**"Gyroskopiya i Navigatsiya" №1, 2002**

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| The current trends in the world market of equipment for Global Navigation Satellite Systems (GNSS) users are analyzed. The state of the art and problems of GNSS GLONASS are discussed in the context of the world trends in the development of user mass equipment. It is concluded that the special Federal program "Global navigation system" approved by the Russian govern-ment in 2001 takes proper account of the present-day trends in the development of user equip-ment, provides the basis for advancement and integration of the GLONASS system into the world market of GNSS. |  |

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| **L.P. Nesenyuk** | **Strapdown inertial systems. A review of the state-of-the-art and prospects for the development** | **13** |
| The article considers the main tendencies in the development of strapdown inertial systems (SINS) in the last two decades. Two major problems that made possible high accuracy SINS for aviation as well as other applications have been solved to advantage in this period: creation of navigation accuracy class gyroscopes suitable for SINS and a high-speed onboard computer with sufficient memory. The first problem was solved due to the advent of laser gyros, the second - owing to the onrush of computer aids. In the recent years much of the progress in this field stems from the integration of SINS and the receiving equipment of the global satellite navigation systems GPS and GLONASS. The review of the state-of-the-art and immediate prospects for the SINS development in Russia and abroad shows that the latest elaborations are aimed at improving their operational charac-teristics and reducing costs rather than increasing accuracy. It is anticipated that the advance in this direction will be connected with the use of fiber-optic and micromechanical gyros. |  |

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| **O.A.Stepanov** | **Integrated inertial-satellite navigation systems** | **23** |
| The paper is a review of integrated inertial satellite navigation systems. Various designs of sys-tems are considered and compared, their peculiar features are discussed. Considerable attention is given to the specific ways of determining attitude in integrated systems. The experience of leading firms accumulated in the development and application of various integrated inertial-satellite systems is analyzed. Besides separate publications that appeared in this field in the last few years, the author makes use of the materials of the digest "Integrated inertial-satellite navigation systems" issued by the SRC RF - CSRI Elektropribor, St. Petersburg, 2001 [1]. |  |

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| **Yu.S.Aleksandrov** | **Calculation of radial deviation quantiles under normal and close to normal dissipation on the plane** | **46** |
| The following formula is proved for calculation of any order *P* quantile *R* of the radial deviation of points, which have Gaussian unbiased scattering on the plane*R=(0.5 Sp Q)1/2 u(0,P) k( , P),*where *Sp Q* is the trace of the correlation matrix *Q* of the two-dimensional vector of the deviation, *u(0,P)=[-2 ln(1-P)]1/2* is the order *P* quantile of the square root from a random variable, which has the 2-distribution, *k( , P)* is the function of *P* and =[1-4|*Q*|(*Sp Q*)-2]1/2 , |*Q*| is the determinant of the *Q*. The function *k( , P*)1 when =0. In this case the deviation of the points has the circular normal distribution and the formula obtained takes the form of the known one. The table of function *k( , P*) for the other values of **  and *P* is given. It permits obtaining initial approximations for *R*. The approximate formula for the quantile *R* is deduced when the distribution deviates from the normal one. The results may be used to derive guidance and navigation accuracy estimates. |  |

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| **S.G.Kucherkov** | **Determination of the required vacuum level in the operation cavity of a micromechanical gyro oscillator** | **52** |
| In the conditions of limited force resources of the drive for primary oscillation excitation, the sensitivity of the micro-mechanical gyroscope (MMG) essentially depends on the oscillator Q-factor realized in the structure of the device. First of all, the Q-factor value is determined by aero-dynamical interaction between the oscillator and environment. As a rule, the MMG oscillator is placed in a hermetic vacuum-processed housing. The choice of the necessary vacuum level is one of the design problems that affect the accuracy characteristics and the cost of the device. There are practically no publications devoted to Q-factor design estimation depending on the vacuum level for micro-mechanical oscillators. The results of the analysis and statistical estimation are presented in the paper for experimentally obtained dependences of Q-factor from the environment pressure for single-type silicon micro-oscillators of different structures. It is shown that Q-factor of no less than 104 can be ensured only if the environment pressure in the operation cavity of the device does not exceed 0.01 Torr. Obtaining the level of Q≥105 in real MMG structures is problematic because of the internal friction impact and interaction of alternating electric fields. |  |

**Papers Presented at the 8th Saint Petersburg International Conference
on Integrated Navigation Systems**

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| **V.G.Peshekhonov, L.P.Nesenyuk,L.P.Staroseltsev, B.A.Blazhnov, A.S Buravlyov** | **A fiber-optic gyrocompass and attitude reference system with sensory package rotation** | **57** |
| The paper considers the configuration and the first test results of a Fiber-Optic Gyrocompass and an Attitude Reference System with sensory package rotation. The sensory package was set rotating in the System as the performance of the gyroscope used does not meet the strict requirements for the North Finder gyroscope. Besides three fiber-optic gyroscopes VG 951 and three pendulous-rebalanced accelerometers AK 10/4, the rotating package also includes a set of PC-104 electronic digital boards that form the system microcomputer. This package is mounted on the rotating table with a gearless servo drive controlled by the microcontroller connected to the microcomputer through a serial port. The first test results have verified the heading accuracy that was previously evaluated by computer modeling of the System. |  |

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| The navigation system of the HUGIN series of autonomous underwater vehicles is presented. Both inertial sensors and aiding sensors are described. Particular attention is paid to the acoustic positioning system (DGPS-Ultra Short Baseline). The Kalman filter equations used in HUGIN are shown. The problems caused by delayed measurements arriving out of sequence with other measurements are discussed. A solution to these problems is presented. The achieved accuracy of this system is documented. |  |

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| **G. Elkaim, B. Parkinson** | **System identification for precision control of a GPS-autonomous catama** | **75** |
| An autonomous catamaran, based on a modified l'rindle-19 day-sailing catamaran wax built to test the viability of GPS-based system identification for precision control. The catamaran was fitted with several sensors and actuators to characterize the dynamics. Using an electric trolling motor, and lead ballast to match all-up weight, several system identification passes were performed to excite system modes and model the dynamic response. LQG controllers were designed based on the results of the system identification passes, and tested with the electric trolling motor. Line following performance was excellent, with cross-track error standard deviations of less than 0.15 meters. The wing-sail propulsion system was fitted, and the controllers tested with the wing providing all forward thrust. Line following performance and disturbance rejection were excellent, with the cross-track error standard deviations of approximately 0.30 meters, in spite of wind speed variations of over 50% of nominal value. |  |

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| **U. Schreiber, M. Schneider, A.Velikoseltsev, G.E.Stedman, W.Schluter** | **Very large ring lasers** | **88** |
| Ring lasers are widely used in inertial navigation and motion control systems. They have been greatly improved over a last decades and can provide accurate measurements with high bandwidth. However a precise measurement of fluctuations of earth rotation in geodesy and geophysics with inertial sensors is not yet possible because of their insufficient resolution and stability. Ring lasers with a large enclosed area have the potential to be used for that purpose. The successful construction of C-I ring laser (area of 0.775 m2) has shown that it is possible to build and operate large ring laser gyros. The next well engineered instrument C-II with an area of 1 m2 demonstrated the mechanical requirements for a stable operation, and the successfully built prototype for an even larger ring G0 finally proved that it is possible to operate a ring laser with at least 14 m length of cavity as a gyroscope in the monomode regime. Thus an instrument suitable for geophysical applications can be constructed. The concept and design of such a large ring laser is considered and the results obtained so far are discussed in this paper. |  |

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| **M. Malicorne, M. Bousquet, V.Calmettes, C. Macabiau** | **Effects of masking angle and multipath on Galileo performances in different environments** | **96** |
| Over the past few years, many applications of satellite navigation systems have been developed. Among the wide range of applications of such systems, transportation in urban environment seems to be one of the most prominent. Hence it is important to fully and accurately characterize the receiver performance for this application. The urban environment is characterized by high masking angles and the presence of a great number of obstacles which produce multipath. Investigating the receiver performance in this medium requires a model of the wave propagation. In this paper, a ray launching simulation tool is used to characterize different environments and the receiver errors due to multipath and the receiver performance with and without augmentation are evaluated. |  |

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| **P.Krauss, S.Berberikh, A.Bochkovsky, N.Mikhailov** | **Development of Galileo navigation signals receivers** | **108** |
| Although the structure of the Galileo signal is still under investigation, Astrium GmbH (Munich, Germany) together with Soft Nav Ltd. (St.Petersburg, Russia) developed an experimental navigation receiver with which it is possible to verify different signal design concepts and to demonstrate their properties in hostile environments (jamming, noise, interference). In a first step, the experimental receiver has been designed to process one channel with different chip rates (1 to 10 Mcps), code lengths (1 k to 10 k), PRN codes (M-sequences, Gold codes, Kasami codes) and data bit rates (50 to 3000 bit/s). In a second step, the capabilities of the receiver are extended to process several channels, higher chip rates up to 16 Mcps and code lengths up to 16 k. Furthermore, BPSK modulation is extended to QPSK in each channel. Signal processing for the receiver is based on Astrium's space qualified Mosaic technology. Using experience from Astrium-Soft Nav spaceborne GPS receivers, main parts of signal processing such as code and carrier generation, carrier correlation, signal tracking and data extraction has been implemented in software to ensure easy adaptability to future navigation signals. Signal preprocessing and generic code correlation is implemented in hardware to decrease processor load. Digitalization and final down-conversion of the navigation signal is carried out at an IF of 70 MHz. A test-bed including a programmable navigation signal generator to measure the performance has been set up. Testing of the first single-channel receiver version showed proper operation of the prototype receiver and identified potential for further optimization. The next version of the receiver, which currently under development, is the multichannel receiver. It will be used in the GAFLEX program - Galileo Flight Experiment - during which it is planned to deploy an experimental flexible Galileo signal transmitter on-board a modified GLONASS satellite. On-ground reception of the signal and assessment of its options' potency will be performed with the next version of the described receiver. The investigations were partially funded by INTAS (project 994-0672). |  |

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