

the system. Control of an essentially nonlinear process does not require model simplification. The adaptive prediction algorithms proposed here are not limited to problems of flight control and are applicable to most manufacturing processes, control of moving systems, and other problems.

A88-24792 Fiber-optic gyroscope (Volokonnyi opticheskii giroskop). ALEKSEI GRIGOR'EVICH SHEREMET'EV, Moscow, *Izdatel'stvo Radio i Sviaz*, 1987, 152 pp. 57 Refs.

The principle of operation, general design, and performance characteristics of fiber-optic gyroscopes are discussed. Attention is given to the principal structural components of fiber-optic gyros, methods of compensation for noise and instabilities, direct dynamics effects, and the effect of an external magnetic field. Some specific experimental implementations of fiber-optic gyroscopes designed for different applications are examined.

A87-42128 Prediction of the reliability of aircraft part manufacturing processes (Diagnostika nadezhnosti tekhnologicheskikh protsessov izgotovleniia aviatsionnykh detalei). S. M. BOROVSKII and V. S. MUKHIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), no. 1, 1987, pp. 13-16. 7 Refs.

The problem of predicting the reliability of aircraft part manufacturing processes is reduced to that of determining the probability that a manufactured part will satisfy the corresponding specifications with respect to a single generalized or differential parameter characterizing the quality of the surface layer. It is shown that the approach proposed here makes it possible to continuously refine the quality control of the surface layer using the accumulated experience of quality assurance.

A88-50715 Design features of fiber-optic communications systems and sensors (Osobennosti sozdaniia volokonno-opticheskikh sistem sviazi i datchikov). V. V. ABRAMOV, E. M. BAZARNYI, E. N. BAZAROV, V. V. GRIGOR'YANTS, I. V. GULIAEV et al. IN: *Problems in contemporary radio engineering and electronics*, Moscow, *Izdatel'stvo Nauka*, 1987, pp. 104-118.

Research on fiber-optic communications systems and sensors carried out at the Institute of Radio Engineering and Electronics of the Soviet Academy of Sciences is reviewed. Particular attention is given to the use of electronic switching in the nodes or passive division of the fiber channels in distributed optical communications systems. Fiber-optic sensors of angular velocity, fluid refraction, temperature, and fluid level have been developed. The implementation features of these devices are examined.

A88-50575 High-latitude geophysical phenomena and the prediction of short-wave channels (Vysokoshirotnnye geofizicheskie iavleniia i prognozirovaniie korotkovolnovnykh radiokanalov). DONAT VLADIMIROVICH BLAGOVESHCHENSKI and GELII ALEKSANDROVICH ZHEREBTSOV, Moscow, *Izdatel'stvo Nauka*, 1987, 272 pp.

This book considers the specificity of distributions of decameter radio-waves at high latitudes and the possibility of predicting magnetospheric and ionospheric disturbances using short-wave radio channels. Models are presented for long-term and short-term (a few hours) predictions of the propagation of these disturbances. The effects of auroral substorms and global magnetic storms on the structure of propagating radio waves are examined. Empirical expressions are given which describe the relationships between various signal parameters, atmospheric radio noise, and geophysical effects. Recommendations for the selection of operating frequencies for various radio systems are presented.

A88-17858 Estimation of the accuracy of the identification of instrument errors of inertial navigation systems with additional rotation of the unit of sensitive elements (Otsenka tochnosti identifikatsii instrumental'nykh pogreshnostei inertsiial'nykh navigatsionnykh sistem pri dopolnitel'nom vrashchenii bloka chuvstvitel'nykh elementov). A. V. REPNIKOV, V. A. TIKHONOV, and A. V. VAL'DOVSKI, *Priborostroenie* (ISSN 0021-3454), Vol. 30, Oct. 1987, pp. 62-67.

It is shown that the modulation of the instrument errors of an INS by harmonic functions with the rotation of the sensitive-element unit (SEU) makes it possible to obtain analytical expressions for solving covariation equations for the optimal-estimation errors. The accuracy and convergence rate of the estimation process can be controlled by changing the angular velocity of the additional rotation of the SEU.

A88-40304 Scalar estimation of multidimensional dynamic systems (Skaliarnoe otsenivanie mnogomernykh dinamicheskikh sistem). OLEG STEPANOVICH SALYCHEV, Moscow, *Izdatel'stvo Mashinostroenie*, 1987, 216 pp. 14 Refs.

The theory and methods for estimating multidimensional systems in scalar form are presented. In particular, attention is given to traditional methods of optimal estimation, scalar estimation and identification of multidimensional dynamic systems, wave representation of real perturbations in problems of the scalar estimation of multidimensional dynamic systems, and the use of scalar estimation algorithms for determining the errors of inertial navigation systems. The discussion also covers the initial orientation of inertial navigation systems using scalar estimation methods and scalar extrapolations of measured state vector components.

Japanese Aerospace Literature This month: Aircraft Systems

A88-42074 Properties of coherent optical communication with received quantum state control and its capacity. OSAMU HIROTA, YOSHIHIRO YOSHIDA, MASAO NAKAGAWA, and MIKIO TAKAHARA, *Institute of Electronics, Information and Communication Engineers, Transactions* (ISSN 0913-574X), Vol. E71, April 1988, pp. 372-375. 17 Refs.

An attempt is made to counteract the transmission loss degradation of the advantages obtainable in optical communications by such nonstandard quantum states as the two-photon (or 'squeezed') state and the photon-number state. A clarification is presented of the properties of a coherent optical communication system employing a received quantum state controller; this proposed system is found to furnish noise-free operation, on the basis of its squeezer and phase-shift components' performance.

A88-50574 A digital adaptive flight control system design for aircraft with varying stability derivatives. YUZO SHIMADA, NOBUHIKO KOBAYASHI, and HIROAKI MIYAZAWA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 36, no. 413, 1988, pp. 304-311. 12 Refs.

The analytical derivation of an adaptive digital FCS for aircraft with continuously varying stability derivatives is outlined, and the performance of a prototype controller is demonstrated by means of numerical simulations of an advanced jet fighter. Existing controllers for linear time-varying systems are modified by introducing a parameter-adjustment algorithm which synthesizes the input to the aircraft from estimates of the dynamic-pressure power coefficients. The simulation results are presented in graphs, and the proposed controller is found to exhibit good adaptive capabilities.

A88-46049 Large motion robust flight control of aircraft by equivalent nonlinear elimination. SHOKICHI KANNO and TATSUO CHUBACHI, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 31, May 1988, pp. 48-60. 7 Refs.

This paper is concerned with the large motion robust flight control of aircraft by the theory of approximate perfect servo and equivalent nonlinear elimination method. The perfect servo means that the transfer matrix is $I(m)$, and the output, follows asymptotically any bounded arbitrary com-

mand inputs. The nonlinear dynamics of aircraft are equivalently eliminated by the equivalent elimination, and this operation does not need any numerical computation of aircraft dynamics. This system is robust and stable, being indifferent to the change of flight conditions and to the variation of aircraft dynamics. Simulations about a high speed aircraft showed very good results.

A88-46046 Synthesis of an adaptive flight controller under unknown deterministic disturbances. KIMIO KANAI, SHIGERU UCHIKADO, PETER N. NIKIFORUK, and NORIYUKI HORI, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 31, May 1988, pp. 1-17. 12 Refs.

Two methods of designing an adaptive flight control system are developed using an algebraic polynomial method. The first is based on the direct control method, which identifies the plant parameters implicitly, and the second on the indirect method, which does this explicitly. The controllers which are designed using these schemes are able to take account of the uncertainties in the aircraft's stability and control derivatives, and are robust against the deterministic disturbances. Their application to the flight control of small, high-performance aircraft is examined using numerical simulations which show that the proposed schemes are effective.

A88-38344 Development of fiber optic data bus for aircraft. YUTAKA KOMOUCHI and AKIRA SUEOKA, *Mitsubishi Heavy Industries Technical Review* (ISSN 0026-6817), Vol. 25, Feb. 1988, pp. 57-60.

An account is given of the design, construction, and both ground and flight testing of a star-coupled fiber-optic data bus consisting of an optic coupler, fibers, a connector, and a transmitter/receiver. This system precludes spark/fire hazards and crosstalk problems, while offering very small size and weight for a given capability. The communication protocol for the data bus is of 1 Mbit/sec command response type, and its design attempted to minimize the effect on electronic interfaces as a result of conversion from electrical to fiber-optic buses.

A88-44653 Performance evaluation and design method for statistical failure detection system using Modified Sequential Probability Ratio Test. TAKESHI HASHIMOTO and HARUO KIMURA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 36, no. 412, 1988, pp. 249-254, 17 Refs.

Equations for evaluating the performances of a failure detection system, whose task is to detect changes of some parameters in an object system, are derived as functions of the design parameters in the detection system, and a design method of the detection system based on the equations is proposed. This detection system consists of the Kalman filters and the Modified Sequential Probability Ratio Test. The usefulness of this design method is examined by means of numerical simulations for the parameter changes in a second-order system and for the failure in an aircraft stability augmentation system.

A88-44652 Design of adaptive control system with stochastic disturbances and its application to C flight control system. KIMIO KANAI, SHIGERU UCHIKADO, and MITUHIRO SAKAYANAGI, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 36, no. 412, 1988, pp. 242-248, 13 Refs.

Two design methods of adaptive flight control system with stochastic disturbances are considered. The first method ensures that the expected output error zero approaches asymptotically, and the other is based upon the minimum variance control. Both methods are designed via the polynomial algebraic method, which is a good tool to construct the control system easily. These methods are applied to the flight control system of a small-size high-performance aircraft, and numerical simulations under the stochastic environment can be shown to justify the proposed schemes.

A88-24505 Large motion flight control system design for aircraft by the theory of perfect servo. SHOKICHI KANNO, AKIRA HASHIMOTO, and TATSUO CHUBACHI, *Japan Society for Aeronautical and Space Sciences Transactions* (ISSN 0549-3811), Vol. 30, Nov. 1987, pp. 133-149, 9 Refs.

A decoupled and linearized tracking flight control system design for the large motion of aircraft is analyzed as an application of the theory of a nonlinear perfect tracking servo. The nonlinear rigid body dynamics are considered, but the nonlinear aerodynamics are neglected. The nonlinear terms of state equations are estimated and transformed to be added to the input signals of aircraft, and the nonlinearities are canceled. These nonlinear compensations permit the aircraft system to become linear. The precompensators with signal limiters and subcompensators are added, and the nonlinear perfect servo systems are achieved. The transfer matrix of this servo equals I3, even if the signals are saturated. Simulations on a high-speed aircraft show good results.

A88-26134 Chemiluminescent ozone instrument for aircraft observation. Y. KONDO, H. KOJIMA, N. TORIYAMA, Y. MORITA, M. TAKAGI et al., *Meteorological Society of Japan Journal* (ISSN 0026-1165), Vol. 65, Oct. 1987, pp. 795-802.

Research supported by the National Institute of Polar Research and MOESC. Publication Date: Oct. 1987 10 Refs. A chemiluminescent ethylene-ozone instrument based on a commercial instrument are described. The original instrument was modified so that it can control the sample and ethylene flow rates irrespective of the ambient pressure and temperature. The modified instrument displays sensitivity that is highly dependent on the sample mass flow rate. The sensitivity changes little between 1000 and 500 mb, and the sensitivity change as a function of the ethylene mass flow rate is much less than that of the commercial instrument. The error associated with the stability of the zero level and the standard deviation from a linear relationship is less than 1 ppbv. The results of observations of ozone up to the altitude of 6 km, carried out aboard an aircraft on December 16 and 17, 1985, are presented. The flow control system was able to maintain flow rates constant to within 3 percent.

A88-23319 Development of digital electronic control for aero-engine. TATSUKI SATOH, MINEO KISHIMOTO, MASAHIRO KUROSAKI, and MINORU ARAHATA, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 27, Sept. 1987, pp. 281-287.

Digital electronic control for aeroengines has been advancing from the development phase into practical applications. Integrated flight and propulsion control may improve the control performance of total aircraft systems. In this paper, the performance improvement of engines and propulsion systems due to the introduction of digital electronic control is explained. An outline of the system configuration is presented, and results of tests on FADEC (Full Authority Digital Electronic Control) systems in the XF3-30 turbofan engine and the TF40 reheat turbofan engine are reviewed.

A88-18329 On the feasibility study of a DME-based navigation system in Japan. SUMIO MOTOYAMA and MORIYUKI MIZUMACHI, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 404, 1987, pp. 439-446, 6 Refs.

A study is performed on the feasibility of a DME-based RNAV system in Japan, where the usage of such an airborne equipment is not authorized. Here a navigation method is proposed that utilizes three DME stations (responders) and the airborne altimeter to obtain the positional information of an aircraft. Computations show how effective the navigation system could be with the current Japanese DME facilities (counting a little more than a hundred). The HDOP is used as the evaluation parameter. Results show that the DME-based navigation would exhibit adequate char-

acteristics on the enroute area all over Japan and vicinity; except Okinawa region where geographical conditions rule out a favorable configuration of DME stations.

A88-13094 Flight test results for a GPS receiver in a helicopter and a business aircraft. TOSHIMICHI OKITA and AKIRA IGA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 396, 1987, pp. 57-62, 7 Refs.

Flight test results for the four-channel GPS receiver in helicopters and turboprop business aircraft are reported. No effect of the helicopter rotary wing on the GPS receiver was observed. A block diagram of the receiver is presented.

A88-13093 GPS receivers for air navigation. CHOGO SEKINE, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 396, 1987, pp. 51-56.

The paper describes the design and characteristics of the GPS receiver for air navigation using the C/A code. Various functions of the GPS receiver are considered, including the single-channel sequence, the high-speed single-channel sequence, and the five-channel sequence.

A88-13090 GPS/INS hybrid navigation for aircraft. NAOHIRO YAMASHITA and HIROSHI KIJIMA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 396, 1987, pp. 29-36, 7 Refs.

The efficiency of the GPS/INS hybrid navigation system is evaluated by computer simulation. In the GPS the error was found to increase with maneuvering of the aircraft, while in the INS the error was found to increase with time. Future prospects for the hybrid system are assessed.

A88-13088 Civil aviation application of the Global Positioning System (GPS) and its issues. KOICHI KIMURA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 396, 1987, pp. 15-21, 17 Refs.

Recent trends in the utilization of the GPS for civil aviation are reviewed. Attention is given to GPS precision, the user equivalent range, and the probable error. The relationship between satellite radio-position determination and the GPS is examined.

A88-13087 A hybrid navigation system with GPS. TORU TANABE and MASATOSHI HARIGAE, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 396, 1987, pp. 8-14, 15 Refs.

The design, characteristics, and performance of a hybrid navigation system using the GPS are described. The designs of the GPS-INS, GPS-STAR, and GPS-INS-STAR systems are discussed and compared. The performance of the GPS receiver with a digital signal processor is examined.

A88-13086 An overview of space and aircraft navigation. TATSUKI KOSHIO, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 396, 1987, pp. 2-8, 12 Refs.

Recent developments connected with the utilization of navigation satellites for the GPS and for air traffic control are reviewed. Consideration is given to the airspace management system and to the operating principles of STAR GPS. The future prospects of navigation satellites are assessed.

A87-51981 On design of restructurable control systems for aircraft with some failures. KIMIO KANAI and YOSHIMASA OCHI, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 401, 1987, pp. 311-317, 7 Refs.

Computer simulations of a model of a large scale aircraft are used to design an aircraft control system which automatically restructures itself to accommodate failures and to restore safety and performance. The case of a broken vertical tail and failure of the hydropressure system is considered. The effects of the vertical tail breakage on the dynamic characteristics of the aircraft, and the effectiveness of thrust control using an optimum regulator, are evaluated. A restructurable control system composed of parameter identification and optimal regulator subsystems is then designed.

A87-45097 Design of CCV flight control system of STOL flying boat. KIMIO KANAI, SHIGERU UCHIKADO, and YOSHIKAZU MORITA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 399, 1987, pp. 221-228, 8 Refs.

A control-configured-vehicle (CCV) approach to the flight control of an STOL amphibian aircraft during approach and sea landing (as in rescue operations) is developed analytically and demonstrated by means of numerical simulations. The problems imposed by low-speed approach and the inadequacy of simple automatic throttle control are discussed; the basic principles and implementation of the CCV system are outlined; and the simulation results are presented graphically.

A87-45096 An approach to the synthesis of an adaptive flight control system with incomplete information. KIMIO KANAI and SIGERU UCHIKADO, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 399, 1987, pp. 214-220. 7 Refs.

The change of flight condition leads to variation in an aircraft's parameters. It can also vary the order of the numerator in the pulse-transfer function of such an aircraft. This means, in the discrete-time case, a change in the time delay. It is difficult under these circumstances to maintain the performance of an aircraft with conventional control methods. Here, as an alternative scheme, an adaptive flight control system is proposed which can be used for aircraft with unknown time delay and parameters. By introducing a polynomial identity based on the upper bound on time delay, the control system can be synthesized simply, in spite of the unknown time delay, as in standard model-reference adaptive-control systems. Simulation studies are carried out for small high-performance aircraft to substantiate the analytical work.

A88-16130 Millimeter-wave personal satellite communications experiment. YOSHINORI ARIMOTO, YOSHIKI SUZUKI, RYU MIURA, TADASHI SHIOMI, and TAKASHI IIO et al., *IAF, 38th International Astronautical Congress*, Brighton, England, Oct. 10-17, 1987. 8 pp. 8 Refs. (IAF Paper 87-487)

The concept of experimental millimeter-wave (43/38 GHz) satellite communications systems is discussed, and five demonstrative applications (a portable video phone system, a portable news gathering and distribution system, an observation data transmission system, a communication system for the Asia-Oceanian region, and a mobile information service system) are considered. A millimeter-wave satellite transponder for ETS-VI (to be launched in 1992) is described, in addition to the frequency selection in the millimeter wave band. Key elements of the component design, including the receiver front-end, the local oscillator, and the solid state power amplifier, are also discussed.

A87-49436 Hierarchical multistability and cooperative flip-flop operation in a bistable optical system with distributed nonlinear elements. KENJU OTSUKA and KENSUKE IKEDA, *Optics Letters* (ISSN 0146-9592), Vol. 12, Aug. 1987, pp. 599-601. 7 Refs.

Hierarchical multistabilities featuring spatial period-doubling bifurcations, all types of optical multivibrator operations, and temporal-to-spatial code conversion have been predicted theoretically for a bistable system with distributed nonlinear elements. Various types of flip-flop, which provide key functions for optical signal processing, have also been demonstrated on an all-optical basis. These functions are attributed to the collective behavior of coupled nonlinear elements and cannot be achieved in conventional single-element bistable devices.

A87-28771 Recent advances in coherent fiber communication systems. TAKANORI OKOSHI, *Journal of Lightwave Technology* (ISSN 0733-8724), Vol. LT-5, Jan. 1987, pp. 44-52. 61 Refs.

Research and development of coherent optical fiber communications have been accelerated, mainly because of the possibility of receiver sensitivity improvement reaching 20 dB, and partly because of the possibility of frequency-division multiplexing (FDM) with very fine frequency separation. In this paper, recent advances in the research on coherent optical fiber communication systems are reviewed, with emphasis on those reported in the past two years. The bit-error rate measurements so far reported are classified and investigated in four categories: PCM-ASK, PCM-FSK, PCM-PSK, and PCM-DPSK. The states-of-the-art of polarization-state stabilization techniques are also discussed.

A88-13088 Civil aviation application of the Global Positioning System (GPS) and its issues. KOICHI KIMURA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 35, no. 396, 1987, pp. 15-21. 17 Refs.

Recent trends in the utilization of the GPS for civil aviation are reviewed. Attention is given to GPS precision, the user equivalent range, and the probable error. The relationship between satellite radio-position determination and the GPS is examined.

A88-13080 Design study for an FBW lateral control system. YUICHI HONDA, YASUO TAKEUCHI, and HISANAO NAKAYAMA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 34, no. 394, 1986, pp. 600-607. 5 Refs.

A fly-by-wire (FBW) lateral control system for transport aircraft has been designed, and its safety and reliability have been investigated. System control requirements and examples of control-system failure for the FAR 25 are discussed. Flying quality requirements are discussed along with problems in the design of the FBW control system.

A87-45649 +Gz tolerance and the physical characteristics of JASDF fighter pilots. CHIEKO MIZUMOTO, TADAO YANAKA, MASAOKI IWANE, AKIO NAKAMURA, TSUTOMU ARIMORI et al., *Reports of Japan Air Self Defence Force Aeromedical Laboratory* (ISSN 0023-2858), Vol. 27, Dec. 1986, pp. 123-138. 29 Refs.

The relationship between the +Gz tolerance and the physical parameters of fighter pilots was studied. A total of 123 JASDF F-15 trainees were evaluated for +Gz tolerance while performing spontaneous anti-G straining maneuvers without anti-G suits. Gradual onset run (GOR) and rapid onset run (ROR) G-patterns were used to assess the tolerance. The mean value of G-tolerance for GOR and the mean endurance time for ROR were

5.7 + or - 0.7 Gz and 53 + or - 19 sec, respectively, and the correlation between them was statistically significant. The G-tolerance for GOR correlated with Rohrer's index; that for ROR had the highest correlation with the increment of heart rate. Multiple regression analysis showed that the G-tolerance for GOR appeared to depend on the physical constitution and the responsiveness of the cardiovascular system, while that for ROR depended on these factors and on the degree of endurance of the abdominal musculature.

A87-43222 Electro-physiological measurement system for T2/CCV flight test. ATSUSHI KADOO and MIKIO ONO, *Reports of Japan Air Self Defence Force Aeromedical Laboratory* (ISSN 0023-2858), Vol. 27, Sept. 1986, pp. 101-109. 17 Refs.

Pilot psychophysiological responses during direct lift control and direct side force control (DSC) flight maneuvers by T2/CCV research aircraft were measured in order to develop electrophysiological measurement devices and to determine psychophysiological effects during DSC flight maneuvers. The electrocardiograph and electromyograph responses were determined, and the sitting pressure index representing lateral deviations of the body axis due to Gy forces was ascertained. The electrophysiological measurement devices developed were useful in actual flight, except for the EMG measurement device, which experienced electrical noise interference. The noise reduction problem was solved, however. No remarkable trend caused by Gy forces during test flights was detected from mean heart rate changes and sitting pressure changes, so long as the Gy force was not too high.

A87-32507 Observation of precipitation from space by the weather radar. KENICHI OKAMOTO, HARUNOBU MASUKO, SHIN YOSHIKADO, KENJI NAKAMURA, and MASA HARU FUJITA et al., *IN: 15th International Symposium on Space Technology and Science*, Tokyo, Japan, May 19-23, 1986, Proceedings. Vol. 2 (A87-32276 13-12). AGNE Publishing, Inc., 1986, pp. 1711-1720. 14 Refs.

Progress to date on the development of a spaceborne active microwave weather radar by the Japan Radio Research Laboratory is summarized. The experiments have included joint operation with NASA of an airborne microwave rain scatterometer/radiometer functioning in the X- (9.86 GHz) and Ka-bands (34.45 GHz). Features and performance of the jointly operated system are described, including the scanning patterns explored, the principal characteristics of the radiometers, and data processing and display subsystems, which furnished quick-look color imagery for viewing within the aircraft. Results are reported from comparisons of the rainfall rate estimates obtained with a least-squares method with equivalent data from a ground-based C-band radar, and from measurements of rainfall over the ocean in terms of the attenuation coefficient. Preliminary specifications are provided for a spaceborne weather radar system.

A87-32419 Experimental mobile satellite system (EMSS) using ETS-V. YOSHIHIRO HASE, SHINGO OHMORI, and KATSUHIKO KOSAKA, *IN: 15th International Symposium on Space Technology and Science*, Tokyo, Japan, May 19-23, 1986, Proceedings. Vol. 1 (A87-32276 13-12). AGNE Publishing, Inc., 1986, pp. 1069-1074.

Radio Research Laboratory has been developing a mobile satellite communication system. The satellite to be used in this system is called Engineering Test Satellite-five (ETS-V) and is scheduled to be launched in the summer of 1987. The main purpose of the system is to perform experiments on maritime and aeronautical satellite communications. Experiments on land mobile communications are also to be carried out. L-band frequencies for links between the satellite and mobile earth stations and C-band frequencies for the feeder link between the satellite and a coastal/aeronautical earth station are used in the system. The service area extends to the North Pacific Ocean including Japan and the West Pacific Ocean. In the system, various digital communication experiments are to be carried out through SCPC, TDM/TDMA, and SS channels. This paper describes items of experiments and facilities of the system. This system is an integrated mobile satellite communication system for maritime, aeronautical, and land mobile services, and may be the first of this kind in the world except military systems, though it is not an operational system.

A87-32103 A design method of an aircraft with ACT by nonlinear optimization. EIICHI SAWAKI, MAKOTO KOBAYAKAWA, and HIROYUKI IMAI, *Japan Society for Aeronautical and Space Sciences Transactions* (ISSN 0549-3811), Vol. 29, Nov. 1986, pp. 142-162. 10 Refs.

In this paper, a new design method for an efficient system, which is effectively controlled with less energy by the linear optimal feedback control law, is presented, and applied to the design of an aircraft with ACT. If a system has design parameters under various constraints, the cost function which should be minimized by the optimal control law depends on these parameters. Using the 'Complex method', which is one of direct search methods for constrained nonlinear optimization, the design parameters are so determined as to minimize the cost function within the constrained region. As an example, this method is applied to the design of an aircraft with the GLA system, and the newly designed aircraft is compared with the original one designed by the conventional procedures. The results show that the cost function of the newly designed aircraft is reduced considerably and the effect is exemplified through digital simulations and the power spectral density of controlled variables.

A87-32101 Transonic and supersonic lateral control of aircraft by adaptive perfect servo. TATSUO CHUBACHI and AKIRA HASHIMOTO, *Japan Society for Aeronautical and Space Sciences Transactions* (ISSN 0549-3811), Vol. 29, Nov. 1986, pp. 121-133. 5 Refs.

The system stated here is a kind of adaptive tracking servo which implies saturation of internal signals at the transient state. The closed loop transfer function is 12 for this system, and hence the outputs follow the bounded arbitrary inputs without steady errors, if the system constitution is exact. The system is analogous to the so-called pre-differential servo. This system is applied to the transonic and supersonic flight control of the lateral system of F4C fighter aircraft. The simulation showed fairly good results.

A87-30227 On the construction of an adaptive flight control system with the angle limitation of control surface. TETSUROU NOGUCHI and KIMIO KANAI, *Japan Society for Aeronautical and Space Sciences Transactions* (ISSN 0549-3811), Vol. 29, May 1986, pp. 12-33. 10 Refs.

The problem of constructing an adaptive flight control system for an aircraft with the angle limitation of control surface is addressed. In the first part of this paper, by introducing a dispersion filter which makes it possible to discuss the construction of an adaptive control system as a linear problem for the plant with an input amplitude limitation, a synthesis method which can construct a finite-time settling adaptive control system of a time-invariant discrete scalar system with an input amplitude limitation is proposed. In the second part, this proposed scheme is applied to solve the problem of constructing an adaptive flight control system for both a supersonic and a VTOL aircraft with the angle limitation of control surface. It is shown that an adaptive longitudinal control augmentation system for both cases can be constructed. Simulation studies are included in order to demonstrate the effectiveness and the features of the proposed scheme.

A87-30226 Control of aircraft by decoupled high feedback gain servo. TATSUO CHUBACHI, *Japan Society for Aeronautical and Space Sciences Transactions* (ISSN 0549-3811), Vol. 29, May 1986, pp. 1-11. 6 Refs.

In this paper a method of analysis of nonlinear high feedback gain tracking servo with signal saturation is introduced in the frequency domain, and as an application of it, a design method of lateral tracking servo system for aircraft is described. In this method, the system is decoupled into roll and yaw systems by suitable feedback, and is transformed into a single input and single output problem. Next a transfer function is set almost positive real, and an attempt is made to stabilize the nonlinear systems. This system is highly robust or insensitive to the variation of flight conditions. Simulations about a high speed aircraft showed satisfactory results.

A87-28435 Development and experiment of airborne microwave rain-scatterometer/radio meter system. I - Hardware system. II - Experimental data processing software system. KENICHI OKAMOTO, TAKEYUKI OJIMA, SHIN YOSHIKADO, HARUNOBU MASUKO,

HIDEYUKI INOMATA et al., *Radio Research Laboratory Review* (ISSN 0033-801X), Vol. 32, June 1986, pp. 55-105. 42 Refs.

The features and performance of the hardware and software and the results of analyses of data gathered with an experimental airborne microwave scatterometer precipitation sensor (AMPS) are reported. AMPS has both active (10 GHz and 34.5 GHz) and passive (9.86 GHz and 34.21 GHz) microwave elements. The system was mounted on a Cessna 404 and used to scan the tops of raining areas through clouds during 80 hr of test flights. Details of the system software, including the pre-processing, data analysis, data display and support programs, their outputs and the hardware realizations and the performance of the subsystems are discussed. (M.S.K.)

A87-21276 Boeing 747 crash accident - A theoretical consideration on the variation of the internal pressure. HIROICHI OHIRA, *Kyushu University Technology Reports* (ISSN 0023-2718), Vol. 59, June 1986, pp. 249-255.

The Boeing 747 accident which occurred in Japan on Aug. 12, 1985, is studied. Under the assumption that the pressure dome broke first, the variation of the pressure in the afterbody is analyzed theoretically. The cases of the pressure relief opening and not opening are both examined. It is shown that the net pressure applied to the fin never exceeded 1 atm, and that the fracture of the fire wall occurred last. The fracture was caused by collapse of the vertical tail. Various phenomena such as the 'white mist' and the drop of oxygen masks can be predicted.

A87-12676 Navigation and environment. Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 Japan Institute of Navigation, 1986, 341 pp.

Papers are presented on hydrographic contributions to safety at sea from 1975-1985; laser airborne depth sounding in Australia; the electronic chart; disturbances to airborne navigation and communication systems caused by atmospheric statics; navigation by gradient of geophysical parameter; the safe distance of nautical equipment from magnetic compasses; monitoring of the terminal flight phases environment; and routing and the environment. Consideration is given to the global radio navigation system; the GPS; an integrated GPS/dead-reckoning system; the ring laser gyro dither positional pickoff; characterizing height keeping error distribution using indirect observations; the microwave landing system; air traffic control systems; the aircraft flight deck; the use of differential Loran-C in Norwegian offshore activities; multiradar tracking; and the identification of marine vessels from ship and shore. Topics discussed include interference of the aeronautical Navids from FM broadcasting services; probability estimation of oil spills from a tanker; a unified certification system for merchant marine officers; human dynamic response to the oscillatory motion of fishing vessels in the application of the collision rate as a danger criterion for marine traffic; and the safety of modern shipping and requirements in hydrographic surveying and nautical charting.

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