**"Gyroscopy and Navigation" №4, 2001**

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| **L.N.Belsky, L.V.Vodicheva** | **Short-time precision initial alignment and calibration of an aircraft INS on the moving base** | **3** |
| The paper considers a system intended for determining initial conditions (ICDS) of an INS for an aircraft that takes off from a moving vehicle - a carrier that performs angular and linear motions of a rather wide spectrum. The resolutions of engineering problems offered in the paper formed the basis for creating real ICDSs developed in the Science and Production Association of Automatics. Three generations of these systems have been created in the last 25-30 years. The system in its evolution and specific features of each generation of the systems are described in Section 1. The functional diagram of the first-generation ICDS presented in Fig. 1 makes it possible to estimate how much hardware expenses were reduced in the course of the ICDS evolution: some components of the system were excluded from the second-generation ICDS, others - from the third-generation ICDS. Fundamental mathematical relations used as the basis for the third-generation ICDS are derived in the following sections. Section 2 is devoted to the derivation of the fundamental equation of slaving of the INS to be aligned to the reference one (Eqs. 2.1- 2.6). The equations for the determination of 'non-horizon' angles and components of the initial velocity of the INS being aligned (Eqs. 3.1-3.4) are derived on the basis of the general equation of slaving in Section 3. Also presented is the method used to solve these equations (Eqs. 3.5 - 3.8). Section 4 describes the calibration procedure. The specific features of the system implementation in practice, and mainly the fact that ICDS problems and the navigation problems of the moving carrier are solved by different designers and personnel on different computers, impose certain limitations on the ICDS algorithms. As a result, formulating the requirements to the information of the reference INS that is transmitted to the INS being aligned as the ICDS problems are being solved, is a rather complicated task. This problem is dealt with in Section 5. |  |

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| **Odintsov, V.V.Vasilieva** | **Error equations for marine gimbal inertial navigation systems based on controlled gyros** | **19** |
| The object of this paper is formation of error equations for marine gimbaled INS on controllable precision gyros that have different laws of gyro stabilized platform (GSP) rotation in azimuth, and rearrangement of these equations for various coordinate systems. The paper only deals with semianalytic INS installed on marine slow-speed vehicles. Two cases of generating angular rate of the GSP forced rotation in azimuth were considered in forming the equations: a) the control signal is generated so that the rate of the change in the calculated azimuth should be constant and should not depend either on time, or the local latitude, or the vehicle speed of motion, and therefore should be a variable value (INS A); b) the rate of GSP control in azimuth is a constant value; as a result, the rate in the change of the calculated azimuth becomes a variable value (INS B); The error equations for INS A are given in (27), for INS B - in (29) and (30). The comparison of (27) with (29) and (30) shows complete identity of error equations for INS A and INS B in spite of the fact that there are some differences in their formation. The error equations were obtained in the horizon rotating (31), horizon geographic (43) and equatorial horizon (49) coordinate systems, thus in many cases allowing these equations to be solved analytically. The paper also shows that as the GSP rotates and day-to-day variation damping takes place, the errors of the vertical plotter cause errors in the simulation of the Earth rotation axis. |  |

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| **G.B.Volfson** | **On the possibility of using a state-of-the-art gravity variometer for earthquake forecasting** | **33** |
| At present the problem of effective operative prediction of severe earthquakes does not have any satisfactory solution. The review of the present-day forecasting equipment shows that seismic detectors are often inefficient because of their low frequency selectivity (2). The new technical trend in the development of seismic detectors suggested here uses the dumbell effect in the gravity variometer for generating a signal as a severe earthquake approaches (5). The gradiometrical seismic detector with resonant tuning for the reception of elastic vibration possesses frequency selective features and a polar pattern similar to those of the radar antenna (12). The instrument can be built around the basic module of the geophysical gravity variometer with magnetic suspension of the rocker, using up-to-date techniques of manufacturing vacuum sensors for inertial systems. The paper presents the computed values of the legitimate signal for the case that the instrument experiences seismic vibrations (Fig.4). |  |

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| **V.G.Rozentsvein** | **Determination of higher derivatives of gravity potential and their usagein geophysical problem solution** | **45** |
| No special equipment that would allow measuring third and higher order derivatives of the gravity potential is available at present although the need to determine them is urgent as it is conditioned by the increase in accuracy of gravimetric equipment used in geological survey, study of the Earth's gravity field and its subsequent interpretation as well as in implementation of new technologies and in fine physical experimentation. The analysis of the methods used now to determine higher derivatives shows that the drawback they suffer is low accuracy caused by the necessity to take measurements at various points of an anomalous field in the vicinity of the investigated point. A new method of determining higher derivatives of the gravity potential suggested here is based on the spectrum analysis of signals of gravity gradient instruments with different shapes of inertial bodies (Table 1). This being so, the differences between the output signals of gravity gradient instruments in certain combinations yield values of different higher derivatives (Table 2), free from errors caused by gravity field abnormality. |  |

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| **D.A.Sukhoruchkin** | **On the influence of quadrature on a standing wave precision in a string fixed at the ends** | **57** |
| A string is considered as a one-dimensional continuum only resisting to elongation of its elements in accordance with Hook's law. Nonlinear differential equations (2.7) of the string motion are developed. The universally known linear equations of cross and longitudinal waves propagation can be derived from the nonlinear equations with standard simplifying assumptions. A single-mode approximation is used for the investigation of a cross standing wave with one antinode in a string fixed at the ends. The two-dimensional oscillator with rigid non-linearity is shown to be a model of such a standing wave (Equations 3.4). It is known that in the case of linear oscillations the middle point of the string generally describes an ellipse with constant dimension and attitude. The influence of the ellipse area on angular drift of its axes is investigated by the averaging method. Equations (3.8) for the angular velocity and frequency correction are developed. |  |

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| **S.A.Sarapuloff, I.A.Ulitko** | **Rotation influence upon volume waves in an elastic medium and their usagein solid-state gyroscopy** | **64** |
| Minimechanical solid-state gyros using bulk and surface acoustic waves can be a real alternative to micromechanical oscillatory gyros required higher levels of technological base and initial investments. The report open the principle of operation and a general schematic solution of some instruments of this class. The article gives general analysis of gyroscopic effects observed in elastic waves in dielectric crystals and glasses with low levels of losses (analogues of Sagniac's and Fermi's effects for electromagnetic waves). A special attention have been paid to effect of polarization plane rotation of linear-polarized shear sound for its propagation along an acoustic axis of the crystal coincident with its axis of rotation as a whole. |  |

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| **F.Bernelli-Zazzera,M.Molina, M.Vanotti** | **Low-cost attitude determination using GPS signals for the university microsatellite PalaMede** | **73** |
| The paper presents methodology and results for an algorithm of integer ambiguity resolution. The algorithm uses an instantaneous-static geometric inequality in order to reduce the integer search. A batch-loss function is evaluated for checking the remaining integers and finding the solution. The peculiarity of the algorithm is to find the right solution even for a coplanar antennas array. The main goal of the experimental work is the proof of concept of the procedure for the University Microsatellite PalaMede, for which the foreseen baselines are very short. The procedure is demonstrated using real data, collected from standard not space-qualified GPS receivers. Tests have been performed for different baseline length, from 160 cm to 40 cm. |  |

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| **D.Gebre-Egziabher,J.D.Powell, P.K.Enge** | **Design and performance analysis of a low-cost aided dead reckoning navigation systems** | **83** |
| This paper presents an aided dead reckoning navigation system based on the fusion of inexpensive inertial, air data and magnetic sensors aided by a skeletal network of radio-navigation aids. In the future National Airspace System o/ the United States-in which G is slated to be the primary means of navigation alongside a very small skeletal network of existing ground based radio-navigation aids-inexpensive backup method of navigation will be required for General Aviation users. This backup method of navigation will allow users successfully deal with scenarios where intentional or unintentional radio-magnetic interference renders GPS unusable in a given geographic area. The navigator presented in this paper is intended to be that backup navigation system for General Aviation aircraft. |  |

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