

Soviet Aerospace Literature

This month: *Spacecraft Navigation, Guidance, and Control*

Throughout 1987 the *AIAA Journal* will carry selected abstracts on leading research topics from the Soviet aerospace literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features spacecraft navigation, guidance, and control.

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A87-15533 Control of the motion of a spacecraft near a collinear libration center in the restricted elliptical three-body problem (Upravlenie dvizheniem kosmicheskogo apparata v okrestnosti kollinearnogo tsentra libratsii v ogranichennoi elipticheskoi zadache trekh tel). P. E. ELIASBERG and T. A. TIMOKHOVA, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, July-Aug. 1986, pp. 497-512. 12 refs.

The method of osculating parameters is applied to the problem of the motion control of a spacecraft with the aim of the long-term maintenance of this spacecraft near one of the collinear L1 or L2 libration centers in the restricted elliptical three-body problem. The necessary integral condition for the restriction of the orbit to a given neighborhood of the libration center is obtained. A method for finding the restricted orbit by solving the equations of motion of the spacecraft under the restriction condition is developed along with a method for the calculation of correcting impulses, ensuring the long-term stay of the spacecraft in the restricted orbit. The proposed approach is used to perform numerical calculations for the L2 center of the sun-earth system.

A87-15537 Rapid rotation of a satellite with a magnetic damper. IV Dissipative evolution: Resonance effects (Bystroe vrashchenie sputnika s magnitnym demperom. IV Dissipativnaia evoliutsiia: Rezonansnye efekty). I. U. A. SADOV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, July-Aug. 1986, pp. 553-563. 9 refs.

An analysis is made of the evolutionary motion of a rapidly rotating satellite with a magnetic damper over a time interval $O(\epsilon \exp -2)$ of revolutions in orbit. The determining evolutionary factor in the time period studied is dissipation processes due to small oscillations of the damper magnetization axis with respect to the satellite. Secondary resonance effects are observed in the course of the evolution. These effects lead to the appearance of singularities in the case of resonant frequency ratios of the unperturbed Euler motion of the satellite as well as to the appearance of stationary ratios of these frequencies, close to resonant.

A87-15539 Simplified methods of navigation plotting (Uproshchennye metody navigatsionnykh postroeni). S. K. GROMOV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, July-Aug. 1986, pp. 575-580.

Methods for the mapping of spacecraft motions are presented which can facilitate the work of control personnel, flight crews, and spacecraft designers. These methods make possible the operational analysis and purposeful variation of parameters linking the spacecraft coordinates and reference points on the celestial sphere or planetary surface. Here, the focus of the computational work is shifted to the preparation of the necessary nomograms and graphics; problems are solved simply in a convenient graphic form.

A87-15545 Concerning a certain class of near-equatorial intermediate orbits (Ob odnom klasse okoloekvatorial'nykh promezhutochnykh orbit). N. V. KAPITONOVA and E. L. LUKASHEVICH, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, July-Aug. 1986, pp. 639-642.

A quadrature-inversion procedure is used to obtain expressions defining a class of near-equatorial intermediate satellite orbits with an accuracy to terms of the order of the square of the planetary oblateness. These expressions take into account all perturbations from the second zonal harmonic of the gravitational potential as well as secular and partially periodic perturbations from the arbitrary even zonal harmonic with a coefficient $12n$, n greater than or equal to 2.

A86-21377 Gradiometric navigation near collinear libration points (Gradientometricheskaiia navigatsiia v okrestnosti kollinearnykh tochek libratsii). A. I. U. KOGAN, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, Nov.-Dec. 1985, pp. 814-819.

Gradiometric measurements (i.e., measurements of tidal accelerations) on a spacecraft make possible a unique determination of its position. The present paper examines a navigation system with a gradiometer that measures the mixed second derivatives of the gravitational potential over the coordinates. A linear algorithm for the processing of the measurements is developed for the neighborhood of the L1 and L2 libration points. The optimal orientation of the measuring instrument with respect to the orbital axes is found, and a priori estimates of the accuracy with which the position can be determined are given. Gradiometric navigation is found to be most effective in rapidly rotating systems such as Mars-Phobos and Jupiter-Amalthea.

A87-15532 Determination of an optimal program of measurements with constraints on the error in estimating three motion parameters of a satellite with a 24-hour orbit (Opredelenie optimal'noi programmy izmerenii s ogranicheniiami na oshibki otsenki trekh parametrov dvizheniia sutochnogo sputnika). M. L. LIDOV and L. M. BAKUMA, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, July-Aug. 1986, pp. 483-496.

The paper presents a numerical solution to the problem of determining the optimal measurement program in the case of a seven-dimensional state vector defining the almost-circular motion of the satellite. Three motion parameters of the satellite are estimated on the basis of measurements of range and radial velocity with respect to ground points. It is shown that Lidov's (1985) algorithm can be used to obtain a complete qualitative picture of all the possible constraints on the variances of the errors in the estimation of the three parameters.

A86-11578 Ground-station receiver for satellite communications (Priemnoe ustroistvo dlia nazemnykh stantsii sputnikovoi svyazi). I. ANGELOV, I. STOEV, A. SPASOV, L. URSHEV, and L. KOKONCHEV, *Radiotekhnika* (ISSN 0033-8486), Aug. 1985, pp. 25-28.

The paper describes the design and testing of a microwave (11.5-12 GHz) receiver for use in ground stations in satellite communications systems. The receiver consists of a low-noise Schottky-barrier FET microwave amplifier, a balance mixer, and an IF amplifier.

A86-18988 Method for improving the accuracy of the alignment and calibration of an inertial navigation system with continuous rotation of the gyroplatform about the vertical axis (Metod povysheniia tochnosti vystavkii kalibrovki INS pri nepreryvnom vrashchenii giroplatformy vokrug vertikal'noi osi). V. I. MANOKHIN, L. M. SELIVANOVA, and I. V. SHUSTOV, (Moskovskoe Vyshee Tekhnicheskoe Uchilishche, Moscow, USSR), *Priborostroenie* (ISSN 0021-3454), Vol. 28, Nov. 1985, pp. 76-79.

The paper describes a method for aligning the gyroplatform of an inertial navigation system with continuous rotation of the platform about the vertical axis using a Kalman filter. It is suggested that accuracy of platform alignment in azimuth can be improved and the intrinsic-drift components of the platform can be determined by rotating the platform about the vertical axis with two different velocities.

A86-21376 Analysis of optical autonomous navigation for the motion of a satellite in a low-eccentricity orbit (Analiz opticheskoi avtonomnoi navigatsii pri dvizhenii sputnika po orbite malogo ekscentrisiteta). V. V. IVASHKIN, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, Nov.-Dec. 1985, pp. 803-813. 11 refs.

A numerical algorithm and an approximate numerical-analytical method are used to examine the characteristics of an autonomous navigation system involving the application of an optical horizon star tracker. Navigation accuracy corresponding to independent and correlated measurement errors is assessed. A comparison of the two methods used shows that the approximate method makes possible a satisfactory determination of navigation errors. Navigation accuracy is evaluated for low-eccentricity orbits at altitudes from 300 to 2000 km.

A85-49753 Observability in the problem of navigation with respect to an unspecified reference point (Nabliudaemost' v zadache navigatsii po nezadannomu orientiru). M. I. VINOKUR, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, July-Aug. 1985, pp. 530-534. 5 refs.

The problem of observability in the planetary-approach segment of a spacecraft trajectory is examined in the case of navigation with respect to a known star and an unknown reference point on the planetary surface. Angular measurements are considered for both the two-dimensional and the three-dimensional case, with and without allowance for planetary rotation. It is shown that system observability exists only in the three-dimensional case when the planetary rotation is not taken into account.

A86-41428 An optimal control law for stopping rotation [of spacecraft] (Optimal'nyi zakon upravleniia pri ostanovke vrashcheniia). I. V. GOLUBEV and V. N. DEMIDOV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Mar.-Apr. 1986, pp. 18-24. 15 refs.

Reference is made to an earlier study (Akulenko, 1978) where general solutions in explicit form have been obtained for the problem of the minimum-time spacecraft rotation stoppage by using a family of first integrals of the unperturbed Euler equations. In the present study, the concept of systems with an invariant norm is generalized, and some theoretical approaches to the study of such systems are presented. The mathematical formalism proposed here makes it possible to allow for the existence of a known analytical solution and a two-parameter family of first integrals of the unperturbed dynamic Euler equations.

A86-29259 Structure of higher-order resonance zones in the rotation of a satellite in an elliptical-orbit plane (Struktura rezonansnykh zon starshikh poriadkov vo vrashchenii sputnika v ploskosti ellipticheskoi orbity). E. M. LEVIN, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, Jan.-Feb. 1986, pp. 9-14. 8 refs.

An analysis is made of the rotation of a quasi-dynamically-symmetric satellite in an elliptical-orbit plane under the effect of gravity and dissipation moments. In $p:2q$ type resonant rotation, the satellite performs p revolutions in inertial space for $2q$ orbital revolutions. The method of point mappings is used to study the structure of resonance zones of higher orders $q = 2, 3$; this structure is found to be analogous to the structure of resonance zones of first order $q = 1$. One of the higher-order resonance effects is the gravity-gradient stabilization of the satellite in the inertial space during rotation in the orbit plane.

A86-21378 Methods for improving the accuracy of the navigational determinations of surface objects using a satellite navigation system (Metody povysheniia tochnosti navigatsionnykh opredelenii prizemnykh ob'ektov pri ispol'zovanii sputnikovoi navigatsionnoi sistemy). M. P. NEVOLKO, S. D. SILVESTROV, V. A. ARKHANGELSKII, A. V. MIKHAILOV, and V. V. KULNEV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, Nov.-Dec. 1985, pp. 820-828.

The paper examines certain aspects of the navigation of surface objects according to motion-parameter measurements with respect to navigation satellites. Attention is given to the problem of improving the accuracy of navigational determination through an improved determination of systematic errors in the differences between pseudodistances and radial pseudovelocities to different pairs of satellites.

A86-21380 Algorithms of the inertial navigation of a spacecraft with a high lift-drag ratio during atmospheric descent (Algoritmy inert-sial'noi navigatsii kosmicheskogo apparata s bol'shim aerodinamicheskim kachestvom pri spuske v atmosfere). V. L. BALAKIN and I. N. LAZAREV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, Nov.-Dec. 1985, pp. 843-848.

Consideration is given to the autonomous descent control of a spacecraft with a high lift-drag ratio (much greater than 1) in the earth's atmosphere. Inertial-navigation algorithms with improved determinations of the motion parameters and lift-drag ratio of the spacecraft are examined. The efficiency of the algorithms is analyzed in terms of improving the control accuracy.

A86-21382 Evolution of the rotations of a symmetric satellite with viscoelastic rods about the center of mass in a circular orbit (Evolutsiia vrashchenii simmetrichnogo sputnika s viazkoupругimi sterzhniami vokrug tsentra mass na krugovoi orbite). V. G. VILKE, V. G. DEMIN, and I. G. MARKOV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, Nov.-Dec. 1985, pp. 863-868.

An analysis is made of the motion of a symmetric satellite about the center of mass in the case when four flexible viscoelastic rods are attached to the equatorial plane of the ellipsoid of inertia of the satellite. It is assumed that the center of mass of the system moves in a circular orbit in a Newtonian force field. The averaging method in canonical variables is used to obtain approximate equations describing the evolution of the rotational motion of the system.

A87-15227 Analytical estimation of the lateral deviations of a flight vehicle during a ballistic descent (Analiticheskaiia otsenka bokovykh otklonenii letatel'nogo apparata pri ballisticheskome spuske). O. A. PRIVARNIKOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1986, pp. 104-106.

The lateral force due to the effect of the wind and to the small mass and aerodynamic asymmetries of the flight vehicle leads to lateral deviations during a ballistic descent in the atmosphere. Here, approximate analytical expressions for estimating the lateral deviations are obtained through a numerical integration of the differential equation of lateral motion.

A86-29185 Photoelectric photometry of the Intercosmos-Bulgaria-1300 satellite (Fotoelektricheskaiia fotometriia sputnika 'Interkosmos-Bolgaria-1300'). M. V. BRATICHUK, A. B. GVARIONOV, V. P. EPISHEV, I. F. NAIBAUER, and O. E. STARODUBTSEVA (Uzhgorodskii Gosudarstvennyi Universitet, Uzhgorod, Ukrainian SSR) *Kinematika i Fizika Nebesnykh Tel* (ISSN 0233-7665), Vol. 2, Jan.-Feb. 1986, pp. 60-65. 7 refs.

Photoelectric observations of the Intercosmos-Bulgaria-1300 satellite made it possible to elucidate the character of light scattering by different parts of its surface. Analytical expressions of phase functions for observations carried out from March 1982 to October 1983 are presented. It is shown that the satellite was reoriented during the period of observations.

A86-46271 Coordinate determination by a multiple-arm radiointerferometer using navigation-geodesic satellites (Opredelenie koordinat mnogoplechevym radiointerferometrom po navigatsionno-geodezicheskim sputnikam). N. A. AZBUKINA, V. A. VASILEV, V. M. ZINENKO, and V. G. PESHEKHONOV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, May-June 1986, pp. 466-468.

Reference is made to an earlier study (MacDoran, 1979) in which a method has been proposed for determining the coordinates of ground point by using a multiple-arm radiointerferometer observing four satellites. The method relies on step-by-step survey control, with the maximum distance between a new point and the reference points not exceeding 200 km. It is shown here that the requirement of step-by-step control can be avoided by using 5-6 reference point instead of four. Five reference points should be spaced apart by about 30 deg (3000 km), while the 6th point can be located 2-3 times closer. The mean value of the geometrical factor is 5-10; the accuracy of the new method is several decimeters less than that of the MacDoran method.

A86-29263 Analytical study of spacecraft impact dispersion during reentry (Analiticheskoe issledovanie rasseivaniia kosmicheskikh apparatov pri spuske v atmosfere). O. A. PRIVARNIKOV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, Jan.-Feb. 1986, pp. 39-45. 8 refs.

The paper obtains analytical estimates of spacecraft impact dispersion due to the divergence of atmospheric parameters from calculated ones, the scatter of the frontal drag coefficient, oscillations of the spacecraft with respect to the center of mass, and the displacement of this center in relation to the longitudinal axis during uncontrolled reentry. The method used is based on the approximate analytical solution of a system of equations conjugated with equations of motion in variations and the estimation of integrals specifying range deviations. The method is applied to controlled reentry with a constant angle of trajectory inclination.

A86-41433 Determination of the inertia tensor of a space vehicle in flight (K voprosu opredeleniia tenzora inertsii apparata v polete). K. B. ALEKSEEV, O. V. ZLODYREVA, and O. V. SINILNIKOV, *Akademii Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Mar.-Apr. 1986, pp. 90-93.

Methods are presented for determining the directions of the main central axes of inertia of a space vehicle and the moments of inertia relative to these axes by applying test forces by means of a system of heterodynes. The methods proposed here are based on the conservation of the kinetic moment of a mechanical system consisting of the space vehicle body and electromechanical actuating mechanisms. It is shown that the problem of identification of space vehicle characteristics can be simplified by using information on the probable directions of its main axes of inertia.

A86-41427 Calibration of attitude sensors [by on-board spacecraft computers] (Kalibrovka datchikov orientatsii). E. M. POTAPENKO, *Akademii Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Mar.-Apr. 1986, pp. 11-17. 9 refs.

The principles governing the development of simple algorithms for calibrating attitude and velocity sensors without the need for reference point identification and without using information on the orientation of the moving object are examined. The approach proposed here makes it possible to calibrate attitude and velocity sensors by using an on-board computer.

A86-33299 Statistical dynamics and control optimization of flight vehicles [Russian textbook] (Statisticheskaiia dinamika i optimizatsiia upravleniia letatel'nykh apparatov). A. A. LEBEDEV, V. T. BOBRONNIKOV, M. N. KRASILSHCHIKOV, and V. V. MALYSHEV, *Moscow, Izdatel'stvo Mashinostroenie*, 1985, 280 pp. 37 refs.

The application of the stochastic theory of control to the analysis and synthesis of control systems for flight vehicles is presented in a systematic manner. Topics discussed include methods of statistical description of random quantities, processes, and fields; methods of a priori statistical analysis of the controlled motion of flight vehicles; methods of estimating the states of flight vehicles; and programming of the optimal control of flight vehicles. Attention is then given to the synthesis of the optimal control of flight vehicles and optimal control under conditions of incomplete information.

A86-39978 Navigational support for the Salyut-6-Soyuz-Progress orbital complex [Russian book] (Navigatsionnoe obespechenie poleta orbital'nogo kompleksa 'Saliut-6'-'Soiuz'-'Progress'). B. N. PETROV and I. K. BAZHINOV, Eds, *Moscow, Izdatel'stvo Nauka*, 1985, pp. 376. [No individual items are abstracted in this volume.]

An overview of the experimental work done with regard to ballistic and navigation support for the Salyut-6-Soyuz Progress complex during its first three missions is presented. In addition, data on the orbits of the complex are provided by means of ballistic observations made on board. Methods instrumental in carrying out navigational tasks are presented; these are applicable to both the present work and to ground-based operations.

A86-25498 Direct methods for calculating geodetic coordinates on the basis of results of spatial linear intersections [for satellite tracking by lasers] (Priamye metody vychisleniia geodezicheskikh koordinat po rezul'tatam prostranstvennykh lineinykh zasechek). M. S. URMAEV (Moskovskii Institut Inzhenerov Geodezii, Aerofotos'emki i Kartografii, Moscow, USSR) *Geodeziia i Aerofotos'emka* (ISSN 0536-101X), No. 5, 1985, pp. 3-11.

The paper examines two direct solutions of spatial linear intersection in geodetic coordinates, applicable to laser measurements of satellite positions and orbits. The first solution consists in the representation of the abscissa and ordinate of the unknown point in the form of linear functions of its applanate; the initial system of three quadratic equations decomposes into a quadratic equation and two independent linear equations. The second solution involves a special coordinate transformation, as a result of which the 3×3 reference-point coordinate matrix contains six zero elements. In this case the solution is reduced to a radical and two independent linear equations.

A86-21457 The possibility of compensating for regular ionospheric error in radio altimeters (O vozmozhnosti kompensatsii reguliarnoi ionosfernoi pogreshnosti v radiovysotomerakh). V. M. PAVLOV and I. S. RASSHCHEPLIAEV, *Radiotekhnika i Elektronika* (ISSN 0033-8494), Vol. 30, Dec. 1985, pp. 2302-2307. 5 refs.

An algorithm for compensating for the regular ionospheric error in radio altimeters is developed for the case when the carrier frequency of the radio signal slightly exceeds the critical frequency of the ionospheric plasma. The proposed algorithm is compared with an existing multifrequency algorithm, and it is shown that the former algorithm is more efficient because it requires fewer arithmetical operations for its implementation, while the accuracy is practically the same.

A86-18746 I am Zaria: The story of a ground support complex [Russian book on ground communication with spacecraft] (Ia - 'Zaria': Rasskaz o komandno-izmeritel'nom komplekse). B. A. POKROVSKII, *Moscow, Izdatel'stvo Mashinostroenie*, 1985, 144 pp.

The Soviet ground support complex for space flights is described, with particular emphasis placed on the development of techniques of data reception, transmission, and processing, as well as space-flight control. Mention is made of the Zaria radio station through which the first ground-space-ground communications (Apr. 12, 1961) were effected; 'I am Zaria' is how the ground operator would open the communication.

A86-46258 Optimal reorientation of a spacecraft in the rocking mode (Ob optimal'noi pereorientatsii KA v rezhime 'pokachivaniia'). I. V. IOSLOVICH, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, May-June 1986, pp. 376-379. 12 refs.

The problem of optimal spacecraft reorientation by means of jet engines in the rocking mode is examined. By using Krotov's sufficient conditions, an optimum synthesis is accomplished in a class of cyclic gliding modes; optimal controls and the Krotov-Bellman synthesizing function are determined.

A86-35079 The number of impulses for minimum-energy flight between close Keplerian orbits (O chisle impul'sov pri energeticheski optimal'nom polete mezhdu blizkimi Keplerovymi orbitami). S. N. KIRPICHNIKOV and V. F. BAIKOV, *Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia* (ISSN 0024-0850), Jan. 1986, pp. 103-112. 7 refs.

The problem of determining the maximum number of impulses for minimum energy flight between close elliptical Keplerian orbits is investigated using a general noncoplanar time-free formulation. In the general (nondegenerate) case, all three-impulse flights satisfying the necessary optimality conditions are determined, as are some two-impulse flights satisfying the necessary optimality conditions. It is further shown that the above three-impulse flights do not satisfy the sufficient optimality conditions in the corresponding extreme-value problem with a mobile right end.

A86-46253 Determination of microaccelerations at the Salyut-6 and Salyut-7 orbital complexes (Opredelenie mikrouskorenii na orbital'nykh kompleksakh 'Saliut-6' i 'Saliut-7'). V. A. SARYCHEV, M. I. U. BELIAEV, V. V. SAZONOV, and T. N. TIAN, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 24, May-June 1986, pp. 337-344. 5 refs.

A method is presented for calculating microaccelerations generated at the Salyut-6 and Salyut-7 orbital stations during gravity-gradient stabilization. In accordance with the method, the readings of the attitude control sensors are first processed statistically to determine the motion of the station about its center of mass; for the motion thus determined, microaccelerations are then calculated for any given point of the station. The method proposed here has been implemented in a set of computer software. As an example, microaccelerations are calculated for the real motion of the Salyut-7 station.

A85-49759 Observability in the problem of the mutual geodetic interconnecting of spaced points of multiposition measurement complexes (O nabludaemosti v zadache vzaimnoi geodezicheskoi priviazki raznesennykh punktov mnogopozitsionnykh izmeritel'nykh kompleksov). S. E. FALKOVICH, L. N. KONOVALOV, and A. A. ZHALILO, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, July-Aug. 1985, pp. 587-597. 7 refs.

A method for the measurement of satellite trajectories is examined which involves the determination of the unknown coordinates of the sighted objects and the measurement points of multiposition systems on the basis of synchronous observations. Particular attention is given to the identification of critical cases of the mutual positions of the measurement points and synchronously sighted objects for which the problem of generalized free triangulation does not have a unique solution. The proposed approach can also be used to determine the accuracy of the measurement systems and to optimize the design of the systems and the planning of the trajectory measurements.

A85-49751 Effective algorithm for choosing an optimal program of measurements with constraints on errors in the estimation of several parameters [for impulse trajectory correction] (Effektivnyi algoritm resheniia zadachi o vybore optimal'noi programmy izmerenii s ogranicheniiami na oshibki otsenki neskol'kikh parametrov). M. L. LIDOV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, July-Aug. 1985, pp. 499-517. 6 refs.

The paper examines the Elfving (1952) problem involving the choice of a program of trajectory measurements from a given set of possible measurements with uncorrelated errors. The program consists in the minimization of measurement costs for given constraints on the variance of errors in the estimation of r parameters. An effective algorithm for solving this problem for the case of r greater than 1 is presented. This algorithm involves a specially constructed problem concerning generalized linear impulse correction and a version of the simplex method used to solve it.

A85-49752 Single-axis aerodynamic attitude control of artificial satellites (Odnosnaia aerodinamicheskaia orientatsiia iskusstvennykh sputnikov). V. V. SAZONOV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, July-Aug. 1985, pp. 518-529. 8 refs.

The motion of a satellite with respect to the center of mass in the mode of single-axis aerodynamic attitude control is analyzed. It is assumed that the aerodynamic moment is much larger than the gravitational one, and that the equations of motion contain a large parameter. A two-parameter integral surface for these equations is constructed, describing oscillations and rotations of the satellite about the longitudinal axis directed approximately at a tangent to the orbit. Such motions are considered as nominal unperturbed motions of the satellite in the mode of aerodynamic attitude control. A numerical analysis of the integral surface is presented.

A86-45365 Convergence of measurements in laser observations of artificial earth satellites (O skhodimosti otsenok lazernykh nabliudenii ISZ). G. S. KURBASOVA, L. V. RYKHLOVA, and G. N. SHLIKAR (AN SSSR, Astronomicheskii Sovet, Moscow, USSR) *Kinematika i Fizika Nebesnykh Tel* (ISSN 0233-7665), Vol. 2, May-June 1986, pp. 85-90.

Two approaches for the improvement of convergence in the least squares method when applied to laser observations of satellites are discussed. The first approach is the truncation of measurements and subsequent application of conventional criteria and routines. The second approach is the robust routine of the least squares method. For the improvement of convergence in the robust routine, a method for determination of the initial parameters by the spline approximation is suggested.

A86-32701 Estimation of the gyroscope drift parameters of an inertial navigation system (Otsenivanie parametrov ukhoda giroskopov sistemy inertsial'noi navigatsii). I. A. BALAEVA and N. V. KULIKOV-SKALA, (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) *Mekhanika Giroskopicheskikh Sistem* (ISSN 0203-3771), No. 3, 1984, 39 pp.

Two methods are proposed for estimating the errors of the gyroscopic devices of inertial navigation systems during bench testing. One method employs a generalized Kalman filter for nonlinear systems, while the other method uses a Kalman filter for linear systems with a priori values of the estimated parameters and subsequent statistical processing of the drift estimate. Results of numerical modeling are presented.

A85-49756 Influence of thermoelastic effects on the dynamics of gravity gradient spacecraft (Vliianie termouprugikh effektov na dinamiku gravitatsionnykh kosmicheskikh apparatov). E. M. POTAPENKO, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 23, July-Aug. 1985, pp. 560-573. 12 refs.

Equations of motion are obtained for a spacecraft with allowance for heat-induced deformations under the effect of solar radiation and thermoelastic oscillations of the reaction-boom gravity-gradient stabilizer. The influence of thermoelastic effects in the stabilizer on the spacecraft dynamics is investigated, and situations in which the thermoelastic oscillations can be unstable are defined. It is shown that damping systems adjusted toward libration damping have only a slight effect on the elastic oscillations. Analytical relationships are obtained which make it possible to optimize the damping of the elastic oscillations through the use of damping systems.