# 14th International Symposium on Intelligent Systems (INTELS'20)

Procedia Computer Science Volume 186

Moscow, Russia 14 – 16 December 2020

### **Editors:**

Ivan Zelinka Fernando Manuel Ferreira Lobo Pereira Swagatam Das

Alexander Ilin Askhat Diveev Eugeniy Nikulchev

ISBN: 978-1-7138-3150-1

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© (2021) 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. (2022)

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 Web: www.proceedings.com



Available online at www.sciencedirect.com





Procedia Computer Science 186 (2021) iii-viii

www.elsevier.com/locate/procedia

## Table of Contents

Model of a management system for deterministic scientific services of digital platform S.A. Denisov, and A.A. Sorokin.	1
A Regularization Approach to Analyze the Time-Optimal Motion of a Mobile Robot under State Constraints using Pontryagin's Maximum Principle Fernando Lobo Pereira, Roman Chertovskih, Anna Daryina, Askhat Diveev, Dmitry Karamzin, and Elena Sofronova	11
Study on control methods based on identification of unmanned vehicle model I.V. Prokopyev, and E.A. Sofronova	21
Algorithms for managing service-oriented research processes as services in hybrid computing environments of digital platforms V.A. Kondrashev, and A.A. Sorokin	30
Deployment of parallel computing in a hybrid high-performance cluster based on virtualization technologies K.I. Volovich, S.A. Denisov, and S.I. Malkovsky	40
Combined evolutionary method of feasible directions in multicriteria synthesis problem of a dynamical system program control V.A. Serov	48
Computing infrastructure for scientific research in a digital transformation A.A. Zatsarinnyy	59
Method of centralized reproduction of information transmission processes in the digital platform control loop A.A. Zatsarinnyy, and A.P. Shabanov	63
Minimax Control Problems: Optimality Conditions P.G.P. Aquino, M.d.R. de Pinho, and G.N. Silva	70
Optimal Control Problems in Drone Operations for Disaster Search and Rescue Fernando Lobo Pereira.	78
Control Training Askhat Diveev	87
Robust H∞ fuzzy saturated control of photovoltaic system Noureddine Boubekri, Dounia Saifia, Sofiane Doudou, and Mohammed Chadli	95
Robust Fuzzy Model Predictive Control with time delays for Nonlinear Systems Sofiane Bououden, Ilyes Boulakaibet, Abdelazziz Aboudi, and Mohammed Chadli	109
Study on Urban Traffic Control under Uncertainties of Parameters Elena Sofronova, and Askhat Diveev.	120
Verification of the RRA-Algorithm Regularization for the Analysis of Stochastic Structures in Bioinformatic Intelligent Systems V. Kulikov, A. Kulikov, and V. Khranilov	130

Methodology for determining the value of resistance to movement of a vehicle as a tool for research and optimization of the shape of the elements of a wheeled vehicle immersed in snow D.S. Teslenko, V.V. Belyakov, V.S. Makarov, S.S. Dralkin, D.A. Martynov, K.I Zaitsev, and	
K.P. Zakharkina Camera pose estimation based on structure from motion M.N. Alkhatib, A.V. Bobkov, and N.M. Zadoroznaya	138 146
Symbolic Padé representation of stabilizing regulators for a class of nonlinear control systems with a parameter Yulia Danik, and Mikhail Dmitriev	154
The main aspects of creating a system of data mining on the status of patients with Parkinson's disease Yulia Shichkina, Yulia Irishina, Elizaveta Stanevich, and Armando de Jesus Plasencia Salgueiro	161
Autonomous Wheels And Camera Calibration In Duckietown Project Kirill Krinkin, Konstantin Chayka, Anton Filatov, and Artyom Filatov	169
DBScan and WrapDBScan methods applying for intellectual variance analysis in employee's moving P.A. Savenkov, and A.N. Ivutin	177
Group control under conflict based on local threats and counter-threats method and swarm-leader model E.M. Voronov, V.A. Serov, and D.A. Kozlov.	185
Bit streaming processing algorithms for intelligent hardware converters O.I. Bureneva, M.S. Kupriyanov, and N.M. Safyannikov	194
Backpropagation method modification using Taylor series to improve accuracy of offline neural network training Anton Glushchenko, Vladislav Petrov, and Konstantin Lastochkin	202
Problematic aspects of integrating a complete group of processes in the lifecycle of robotic control systems S.V. Kozlov	210
Unmanned vehicle's control real-time method based on neural network and selection function Anna N. Daryina, and Igor V. Prokopiev	217
Reliable bounding of the implicitly defined sets with applications to robotics Artem D. Maminov, Mikhail A. Posypkin, and Sergey P. Shary	227
Data processing model for mobile IoT systems T.T. Aung, A.M. Thaw, N.A. Zhukova, T. Man, and V.V Chernokulsky	235
Comparison of action recognition from video and IMUs A.V. Podoprosvetov, A.P. Alisejchik, and I.A. Orlov.	242
Cognitive approach to analysis of regular packing of congruent objects on plane N.N. Klevanskiy, S.I. Tkachev, L.A. Voloshchouk, and V.S. Mavzovin	250
A neuro-evolutionary synthesis of coordinated stable-effective compromises in hierarchical systems under conflict and uncertainty V.A. Serov, E.M. Voronov, and D.A. Kozlov.	257
Neural network for grain yield predicting based multispectral satellite imagery: comparative study Z.H. Khalil, and S.M. Abdullaev	269
Comparative study of numerical solutions for the optimal control problem in the presence of uncertainties Askhat Diveev, and Elizaveta Shmalko	279
Development of a prototype of a medical information system for a clinical diagnostic center D.A. Andrikov, and A.S. Kuchin	287

iv

Convolutional neural networks emotion recognition and blink characteristics analysis for operator state estimation Oleg Korsun, and Vladimir Yurko	293
Structural and parametric synthesis of population algorithms for global optimization A.P. Karpenko, and I.A. Kuzmina	299
Homomorphic Encryption within Lattice-Based Encryption System Victor Kadykov, Alla Levina, and Alexander Voznesensky	309
Comparison of Hybrid ACO-k-means algorithm and Grub cut for MRI images segmentation S.A. El-Khatib, Y.A. Skobtsov, and S.I. Rodzin	316
Adaptive MPI collective operations based on evaluations in LogP model A.A. Paznikov, and M.S. Kupriyanov	323
Correction of an admissible control in a nonlinear perturbed problem with fixed ends Yu.S. Belinskaya, M.G. Dmitriev, and D.A. Makarov.	331
Optimizing regular computations based on neural networks and Graph Traversal O.T. Mohammed, M.S. Heidari, and A.A. Paznikov	337
The artificial intelligence influence on real sociality G. Malinetsky, and V. Smolin	344
Application of chaotic Fish School Search optimization algorithm with exponential step decay in neural network loss function optimization L.A. Demidova, and A.V. Gorchakov	352
The construction of local convex hull on the task of pattern recognition Kamilov Mirzoyan, Hudayberdiev Mirzaakbar, and Khamroev Alisher	360
Morphological model of self-similar multilayer neural networks A.Yu. Dorogov	366
Transfer Learning with Demonstration Forgetting for Robotic Manipulator Ermek Aitygulov, and Aleksandr I. Panov	374
Machine learning algorithm based on convex hull analysis A.P. Nemirko, and J.H. Dulá	381
Framing Artificial Intelligence (AI) Additive Manufacturing (AM) Bernhard Heiden, Volodymyr Alieksieiev, Matthias Volk, and Bianca Tonino-Heiden	387
Cluster Keyboard Handwriting Z.V. Ilyichenkova, and S.M. Ivanova.	395
Tracking of atmospheric phenomena with artificial neural networks: a supervised approach Mikhail Krinitskiy, Kirill Grashchenkov, Natalia Tilinina, and Sergey Gulev	403
Monotonicity of equilibriums in Cournot competition with mixed interactions of agents and epistemic models of uncertain market D.N. Fedyanin	411
Disrupting the Connectivity of Multiagent Peering Networks: a Model Study Yuri Monakhov, Anna Kuznetsova, Maria Gerasimova, and Ilya Kulikov	418
Hybrid Recurrent Traffic Flow Model with Artificial Neural Networks For Approximation of Unknown Urban Road Subnetworks Elena Sofronova, and Askhat Diveev.	426
Numerical simulation of the workspace of robots with moving bases in the multi-agent system Laxmidhar Behera, Larisa Rybak, Dmitry Malyshev, and Sergey Khalapyan	431
Real-Time Lidar-based Localization of Mobile Ground Robot Ilya Belkin, Alexander Abramenko, and Dmitry Yudin	440

A proposal for modeling cognitive ontogeny based on the brain-inspired generic framework for social-emotional intelligent actors A.V. Samsonovich, and A.A. Eidlin.	449
The principle of dividing feasible trajectories in a robot control problem V.A. Bereznev	456
Models for supporting the operating scenarios during a life cycle in automated systems V.P. Khranilov, P.V. Misevich, E.N. Pankratova, and A.E. Ermilov	460
<ul> <li>Tokamak plasma models development for plasma magnetic control systems design by first principle equations and identification approach</li> <li>Y.V. Mitrishkin, N.M. Kartsev, A.A. Prokhorov, E.A. Pavlova, P.S. Korenev, A.E. Konkov,</li> <li>V.I. Kruzhkov, and S.L. Ivanova</li> </ul>	466
Data mining techniques for electricity customer characterization Sérgio Ramos, João Soares, Samuel S. Cembranel, Inês Tavares, Z. Foroozandeh, Zita Vale, and Rubipiara Fernandes.	475
Dynamic and Information Properties of Intelligent Control Systems K.A. Pupkov, and Y.K. Brovarskaya	489
Analysis of the impact of visual attacks on the characteristics of neural networks in image recognition N.A. Andriyanov, V.E. Dementiev, and Yu.D. Kargashin	495
Development of a vision system for safe and high-precision soft landing on the Moon Xu Yang, and A.V. Bobkov	503
The modeling of forecasting new situations in the dynamics of the economic system on the example of several financial indicators N. Gabdrakhmanova, V. Fedin, B. Matsuta, and M. Pilgun	512
Modeling the dynamics of particles of gas-dust clouds in the photogravitational field of binary stellar systems A.T. Tureshbaev, and U.Sh. Omarova	521
A decision support system for DM algorithm selection based on module extraction T. Man, N.A. Zhukova, A.M. Thaw, and S.A. Abbas	529
Pre-launch AI matcher for distributed intelligent photo surveying Anton Ivaschenko, Arkadiy Krivosheev, and Pavel Sitnikov	538
Parkinson's Disease Classification and Medication Adherence Monitoring Using Smartphone-based Gait Assessment and Deep Reinforcement Learning Algorithm Armando de Jesús Plasencia Salgueiro, Yulia Shichkina, Arlety García García, and Lynnette González Rodríguez	546
Decentralized model predictive control for autonomous robot swarms with restricted communication skills in unknown environments Alexander Puzicha, and Peter Buchholz	555
Algorithmization of control of information and telecommunication systems based on the optimization model I.Ya. Lvovich, Ya.E. Lvovich, A.P. Preobrazhenskiy, and O.N. Choporov	563
The method of inductive synthesis of hierarchical knowledge graphs of telecommunication networks based on statistical data K.V. Krinkin, A.I. Vodyaho, I.A. Kulikov, and N.A. Zhukova	571
Continuous Wavelet Transform Applications In Steganography Vladmir Varuikhin, and Alla Levina	580
Control of network representation efficiency in neurogenesis M.A. Mitrokhin, N.V. Sleptsov, I.I. Kochegarov, A.V. Lysenko, and N.K. Yurkov	588

The constructing of cognitive functions ontology M.Sh. Murtazina, and T.V. Avdeenko	595
Creation of adequate simulation models to analyze performance parameters of a virtual fog computing infrastructure	
Margarita Ushakova, Yury Ushakov, Irina Bolodurina, Alexander Shukhman, Leonid Legashev, and Denis Parfenov	603
Adaptive robust control of a multi-degree-of-freedom mechanical plant with resilient properties Le Hong Quang, V.V. Putov, and V.N. Sheludko	611
An approach to identify the hidden patterns in the datasets for patients with the multiple chronic diseases L.A. Demidova, and N.V. Doroshina	620
Quadcopter active phased antenna array D.A. Milyakov, V.S. Verba, V.I. Merkulov, and A.S. Plyashechnik	628
A new two-step approach for solving a control system synthesis problem by symbolic regression methods S.V. Konstantinov, and A.I. Diveev	636
Solution of the optimal control problem by symbolic regression method A.I. Diveev, S.V. Konstantinov, and A.M. Danilova	646
Decision support systems configuration based on knowledge-driven automated service composition: requirements and conceptual model Andrew Ponomarev, and Nikolay Mustafin	654
Automatic Animal Behavior Analysis: Opportunities for Combining Knowledge Representation with Machine Learning Anna Zamansky, Aleksandr Sinitca, Dirk van der Linden, and Dmitry Kaplun	661
Secure-reliable smart contract applications based blockchain technology in smart cities environment Alexander A. Varfolomeev, Liwa H. Alfarhani, and Zahraa Ch. Oleiwi	669
Cognitive systems, artificial neural networks and differential equations: social media data N. Gabdrakhmanova, and M. Pilgun	677
Stratified model of self-similar multi-layer neural network A.Yu. Dorogov	685
Approaches to aircraft flight tests at high angles of attack O.A. Balyk, O.N. Korsun, and M.V. Zolotaeva	693
Coordination strategies in distribution network considering multiple aggregators and high penetration of electric vehicles	
José Almeida, João Soares, Bruno Canizes, and Zita Vale	698
Intelligent processing of open-ended questions in mass web-surveys Evgeny Nikulchev, Anastasiya Silaeva, Dmitry Ilin, and Sergey Malykh	706
Formulation and research of new fitness function in the genetic algorithm for maximum code coverage T.V. Avdeenko, K.E. Serdyukov, and Z.B. Tsydenov.	713
Comparison of Poisson process and machine learning algorithms approach for credit card fraud detection Anastasiia Izotova, and Adel Valiullin	721
Collision-aware formation assignment of quadrotors I.P. Titkov, and A.A Karpunin	727
Research on the possibility to apply vibration blurring of a round mark image in technical condition monitoring of moving mechanisms A.V. Grigoriev, I.I. Kochegarov, N.K. Yurkov, N.V. Goryachev, and N.S. Reuta	736
Variational analytic programming for synthesis of optimal control N.B. Konyrbaev, A.O. Dauitbayeva, A.B. Ostayeva, A.U. Yessirkepova, and A.B. Bexeitova	743

viii

Usage of natural balance mode in automatic trajectory control of aircraft with non-standard configurations I.V. Mironova, M.E. Savrushkina, and N.A. Chulin	751
Scissored pair control moment gyroscope inverted pendulum Stanislav Aranovskiy, Igor Ryadchikov, Nikita Mikhalkov, Dmitry Kazakov, Alexey Simulin, and Dmitry Sokolov	761
Real-time system architecture design practices Andrey Getmanskiy, Semen Sechenev, Igor Ryadchikov, Alexander Gusev, Nikita Mikhalkov, Dmitry Kazakov, Alexey Simulin, and Dmitry Sokolov	769
Development of a gaming application for a customized eight-processor device with a tangible interface Ilya V. Osipov, Simon Orlov, Ilya Egorushkin, and Evgeny Nikulchev	777
Parametric optimization of unmanned vehicle controller by PSO algorithm Anna N. Daryina, and Igor V. Prokopiev	787
Multicriterial analyses of Pareto-efficiency for collaborative multi-agent systems using genetic algorithm with variations	793
Vladimir Serebrenny, and Elizaveta Shmalko Evolutionary Computations for Traffic Signals Optimization Elena Sofronova	802