**"Gyroskopiya i Navigatsiya" №2, 2003**

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| **M.I.Evstifeev, A.A.Untilov** | **The requirements to manufacturing accuracy for elastic suspension of a micromechanical gyro** | **24** |
| Requirements for manufacture precision of micromechanical gyroscope (MMG) torsion suspension were derived under various relations of natural frequencies - without resonant tuning and with resonant tuning in case of low and high quality factors. For first relation it is necessary to ensure resonance absent by frequencies misalignment in variable environment conditions. For resonant tuning devices it is necessary to use electrical frequencies tuning system due to manufacture impossibility of torsion suspension elements with tolerances of micrometer thousandth.  Technological tolerance calculation method of torsion suspension parts with use of finite element analysis was suggested. Voltage assessments of frequencies tuning system were realized. Voltage maintenance precision was defined for MMG with low and high quality factors. | |  |

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| **V.V.Chikovani, Yu.A.Yatsenko, V.A.Kovalenko** | **Test results for the first batch of Coriolis vibratory gyros and analysis of their performance** | **32** |
| The performance characteristics of the first batch of commercial Coriolis vibratory gyroscopes with metallic cylindrical resonator (CVGs), developed and produced in the Ukrainian Center for Optical Instrument Technology, are presented in this work. The first batch consists of three gyros: two gyros have a 22 mm-diameter resonator and one - 17 mm. The gyros have fully analog electronics, and an output signal is presented as voltage proportional to angular rate being measured.  The analysis of basic parameters of the first-batch CVGs showed that they are slightly worse by dimension, weight and level of random noise, than the same-grade gyros (including fiber optic and micromechanical ones) produced by the countries leading in this field of technology, but in terms of bias drift, temperature sensitivity, scale factor stability and non-linearity they are on a par with them.  As a result of the first-batch gyro drawbacks analysis, their elimination and some planned improvements, the next CVGs batch is going to have dimensions Ø50x45 mm, mass of no more than 80 g, power consumption less than 1 W and bias drift from 1 to 10 deg/h. | |  |

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| **Ya.I.Binder** | **Analytical compassing in slim hole inclinometry** | **38** |
| The paper considers the gyrocompassing process for measuring parameters of small-diameter horizontal well path. Shown for the first time is the possibility to use an incomplete (two-axis) circuit of measuring the Earth rotation angular rate using angular velocity transducers. Limits of two-axis circuit application are determined. Its errors are estimated, including errors in limiting modes. | |  |

**Materials of the 9th Saint Petersburg International Conference  
on Integrated Navigation Systems**

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| **B.Eissfeller, C.Kreye, D.Sanroma, T.Luck** | **Development and performance analysis of a tightly coupled GNSS/INS system** | **47** |
| Apart from space and control segment the GNSS performance depends on several parameters, e.g. signal properties, multipath conditions, signal interruptions, signal-to-noise ratio, dynamics and receiver errors like thermal noise and oscillator instabilities. The impact of these influences are based on the behaviour of the Phase Lock Loop (PLL) and the Delay Lock Loop (DLL) implemented in the GNSS receiver. To guarantee availability of a precise navigation solution the loop errors have to be significantly lower than the lock thresholds.  The first part of the paper presents investigations about the interaction of loop bandwidth, signal-to-noise ratio, accelerations, oscillator Allan variance and oscillator vibrations. In order to decrease the influence of receiver noise the tracking loop bandwidth has to be reduced. Consequently under high dynamic conditions or in a jamming environment the dynamics of the pseudoranges have to be removed from the loop signal to keep them in lock.  If the vehicle dynamics on the other hand is measured by a low cost INS, the range velocities, accelerations and higher derivatives can be computed by aid of inertial data.  In this context investigations about the different coupling principles between GNSS and INS are presented. With tight coupling the filtered INS-data is fed back directly into the GNSS receiver code and carrier tracking loops. A possible filter design for low cost INS-data and its transfer function are described.  In opposite to the unaided receiver the tightly coupled sensors are no longer depending on the accelerations but on the accelerometer bias and gyro drift behaviour of the INS. The Schuler frequency dominates the jitter value of the loops. The paper demonstrates that a gyro rate of approximately 1œ/h is necessary to support the phase lock loop. Concerning the delay lock loop a gyro rate of 10œ/h is sufficient.  In next part of the paper a simulation tool for a tightly coupled GPS/INS-Sensor is described. Used algorithms and sensor models are reviewed. The data flow beginning with original data and ending with the integrated navigation solution is presented. First simulation results are also shown. Advantages and problems of the coupled sensor system are mentioned.  The development of an experimental tight coupling system using the MITEL GPS Architect receiver and the LITTON LN-200 Inertial Measurement Unit is the key point of the final section of the paper. Besides hardware and software aspects methods of time synchronisation and data processing are addressed. | |  |

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| **Q.Ladetto, B.Merminod** | **Digital magnetic compass and gyroscope integration for pedestrian navigation** | **65** |
| When satellite signals are available, the localisation of a pedestrian is fairly straightforward. However, in cities or indoors, dead reckoning systems are necessary. Our current research focuses on the development of algorithms for pedestrian navigation in both post-processing and real-time modes. Experience shows that the main source of error in position comes from the errors in the determination of the azimuth of walk. By coupling a magnetic compass with a low-cost gyroscope in a decentralized Kalman filter configuration, the advantage of one device can compensate the drawback of the other.  If we compare the rate of change of both signals while measuring the strength of the magnetic field, it is possible to detect and compensate magnetic disturbances. In the absence of such disturbances, the continuous measurement of the azimuth allows to estimate and compensate the bias and the scale factor of the gyroscope. The reliability of indoor and outdoor navigation improves significantly thanks to the redundancy in the information. Numerous tests conducted with different subjects and in various environments validate this approach. | |  |

**Materials of the 23th Conference in memory of N.N.Ostryakov**

**Articles**

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| Considered is the problem of rapid compassing on a completely fixed base. For measurements a gyrostabilized platform is used, which can rotate forcedly in azimuth. It is considered that the compassing accuracy can be achieved by platform rotation in azimuth by 180 deg during measurements. In this case the compassing error caused by the gyro drift changes its sign while turning. The problem becomes complicated because the operating speed requirement makes the measurements to be carried out before drift stabilization. In the methods proposed below the gyro drift is approximated by the parabolic dependence on time separately for sections before and after the turn. Readings taken from integrators of accelerometer indications are processed by Kalman filter algorithms. | |  |

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| **A.F.Dyumin,**   |  | | --- | | **S.N.Egorov** | | **Observability of constant gyro drifts in an orbital gyrocompass** | **85** |
| Considered is the orbital gyrocompass manufactured as a free two-degree-of-freedom gyro which position is adjusted by the readings of local leveler sensor. Orbital gyroscope is supposed to be intended only for the definition of spacecraft yawing angle in the orbital frame that is the main task of orbital gyrocompassing. Errors of such gyrocompass comprise gyro drift and instrumental roll angle pick-off error for the leveler sensor. The observation device of optimal accuracy was produced for the spacecraft circular orbit motion. This device can estimate the incompletely observed positions with the maximal available accuracy. For the case of spacecraft motion along the elliptical orbit full observation of gyro drifts and instrumental error of local leveler sensor are presented. | |  |

**Brief notes**

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| **O.B.Basun, V.A.Granovsky, T.N.Siraya, A.P.Sukharev** | **Metrological support for the development of navigation systems: problem statement, solution methods** | **93** |
| Metrological support of navigation systems is presented as a package of measures aimed at the quality maintenance by metrological methods. They are directed to ensuring comparability of measurement results and to achieving the required accuracy of measurements. Peculiarity of the navigation system support is due to the need for expansion of the measurement concept, as the main navigation parameters are not physical values, and the navigation systems are not measuring instruments in strict sense. At the same time, it is necessary to ensure the high accuracy of results under working conditions, when the standards are either inaccessible or enable the required accuracy to be ensured.  The necessity is substantiated for the anticipatory metrological study at the early stages of the navigation system development. There is a specific form of metrological support for navigation systems such as the metrological expertise at the various stages of the system development. The obligatory expertise is carried out at the stage of the requirement specification negotiation for the navigation system development.  The most important tasks at the stage of navigation system trials are due to the standard problems. There are two levels of these problems, namely, internal and external ones. The external standard problems are conditioned by the complexity of the objects and by the ambiguity of the parameter definitions in marine environment.  For quality maintenance of the navigation systems it is essential that the metrological support would be realized as the continuous process during all the period of system development. | |  |

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| **S.G.Kucherkov, D.I.Lychev, A.I.Skalon, L.A.Chertkov** | **The use of Allan variation in investigating characteristics of a micromechanical gyro** | **98** |
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**History pages**

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| **S.S.Rivkin** | **Development of artillery gyroscopy in the Russian Navy** | **105** |
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**Information**

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