

# **13th International Symposium on Intelligent Systems (INTELS'18)**

Procedia Computer Science Volume 150

St. Petersburg, Russia  
22 – 24 October 2018

## **Editors:**

**Askhat Diveev**  
**Ivan Zelinka**

**Fernando Lobo Pereira**  
**Eugeny Nikulchev**

ISBN: 978-1-7138-0649-3

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2019) The Authors. Published by Elsevier Ltd.  
Creative Commons Attribution 4.0 International License.  
License details: <http://creativecommons.org/licenses/by/4.0/>.

No changes have been made to the content of these proceedings. There may be changes to pagination, and minor adjustments for aesthetics.

Printed with permission by Curran Associates, Inc. (2021)

For permission requests, please contact the publisher:

Elsevier B.V.  
Radarweg 29  
Amsterdam 1043 NX  
The Netherlands

Phone: +31 20 485 3911  
Fax: +31 20 485 2457

<http://www.elsevierpublishingsolutions.com/contact.asp>

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

**ScienceDirect**

Procedia Computer Science 150 (2019) iii-viii

**Procedia**  
Computer Science

[www.elsevier.com/locate/procedia](http://www.elsevier.com/locate/procedia)

## Table of Contents

XIII International Symposium Intelligent Systems 2018 .....	1
Intelligent Control of Autonomous and Anthropocentric On-board Systems M.E. Buzikov, A.A. Galyaev, Yu.V. Guryev, K.B. Titov, E.I. Yakushenko, and S.N. Vassilyev .....	10
Model Predictive Control for Autonomous Underwater Vehicles Rui Gomes, and Fernando Lobo Pereira .....	19
Synthesis of Fuzzy Controller Based on Simple PID Controller L.A. Alsafadi, N.A. Chulin, and I.V. Mironova .....	28
The Approach to Managing a Group of UAVs as a System with Distributed Parameters D.A. Milyakov, and V.I. Merkulov .....	39
Machine Learning Algorithms for Stratigraphy Classification on Uranium Deposits Timur Merembayev, Rassul Yunussov, and Amirgaliyev Yedilkhan .....	46
Generalized Information Content based on Variability Map for Exploratory Landscape Analysis of Global Optimization Problems T.A. Agasiev .....	53
The Design Principles of Intelligent Load Balancing for Scalable WebSocket Services Used with Grid Computing V.A. Alexeev, P.V. Domashnev, T.V. Lavrukhina, and O.A. Nazarkin .....	61
Control of the Motion Orientation of Autonomous Underwater Vehicle Nguyen Quang Vinh, and Pham Van Phuc .....	69
Sliding Mode Based Lateral Control of Unmanned Aerial Vehicles Pham Thi Phuong Anh, Nguyen Vu, Phan Tuong Lai, and Nguyen Quang Vinh .....	78
Fuzzy Description Hemispherical Resonator Gyro Error N.P. Demenkov, and D.M. Tran .....	88
Advanced Cat Swarm Optimization Algorithm in Group Robotics Problem A.P. Karpenko, and I.A. Leshchev .....	95
Intelligent Analysis of Biomedical Signals for Personal Identification and Life Support Systems A.P. Nemirko, and L.A. Manilo .....	102
Cascade Non-linear Filters for Image Recovery Elena Solovyeva .....	109
Algorithm for the Development of a Training Set that Best Describes the Objects of Recognition M. Kamilov, M. Hudayberdiev, and A. Khamroev .....	116
Networked Control for Active Suspension System S.F. Youness, and E.C. Lobusov .....	123
Approaches to Speed up Data Processing in Relational Databases Yulia Shichkina .....	131

Class Reconstruction in the Space of Natural System Classification T. Kachanova, K. Turalchuk, and B. Fomin.....	140
Software and Hardware Complex for the Management of Small-sized Underwater Vehicle Pham Van Tuan, and A.G. Shpektorov.....	147
Development of a Knowledge Base in the “Smart Farming” System for Agricultural Enterprise Management P.O. Skobelev, E.V. Simonova, S.V. Smirnov, D.S. Budaev, G.Yu. Voshchuk, and A.L. Morokov .....	154
Open source robotic simulators platforms for teaching deep reinforcement learning algorithms Armando Plasencia, Yulia Shichkina, Ileana Suárez, and Zoila Ruiz .....	162
Multi-agent Algorithm for Re-allocating Grid-resources and Improving Fault-tolerance of Problem-solving Processes Alexander Feoktistov, Roman Kostromin, Ivan Sidorov, Sergey Gorsky, and Gennady Oparin .....	171
Protozoa Behavior Reproduced by the Combination of Genetic Optimization and Learning Oleg Nikitin, and Olga Lukyanova .....	179
All convolutional neural networks for radar-based precipitation nowcasting G. Ayzel, M. Heistermann, A. Sorokin, O. Nikitin, and O. Lukyanova.....	186
The Analytical Approach to the Parameterized Fuzzy Operators Design S. Butenkov, V. Krivsha, and N. Krivsha.....	193
Methods of Visual Navigation in the Task of Moon Landing A.V. Bobkov, and Xu Yang .....	201
On Development of Module for Neural Tuner to Adjust D-part of PID-controller Online A.I. Glushchenko .....	208
Collective Opinion Formation as a Set of Intelligent Agents to Achieve the Goal K.A. Pupkov, and I. Fadi .....	216
Problems of Design of the Generalized Power Module for Control Systems of Solar Installations T.A. Demenkova, A.A. Phinenko, and D.B. Kulakov .....	223
An Adaptive Control of the Board Oscillations of Onboard Radio-electronic Equipment in the Resonant Mode A.V. Lysenko, N.V. Goryachev, V.A. Trusov, I.I. Kochegarov, and N.K. Yurkov .....	230
Multi-project Scheduling: Multicriteria Time-cost Trade-off Problem N.N. Klevanskiy, S.I. Tkachev, and L.A. Voloshchouk.....	237
Advanced Iterative Action Planning for Intelligent Real-Time Agents M.G. Pantaleev.....	244
A Model for Decision Making Support for Evaluation of Functional Efficiency of Lower Limb Orthotics L.M. Smirnova, and Z.M. Yuldashev.....	253
Stability-based Hierarchical Clustering of Cases in the Intelligent IT-consulting System Based on Semantic Integration with the Ontology A.Yu. Timofeeva, T.V. Avdeenko, and E.S. Makarova .....	261
Principles of Constructing of Intellectual Systems for the Diagnostics and the Rehabilitation of the Human Spine N.V. Dorofeev, A.V. Grecheneva, and O.R. Kuzichkin .....	270
Manipulation Robots’ Trajectory Motion Adaptive Control V. Putov, V. Sheludko, A. Putov, N. Thang, and M. Kopichev .....	279
Development of the Ground Mobile Robot with Adaptive Agility Systems D.Yu. Tyugin, V.V. Belyakov, A.A. Kurkin, D.V. Zeziulin, and V.I. Filatov .....	287

Unmanned Flying Vehicle Trajectory Guaranteeing Control at Approach to the Maneuvering Air Target V.N. Evdokimenkov, M.N. Krasil'shchikov, and G.G. Sebryakov .....	294
Optimal Control for Traffic Flows in the Urban Road Networks and Its Solution by Variational Genetic Algorithm E.A. Sofronova, A.A. Belyakov, and D.B. Khamadiyarov .....	302
The Application of Hardware-in-the-Loop (HIL) Simulation for Evaluation of Active Safety of Vehicles Equipped with Electronic Stability Control (ESC) Systems A.V. Tumasov, A.S. Vashurin, Y.P. Trusov, E.I. Toropov, P.S. Moshkov, V.S. Kryaskov, and A.S. Vasilyev	309
A Method of Monitoring and Detecting APT Attacks Based on Unknown Domains Do Xuan Cho, and Ha Hai Nam.....	316
Theoretical and Experimental Evaluation of Hybrid ACO-k-means Image Segmentation Algorithm for MRI Images Using Drift-analysis S.A. El-Khatib, Y.A. Skobtsov, and S.I. Rodzin .....	324
Non-invasive Method of Intelligent Sensory Control of Hands' Motor Functions for Bionic Systems N.M. Safyannikov, O.I. Bureneva, and Z.A. Aleksanyan .....	333
Electrical Energy Consumption Prediction is based on the Recurrent Neural Network S.A. Zagrebina, V.G. Mokhov, and V.I. Tsimbol .....	340
Applying Eye Tracking in Information Security Zh. Shokishalov, and H. Wang.....	347
Heart Rhythm Intelligent Monitoring Algorithm for the Atrial Fibrillation Episodes Detection in the Telemedicine System Trong Tuyen Nguyen, Trong Huu Tran, Mau Thach Nguyen, and Z.M. Yuldashev .....	352
Optimal Control Design for Maneuverable Aircraft Using Population-based Algorithms O.N. Korsun, S.A. Sergeev, and A.V. Stulovskii .....	361
The Use of a Convolutional Neural Network for Detecting Snow According to the Data of the Multichannel Satellite Device of Meteor-M No.2 Spacecraft L.S. Kramareva, A.I. Andreev, E.V. Simonenko, and A.A. Sorokin .....	368
Autonomous Unmanned Aerial Vehicles Control System Intellectualization W.V. Insarov, G.G. Sebriakov, S.V. Tihonova, and S.A. Dronsky .....	376
Violation Detection in Heterogeneous Events Streams Ya.A. Bekeneva, I.I. Kholod, S.I. Lebedev, E.S. Novikova, and A.V. Shorov .....	381
Training Normal Bayes Classifier on Distributed Data I.I. Kholod, M.S. Kuprianov, E.V. Titkov, A.V. Shorov, E.V. Postnikov, I.G. Mironenko, and S.S. Sokolov.....	389
The Method of Smart Monitoring and Detection of Sleep Apnea of the Patient out of the Medical Institution T.H. Tran, T.T. Nguyen, Z.M. Yuldashev, E.V. Sadykova, and M.T. Nguyen .....	397
The Predictive Principle in Control Systems with Standard Lows G.A. Pikina, and F.F. Pashchenko .....	403
Some Methods of Solving the NP-difficult Problem of Optimal Schedule for the University A.I. Diveev, O.V. Bobr, D.E. Kazaryan, and O. Hussein.....	410
Visual Explorer of Multivariate Data Tisagh Chase, Tatiana Mylläri, and Aleksandr Mylläri .....	416
Obstacle Avoidance for Swarm Robot Based on Self-Organizing Migrating Algorithm Diep Quoc Bao, and Ivan Zelinka .....	425

Dynamic Correction Algorithms in Multi-axis Systems Based on Predictive and Invariant Control Methods A.A. Kobzev, A.V. Lekareva, and Y.M. Monakhov . . . . .	433
Hierarchical Model of Parallel Metaheuristic Optimization Algorithms E.Y. Seliverstov, and A.P. Karpenko . . . . .	441
Development and Research of Hand Segmentation Algorithms on the Image Based on Convolutional Neural Networks S.Ya. Kazdorff, Zh.S. Pershina, and A.B. Kolker . . . . .	450
Hybrid Approach to Improving the Results of the SVM Classification Using the Random Forest Algorithm L.A. Demidova, I.A. Klyueva, and A.N. Pylkin . . . . .	455
Comparative Research of Random Search Algorithms and Evolutionary Algorithms for the Optimal Control Problem of the Mobile Robot S.V. Konstantinov, A.I. Diveev, G.I. Balandina, and A.A. Baryshnikov . . . . .	462
A Novel Hybrid Method of Global Optimization Based on the Grey Wolf Optimizer and the Bees Algorithm S.V. Konstantinov, U.K. Khamidova, and E.A. Sofronova . . . . .	471
A Generalized Filippov-like Existence Theorem for Optimal Control Problems with Constraints D.Yu. Karamzin, V.A. de Oliveira, F.L. Pereira, and G.N. Silva . . . . .	478
Towards the Formalization of Contradictions in a Legal Multiagent System G.M. Novikova, E.J. Azofeifa, and V.R. Milov . . . . .	488
A Genetic Approach for Auto-Tuning of Adaptive Fuzzy PID Control of a Telescope's Tracking System G.L. Demidova, D.V. Lukichev, and A.Yu. Kuzin . . . . .	495
A Self-tuning Multiobjective Genetic Algorithm with Application in the SVM Classification L.A. Demidova, M.M. Egin, and R.V. Tishkin . . . . .	503
Towards Automating the Creation of OBDA Systems I.S. Postanogov . . . . .	511
Distribution of Roles in Groups of Robots with Limited Communications Based on the Swarm Interaction D.Ya. Ivanov . . . . .	518
On Decision Making under Fuzzy Information about an Uncontrolled Factor V.I. Ukhobotov, I.S. Stabulit, and K.N. Kudryavtsev . . . . .	524
Using the Ensemble of Deep Neural Networks for Normal and Abnormal Situations Detection and Recognition in the Continuous Video Stream of the Security System O.S. Amosov, S.G. Amosova, Y.S. Ivanov, and S.V. Zhiganov . . . . .	532
Intelligent Systems and Human Being K.A. Pupkov . . . . .	540
Monitoring, Certification and Verification of Autonomous Robots and Intelligent Systems: Technical and Legal Approaches L.V. Legashev, T.V. Letuta, P.N. Polezhaev, A.E. Shukhman, and Yu.A. Ushakov . . . . .	544
Model of a Prospective Digital Platform to Consolidate the Resources of Economic Activity in the Digital Economy A.A. Zatsarinnyy, and A.P. Shabanov . . . . .	552

Hold-in, Pull-in and Lock-in Ranges for Phase-locked Loop with Tangential Characteristic of the Phase Detector M.V. Blagov, O.A. Kuznetsova, E.V. Kudryashova, N.V. Kuznetsov, T.N. Mokaev, R.N. Mokaev, M.V. Yuldashev, and R.V. Yuldashev .....	558
An Online Priority Configuration Algorithm for the UAV Swarm in Complex Context Zhu Lihua, Du Jianfeng, Wang Yu, and Wu Zhiqiang .....	567
Interval Quadratic Connected Control Systems in Industrial Robotics and Mechatronics M.M. Stebulyanin, E.E. Kovshov, and V.S. Kuvshinnikov .....	579
Computer and Experimental Modelling of Heat Leakage from Porous Substrates of LED Lighting Devices V.K. Velichko, K.D. Nessemon, V.V. Belyaev, E.S. Mikhaleva, A.A. Belyaev, E.D. Besprozvannyi, I.V. Muzalevsky, O.A. Morozova, A.N. Yatsenko, A.A. Gorbunov, and V.A. Zhachkin .....	586
Adaptive Wind Turbine PID Controller Tuner Algorithm with Elements of Artificial Intelligence A.N. Lisitsyn, and N.M. Zadorozhnaya .....	591
Intelligent Decision Supporting System of Rescue Equipment Using in Case of a Threat of a Temporary Inundation of a River Displacement Vessel A.V. Valiae .....	597
The Crossover Operator of a Genetic Algorithm as Applied to the Task of a Production Planning S.L. Podvalny, M.I. Chizhov, P.Y. Gusev, and K.Y. Gusev .....	603
Process of the Positioning Complex Modeling Objects with Elements of Intellectual Analysis N.B. Glebov, A.A. Zhilenkov, S.G. Chernyi, and S.S. Sokolov .....	609
Construction a Neural-Net Model of Network Traffic Using the Topologic Analysis of Its Time Series Complexity N. Gabdrakhmanova .....	616
Toward High Performance Solutions as Services of Research Digital Platform A.A. Zatsarinny, A.K. Gorshenin, V.A. Kondrashev, K.I. Volovich, and S.A. Denisov .....	622
An Ontology-based Approach to Support for Requirements Traceability in Agile Development M.Sh. Murtazina, and T.V. Avdeenko .....	628
A Newton-Type Method for Quadratic Programming Problem and Variational Equilibrium Problem A.N. Daryina, K.Yu. Andrianov, and B.B. Kulakov .....	636
Smart City Platform Architecture for Citizens' Mobility Support N.N. Teslya, I.A. Ryabchikov, M.V. Petrov, A.A. Taramov, and E.O. Lipkin .....	646
Implementation and Analysis of Distributed Relaxed Concurrent Queues in Remote Memory Access Model A.A. Paznikov, and A.D. Anenkov .....	654
Evaluation of the Influence of Cross-connections Accounting in the Simplified Mathematical Model of the Quadrotor Motion in Three-dimensional Space A.A. Karpunin, and I.P. Titkov .....	663
Modified Recognition Algorithms Based on the Construction of Models of Elementary Transformations Sh.Kh. Fazilov, N.M. Mirzaev, and G.R. Mirzaeva .....	671
Python Package for the Network Operator Implementation and its Application for Group Control System Synthesis Problem A.V. Dotsenko, A.I. Diveev, Yu.A. Malyuk, and D.A. Ryndin .....	679
Methods of a Heterogeneous Multi-agent Robotic System Group Control O.V. Darintsev, B.S. Yudintsev, A.Yu. Alekseev, D.R. Bogdanov, and A.B. Migranov .....	687

Problem of Cost Function Synthesis for Mobile Robot's Trajectory and the Network Operator Method for its Solution A.V. Betskov, I.V. Prokopyev, and A.E. Iljinbaev . . . . .	695
Robotic Solutions for Arctic Transit Corridor Cargo Autonomous Undersea Vehicles G.G. Malinetsky, and V.S. Smolin . . . . .	702
Evolutional Methods for Creating Artificial Intelligence of Robotic Technical Systems N.B. Konyrbaev, S.I. Ibadulla, and A.I. Diveev . . . . .	709
Retrial Queuing System with Randomized Push-Out Mechanism and Non-Preemptive Priority M. Korenevskaya, O. Zayats, A. Ilyashenko, and V. Muliukha . . . . .	716
Modeling of Interaction in Command-information Systems with Dynamic Replicas A.A. Kochkarov, G.G. Malinetskii, and D.V. Yatskin . . . . .	726
Knowledge Company: Approaches to Assessing New Knowledge and Representation it to Society A.E. Suleimankadieva, V.I. Pilipenko, and J. Sági . . . . .	730
Analysis of Control System Models with Conventional LQR and Fuzzy LQR Controller Y.I. Kudinov, F.F. Pashchenko, A.Y. Kelina, D.I. Vasutin, E.S. Duvanov, and A.F. Pashchenko . . . . .	737
Analysis of the AnyWalker Software Architecture Using the UML Refactoring Tool O. Deryugina, E. Nikulchev, I. Ryadchikov, S. Sechenev, and E. Shmalko . . . . .	743
From Malware Testing to Virtualization Lukáš Révay . . . . .	751
Convolutional Neural Network in the Recognition of Spatial Images of Sugarcane Crops in the Troncal Region of the Coast of Ecuador J.P. Cobeña Cevallos, J.M. Atiencia Villagomez, and I.S. Andryshchenko . . . . .	757