**"Gyroskopiya i Navigatsiya" №2, 2007**

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| The paper presents the development results for solid-rotor electrostatic gyro and an attitude reference system, based on this gyro, for spacecrafts of the Earth remote sensing. Some results of the attitude reference system flight tests aboard two types of spacecrafts are presented. The algorithm of spacecraft attitude determination is based on the methods of drift compensation using a physical model with coefficients calculated at the bench, as well as using constant corrections, calculated periodically by the data about accumulated errors of the attitude control system between stellar updates. It is shown that errors of relative orientation of the bases of the attitude reference system and star sensor are determinants in estimation of gyro drift parameters. Besides, the necessity to refine the drift model and introduce a special calibration mode is revealed. | |  |

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| Issues of planning and checking of computations in the integrated navigation system are considered. Suboptimal planning algorithm for real time computation process, which takes peculiarities of the integrated navigation system into account and virtually does not require enumeration of possibilities, is offered. Results of its efficiency investigation on the basis of random case generation are presented. Functional capabilities of the information system implementing software support for planning and checking procedures of computation process in the integrated navigation system are described. As this takes place, computation process checking can be performed both in real time mode and in postanalysis mode using the specialized expert system shell developed by the authors. | |  |

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| **J. Metzger, A. Maier, G.F. Trommer** | **Comparison of modular and centralized terrain referenced navigation filters** | **24** |
| The measurement equation of a terrain referenced navigation (TRN) system is non-linear because of the influence of a reference map connecting position and terrain height. It is possible to design different navigation filters that process radar altimeter measurements based on this measurement equation. The first proposed system is based on an extended Kalman, the second on a sigma-point, the third on a bootstrap, and the fourth on a modified particle filter. The first and second filter approximate the state probability density function by a Gaussian distribution, while the third and fourth filter allow a more general density estimation by particles. All four systems can be used as central navigation systems processing radar height measurements and estimating position, velocity, and attitude. Especially for both particle filters the system performance is not ideal, because of the weak observability of the velocity and attitude states. In another situation where the TRN-system has to be separated from the central navigation a setup with a central Kalman filter and a terrain referenced navigation module with a reduced state space is proposed. Compared to the central TRN filters the overall accuracy of the modular filter is reduced due to the separation of the non-linear TRN-module and the linear central navigation. Anyhow, because of the reduction of the state space the modular particle filters can gain robustness and achieve similar accuracy than the central systems. | |  |

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| In this presentation a version of control scheme is proposed in which signals compensating frequency diversity are added to traditional control signal. Compensating signals are calculated by means of the integration of control signals multiplied by some trigonometry functions of angle of wave orientation. In this case the level of dynamical errors appearing in traditional scheme when wave orientation in resonator is changed can be decreased significantly. Tests on real system have proved efficiency of proposed control loop. | |  |

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| **A.P. Kolevatov, S.G. Nikolaev, A.G. Andreyev, V.S. Ermakov, D.A. Dunayev, O.L. Kel, N.V. Malgin** | **Development of a dual mode attitude and heading reference system on three-component fiber optic gyros** | **43** |
| Dual mode Attitude and Heading Reference Device (DGGKU) is designed for output of orientation angles in gyrocompass mode and in directional gyro mode. DGGKU is configured as a strapdown Inertial Navigation System. It includes three rate sensors with three axes fiber optic gyroscopes BVOG 120/3 and three accelerometers A-15. Both sensors are manufactured by Perm Scientific-Industrial Instrument Making Company (JSC PNPPK). BVOG 120/3 characteristics are showed in the page 45. DGGKU is an integral unit that contains Inertial Measurement Unit and airborne computer in one casing. Airborne computer is made on TMS320VC33 processor. Algorithm structure follows operating modes of the system: initial alignment, operation. Algorithm of initial alignment is divided into three stages: coarse leveling, fine leveling and fine gyrocompassing. Algorithms of operation mode provide heading angle storage on the vehicle move and gyrocompass alignment on steady platform. DGGKU passed laboratory tests in the test benches of PNPPK and mobile laboratory arranged on automobile GAZ 66. Results of Tests are in Table 3. During bench tests heading determination error in gyrocompass mode did not exceed +/-0,18 sec \phi. | |  |

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| **Jozef Sofka, Victor Skormin** | **Optical platform stabilization using the omni-wrist robotic manipulator Omni-Wrist III** | **52** |
| The utilization of the benefits of the laser beam as a communications medium is complicated by the inherent strict requirements on agile and accurate steering of the laser beam over a wide angular range. The Pointing, Acquisition, and Tracking (PAT) system is required to compensate for the vibrations applied to the optical platform while the vehicle carrying the optical instrumentation navigates through rough terrain. The degradation of the performance of the communication system is mitigated through the proper application of advanced control laws. A feedforward vibration rejection control system presented in this paper utilizes a set of inertial navigation sensors to measure the optical platform orientation disturbance and calculates the control effort that drives the actuators of the Omni-Wrist III, a novel singularity-free full-hemisphere-range robotic manipulator. The signals from the inertial navigational unit, consisting of a 3-axis gyroscope, 3-axis accelerometer, and a 3-axis magnetic sensor, are "fused" to form a quaternion representation of the orientation of the optical platform. This paper presents the development of an Extended Kalman filter "fusing" the inertial navigation sensor data, the design and implementation of the disturbance rejection control system, as well as the results of the experimental evaluation of its performance in which the system is subjected to vibrations spectra representing the navigation of the Humvee in difficult terrain. | |  |

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| **M.B. Bogdanov, A.V. Prokhortsov,V.V. Savelyev, V.A. Smirnov, B.V. Sukhinin, A.A. Chepurin** | **Integrated attitude determination and navigation system for highly-maneuverable aircraft with short flight time** | **115** |
| Taking into account the novel solutions the mathematical model of an integrated navigation system is elaborated. The model includes the strapdown system, the satellite navigation system, the conjunction and estimation unit and the trajectory of flight submodels. Algorithms for computation of navigation and orientation parameters of highly-manoeuvrable airborne vehicle with short flight time (several minutes) are proposed on the basis of the elaborated model. When discussing strapdown system it is considered in the article that moderately priced sensors are used. Correction of strapdown system output signals can be made in real time by means of satellite navigation system data while one or more navigational satellite signals are available. It is possible to vary the overall accuracy of the system according to the design by means of changing the composition of retrieved from satellite navigation system data. Obtained results are confirmed by computer modeling. | |  |

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| **Yu.B. Podchufarov** | **Use of satellite navigation aids in military equipment control** | **125** |
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**Information**

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