics: Neuroscience, Devices, Modeling, and Applications*, 77-84. [Link](#)
- S. Bochereau, A.V. Terekhov, V. Hayward. Amplitude and Duration Interdependence in the Perceived Intensity of Complex Tactile Signals. (in press) *Haptics: Neuroscience, Devices, Modeling, and Applications*, 93-100. [Link](#)
- A. Moscatelli, M. Bianchi, A. Serio, O.A. Atassi, S. Fani, A.V. Terekhov, V. Hayward, M. Ernst, A. Bicchi. A change in the fingertip contact area induces an illusory displacement of the finger. (in press) *Haptics: Neuroscience, Devices, Modeling, and Applications*. [Link](#)
- A. Laflaquiere, A.V. Terekhov, B. Gas, J.K. O'Regan. Learning an internal representation of the end-effector configuration space. (2013) *IROS - IEEE/RSJ International Conference on Intelligent Robots and Systems*. [Link](#)
- A.V. Terekhov, J.-B. Mouret, C. Grand. Stochastic optimization of a chain sliding mode controller for the mobile robot maneuvering. (2011) *IROS - IEEE/RSJ International Conference on Intelligent Robots and Systems*. [Link](#)
- E. Lucet, C. Grand, A.V. Terekhov, P. Bidaud. Experimental study of a fast mobile robot performing a drift maneuver. (2010) *CLAWAR - Thirteenth International Conference on Climbing and Walking Robots and the Support Technologies for Mobile Machine*. [Link](#)
- A.V. Terekhov, J.-B. Mouret, C. Grand. Stochastic optimization of a neural network-based controller for aggressive maneuvers on loose surface. (2010) *IROS - IEEE/RSJ International Conference on Intelligent Robots and Systems*. [Link](#)

- A.V. Terekhov, J.-B. Mouret, C. Grand. Stochastic Multi-objective optimization for aggressive maneuver trajectory planning on loose surface. (2010) 7th Symposium on Intelligent Autonomous Vehicles, IFAC. [Link](#)

Other: papers in national journals (1)

- A.V. Terekhov. Adaptive control in the system of the vertical posture regulation. (2006) Control Systems and Information Technologies, 23(1.2):287-290 (in Russian)

Book chapters (2)

- I.V. Novozhilov, A.V. Terekhov, A.V. Zabelin, Yu.S. Levik, V.Yu. Shlikov, O.V. Kazennikov. Three-link mathematical model for the problem of human vertical posture stabilization. (2005) In Mathematical modeling of human movements in the norm and at some kinds of pathology. Eds: I.V. Novozhilov, P.A. Kruchinin. Moscow State University, pp 7-20 (in Russian).
- A.V. Terekhov. Mathematical model for the human vertical posture stabilization process in case of slow support inclinations. (2005) In Mathematical modeling of human movements in the norm and at some kinds of pathology. Eds: I.V. Novozhilov, P.A. Kruchinin. Moscow State University, pp 21-27 (in Russian).

More than 20 conference abstracts