

2021 28th Saint Petersburg International Conference on Integrated Navigation Systems (ICINS 2021)

**Saint Petersburg, Russia
31 May – 2 June 2021**



**IEEE Catalog Number: CFP2133X-POD
ISBN: 978-1-6654-4191-9**

**Copyright © 2021, State Research Center of the Russian Federation - Concern
CSRI Elektropribor, JSC
All Rights Reserved**

****** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP2133X-POD
ISBN (Print-On-Demand):	978-1-6654-4191-9
ISBN (Online):	978-5-91995-080-6

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
E-mail: curran@proceedings.com
Web: www.proceedings.com

CURRAN ASSOCIATES INC.
proceedings
.com

TABLE OF CONTENTS

SESSION I – MOTION CONTROL

1. From the First Manned Mission into Space to the Permanently Manned Orbital Station...1
M.Yu. Belyaev, G.P. Anshakov
2. Motion control of spacecraft with low-thrust engines for a flight to a Near-Earth asteroid...12
E.A. Sergaeva, O.L. Starinova
3. Development of a Single-Axis Control Law Based on SDRE-Technology for Inspection Motion of Two Nanosatellites...16
I.V. Belokonov, M.S. Shcherbakov
4. Pulse Correction of a Trajectory of a Gyrostat-Nanosatellite with an Electrothermal Propulsion System: Probabilistic Analysis...20
L.I. Sinitsyn, I.V. Belokonov
5. Modern problems of WIG-craft navigation and flight control...24
A. Nebylov, V. Nebylov
6. Development of an integrated system of onboard equipment to provide trajectory control of a small unmanned aerial vehicle...27
X.Y. Hu, V. Perliouk, A. Nebylov
7. Study of Resonant Modes of Motion of a Cubesat Nanosatellite with Small Inertia-Mass Asymmetry under the Aerodynamic Moment...31
E.V. Barinova, I.V. Belokonov, I.A. Timbai
8. Algorithms for UAV Flight Control Along a Given Path Based on Guiding Vector Field...36
D. Kostygin, A. Popov
9. Guidance and Control of a Space Robot at Additional Launching and Approaching an Information Geostationary Satellite...39
Ye. Somov, S. Butyrin, S. Somov
10. Search for Optimal Propellant Cyclograms of Jet Engines Firing for Large-Sized Spacecraft Reorientations...43
A.A. Prut'ko

SESSION II – INTEGRATED SYSTEMS

11. New Strapdown Airborne Gravimetry Algorithms: Testing with Real Flight Data...46
V. Vyazmin, A. Golovan, Yu. Bolotin
12. Yaw aided Radar Inertial Odometry using Manhattan World Assumptions...53
C. Doer, G. F. Trommer
13. Algorithms for fast computation of navigation parameters of mobile objects by the SNS signals...62
A. Prohortsov, V. Smirnov, O. Minina
14. Integrated Navigation System with Spaced Accelerometers...65
A. Prohortsov, N. Yudakova
15. Comparison of Navigation Accuracy of Pedestrian Navigation for Several Aiding Algorithms...67
Yu. Bolotin, A. Bragin
16. Vision–IMU Integrated Vehicle Pose Estimation based on Hybrid Multi-Feature Deep Neural Network and Federated Filter...71
Xu Qimin, Chang Bin, Li Xu, Liu Xixiang, Tian Yuan
17. Adaptive-robust Methods for Detecting, Capturing and Tracking Hovering, Low- and High-speed Objects in Integrated Radar-Inertial Systems with Quasi-continuous Radiation...76
V. Kovregin, G. Kovregin
18. Method for autonomous navigation based on integrated inertial and opto-electronic measurements...80
A. Savkin, D. Antonov, E. Chekhov, L. Kolganov
19. A Loose Integrated Positioning Method of Longwall Shearer Assisted by INS and Laser Scanner...83
Jiangtao Zheng, Sihai Li, Qiangwen Fu
20. Algorithm for Planning an Informative Route for Map-Aided Navigation...87
O.A. Stepanov, A.S. Nosov
21. Developing and Assessing the Airborne Integrated Data Processing Characteristics from Inertial and Radio-Technical Systems in Flight and Navigation System...92
E. Kharin, I. Kopylov, E. Falkov, V. Kopelovich, L. Bardina, A. Yakushev, A. Zhabin, A. Makarova

22. Map-Aided Automotive Dead-Reckoning using Rao-Blackwellized Particle Filter...97
A. Mikov, R. Voronov, A. Moschevikin
23. Odometer-Aided Ultra-Tight GPS/MIMU Integration for Land Vehicle Navigation in Urban Canyons...108
Shiming Liu, Sihai Li
24. GNSS Landing System on a mobile platform with MEMS sensors...116
K.B. Amelin, G.G. Negreskul, A.R. Bestugin, A.A. Rogova, I.A. Kirshina, P.A. Semenov
25. Integration of a Sun light Polarization Camera and Latest-Generation Inertial Sensors to Support High Integrity Navigation...120
C. Conte, G. de Alteriis, F. De Pandi, R. S. Lo Moriello, G. Rufino, D. Accardo
26. Object Detection on Thermal Images for Unmanned Aerial Vehicles Using Domain Adaption Through Fine-Tuning...128
J. Rauch, C. Doer, G.F. Trommer
27. Human Internal Organs Diagnostics based on Heart Biophysical Signals...132
V.M. Achi'ldiev, Yu.N. Evseeva, Yu.K. Gruzevich, N.A. Bedro, M.A. Basarab, V.M. Uspenskiy, N.S. Konnova
28. On the Estimation Of Subspaces Dimensionality in the Correlation Analysis of Signals Received and Processed by a GNSS Digital Antenna Array...136
A.V. Nemov, D.Yu. Tyuftyakov
29. On the Estimation of the Measurement Accuracy of Satellite Navigation Systems Using Dynamic Recursive Correction...140
A.V. Telný
30. GNSS Signal Tracking Algorithm with Data Reduction...144
A. Kumarin , I. Kudryavtsev, S. Shafran, V. Grechishnikov
31. Small Satellite Formations: Challenges in Navigation and its Application Potential...148
K. Schilling
32. Comparison of GNSS Solution Errors Using an Atomic Clock or Crystal Oscillator...152
V. Pudlovsky
33. Correction of the Navigation System of a Re-entry Spacecraft after External Sensors are Disabled...161
M.S. Selezneva, A.V. Proletarsky, K.A. Neusypin
34. Simulation of Self-Consistent Transformants for the Anomalous Gravity Field at Local Regions...165
A. Sholokhov, S. Berkovich, N. Kotov

35. Method for Integrating Measuring Systems of a Space Unmanned Aerial Vehicle...169
M.S. Selezneva, K.A. Neusypin, Truong Xuan Pham
36. Development of Intelligent Control Architecture for Multi-Tracking Surveillance Systems...172
I. Olusegun Lawal, S. Olusegun Sholiyi, A. Nebylov
37. Algorithm of Determining the Spatial Orientation of Noncooperative Space Object Based on Processing of a Sequence of Stereo Images...177
S. Simakov, I. Belokonov
38. Development, Tuning and Testing of a New Small-Sized Integrated Navigation System...181
A.B. Tarasenko, A.A. Fomichev, P.V. Larionov, A.B. Kolchev, P.V. Filatov, E.A. Milikov
39. Ground Uniaxial Wheeled Modules for Transportation and Angular Orientation Control of Environmental Monitoring Equipment...188
B. S. Aleshin, K. S. Lelkov, T. S. Khorev, A. I. Chernomorsky, V. V. Miheev, E. D. Kuris, V. A. Petruhin
40. Integration of atom interferometers and inertial measurement units to improve navigation performance...195
B. Tennstedt, S. Schön
41. Error Estimation of a Strapdown Inertial Navigation System Based on the Results of Road Sign Recognition in a Multidimensional Optical Geophysical Field...204
R.R. Bikmaev

SESSION III – INERTIAL SYSTEMS AND SENSORS

42. Inertial Navigation and Geophysical Invariants...211
A.V. Chernodarov, A.P. Patrikeev, A.P. Patrikeev
43. Estimation of Generic Parameters in a Technique for Initial Alignment and Calibration of INS for Space Launch Vehicles...219
L. Belsky, L. Vodicheva, Yu. Parysheva
44. A Method for Calibration of Medium-Accuracy Strapdown INS...223
A. Prokhortsov, A. Soloviev, V. Smirnov
45. The Performance Evaluation of Gravity and Zero Velocity Measurement Based Field Calibration Methods Applicable for Various Grades of Inertial Sensors...226
L. O. Yaman
46. Test bench calibration of an accelerometer unit with scale factor errors depending on input signal signs...230
G.O. Barantsev, A.A. Golovan, A.I. Matasov, P.V. Alyunov, A.Yu. Mishin, D.M. Fomin

47. Determining Permissible Levels of Frequency Characteristics of Measuring Channels in a Strapdown Inertial Navigation System...233
A.A. Fedotov, S.Yu. Perepelkina
48. A Method for Autonomous Determination of a Vehicle's Latitude and Longitude...237
V. Avrutov, O. Nesterenko
49. Adaptive Robust Processing of Inertial Sensor Signals...240
A.V. Chernodarov, P.S. Gorshkov, A.P. Patrikeev
50. Initial Alignment of Swing Base Based on Parameter Identification Method without Latitude...243
Y. Tian, N. Li, G. M. Yan, Z. S. Yu
51. The Results of Estimating the Accuracy of Azimuth Determination by Ring Laser Gyroscopes...248
D.A. Burov
52. Specific Features of Using Micromechanical Accelerometers for Monitoring Short and Impact Irregularities of the Railway Track...251
A. Bolshakova, L. Podgornaya, A. Tkachenko, D. Larionov, R. Shalymov, A. Boronachin, E. Bokhman
53. A Reliable Fault-Tolerant Estimation Method of Roll State for Tank Semi-trailer based on Inertial Measurement...254
Wei Kun, Li Xu, Liu Xixiang, Ni Peizhou, Li Xiaonan
54. Enhancing CubeSat Active Magnetic Attitude Control based on the results of the Ground Tests...261
N. Abdelrahman, A. Annenkova, D. Ivanov, D. Pritykin
55. Human Respiration Measurement System...265
A. Prohortsov, V. Smirnov, M. Prohortsova
56. Reduction of the Shupe Effect in Fiber Coil Based on Turn Number Optimization...267
Xu-dong Hu, Wei Hong, Pei Zhang, Hong-gang Chen, Wei Jiang, Bo Huang, Shao-feng Lou, Jian-qing Wang, Han-rui Yang
57. A Real Time Gravity Compensation Method for High Precision INS Based on Neural Network...272
Duanyang Gao, Xu Lyu, Fangjun Qin, Lubin Chang, Baiqing Hu
58. Identification of the Model Parameters for a Damped Gravimeter...277
A. Motorin, O. Stepanov, A. Sokolov, A. Krasnov
59. Estimation of Errors in Modern Information and Measurement Systems under Real Operating Conditions Using the Frequency Method...281
D.M. Kalikhman, E.A. Deputatova, D.S. Gnusarev

60. Self-Gradient Calculation Method of Gravity Gradiometer Platform Based on Finite Element...286
Da Li, Hongwei Gao, Hongguang Liu, Wei Wang, Li Li
61. Method for Determining the Stability Regions of Stationary Oscillations of a Nonlinear MEMS Resonator under the Action of Phase-Locked-Loop and Automatic Gain Control Systems...292
A.V. Lukin
62. Inertial Navigation and Control of a Space Robot for Servicing a Geostationary Satellite...295
Ye. Somov, S. Butyrin, S. Somov
63. Multifrequency Solid-State Ring Laser Gyroscope Based on YAG:Cr⁴⁺ ...300
Yu.Yu. Broslavets, D.M. Ambartsumyan, V.G. Semenov, A.A. Fomichev, E.A. Polukeev
64. New Four-Frequency Zeeman Laser Gyroscope with a Nonplanar Symmetric Cavity, its Parameters and Operation...308
Yu.Yu. Broslavets, E.A. Milikov, A.B. Tarasenko, P.V. Larionov, V.G. Semenov, P.A. Filatov, E.A. Polukeev, A.B. Kolchev, A.A. Fomichev, A.I. Varenik, A.D. Morozov
65. Methods for Studying Temperature Characteristics of a FOG Sensing Coil...316
D. Smirnov, I. Deyneka, A. Kulikov, V. Strigalev, I. Meshkovsky
66. Polarization-Maintaining Germanosilicate Waveguide with Elliptical Core for Fiber-Optic Gyroscopes...318
D.R. Devetyarov
67. Dissipative and Conservative Backscattering in a Laser Gyro Ring Cavity...320
E.A. Petrukhin, A.S. Bessonov
68. Elastic Dynamic Torsion of a Ring Laser Gyroscope Mechanical Dither and its Effect on the Accuracy of Attitude Determination...324
G.O. Barantsev, A.V. Kozlov, I.Kh. Shaimardanov, A.V. Nekrasov
69. Simulation of the Dither Parameters Measuring Provided by the Optoelectronic System for a Laser Gyro under the Influence of Real Disturbances...328
A.A. Aviev
70. Studying the Accuracy Characteristics of Q-flex Accelerometers for Modernization of SINS...331
P.A. Filatov, V.G. Semenov, A.B. Tarasenko, A.D. Morozov, A.A. Fomichev, E.A. Milikov, A.I. Varenik
71. Investigation on the Optimal Fixation Condition of Cylindrical Resonators...334
Y. Pan, Y. Tao, L. Zeng, X. Tang, K. Yang, H. Luo

72. Gyrostabilizer with an Increased Controlled Precession Rate Based on a Gyroscope with a Spherical Ball Bearing Suspension...337
V.Ya. Raspopov, R.V. Alaluev, S.I. Shepilov, V.V. Likhosherst
73. Study of the Effect of Introducing a Computer Model of Translational Motions and Negative Feedback Loops to the Three-Component Gyroscopic Angular Rate Meter Based on Kovalevskaya Gyroscope...341
P. K. Plotnikov
74. Development of Digital Angle Measuring Technologies Based on the Use of Two-Dimensional Scales for Metrological Support of Navigation Systems...344
A. Korolev, A. Lukin, E. Bokhman, P. Pavlov, P. Ivanov, Yu. Filatov
75. Computer-aided synthesis of a pendulum accelerometer correction circuit...348
V.M. Nikiforov, A.S. Anokhin, K.A. Andreev, B.D. Chernyshev, A.A. Gusev, A.A. Nizhegorodov, A.D. Vorona
76. A Method for Measuring the Lock-In Zone in Laser Gyro Sensors...352
I. Khokhlov, A. Sinelnikov
77. The Impact of Nonlinearity and Frequency Difference on the Drift of the Solid-State Wave Gyroscope in the Angular Velocity Sensor Mode...355
A.A. Maslov, I.V. Merkuriev, D.A. Maslov, V.V. Podalkov
78. Parameter Estimation of the Solid-State Wave Gyroscope on the Basis of the Neural Network Autoregression Algorithm for Time Series Prognosis...359
M. Basarab, I. Ivanov, B. Lunin

SESSION IV – RELEVANT ISSUES OF THEORY

79. Inertial Navigation by the Trident Quaternion...362
Wei Ouyang, Yuanxin Wu
80. New quaternion models of spaceflight regular mechanics and their applications in the problems of motion prediction for cosmic bodies and in inertial navigation in space...370
Yu.N. Chelnokov, M.Yu. Loginov
81. Quaternion Algorithm for Mathematical Initial Alignment of Strapdown INS on a Fixed Base Using Tikhonov Regularization...374
A.V. Molodenkov, Yu.N. Chelnokov, S.E. Perelyaev
82. Analysis of Motion Equations and Some Properties of the Corrected Strapdown Computer-Aided Gyrocompass...378
P. K. Plotnikov, A. P. Plotnikov
83. Theory of the Van der Pol Two-Degree-of-Freedom Oscillator: Technical Applications to Modern Solid-State Wave Gyros...383
S.E. Perelyaev, V.Ph. Zhuravlev, B.P. Bodunov, S.B. Bodunov

84. GNSS-Based Continuous Estimation of Speed Using the Smoothing Splines with an A Priori Uncertain Smoothing Parameter...387

D.A. Koshaev

85. Multicriteria Optimization of the Trajectory Tracking Filtering Procedure by Genetic Algorithm...393

D.A. Bedin, A.G. Ivanov

86. Application of the Gradient Projection Method to the Problem of Sensors Arrangement for Counteraction to the Evasive Object...397

A. Galyaev, A. Samokhin, M. Samokhina

87. Adaptive Estimation of the Processes Having Disorders in Navigation Applications Using Machine Learning...400

O.S. Amosov, S.G. Amosova

88. Nanoscale Inertial-Sensor Elements. Numerical and Analytical Modeling of Motion...404

M.A. Barulina, S.A. Galkina, D.V. Kondratov, O.V. Markelova

89. General Theory of NEMS Resonators in the Form of Nanobeams and Nanoplates...407

I.V. Papkova, A.V. Krysko, V.A. Krysko

PANEL DISCUSSION: Motion Control of Moving Objects

90. Motion control and navigation problems in interplanetary missions based on small spacecraft...411

M.Yu. Ovchinnikov

91. Resolving the Navigation and Control Problems of Payload Insertion into a Geostationary Orbit on the Basis of the Modern and Potential GNSS Technologies...419

D. Kozorez, M. Krasilshchikov, D. Kruzhkov

92. Navigation and Control Problems in Precision Farming...427

L. Rapoport, A. Generalov, M. Shavin, T. Tormagov

93. The problem of studying the maximum error in solving the motion control problems...435

A.V. Nebylov