China International Conference on Inertial Technology and Navigation（CICITN 2016）

1st November, 2016　　China Hall of Science and Technology, Beijing

Officially established in 1987 with the approval of China Ministry of Civil Affaires and China Association for Science and Technology, Chinese Society of Inertial Technology (CSIT) is a first class national society with more than 4000 existing members, over 150 group members and 6 local societies (Shanghai, Nanjing, Chongqing, Luoyang, Xi'an and Harbin). Edited and published academic journals such as《Journal of Chinese Inertial Technology》(included by EI) and《NAAS & Inertial Technology》, CSIT held all kinds of internal and international academic exchange activities more than 300 times. CSIT builds a broad academic platform for inertial technology works.

◆ Conference Date ◆

1st November, 2016

◆ Conference Place ◆

China Hall of Science and Technology

No.3 Fuxing Road, Haidian District, Beijing China.

◆ Sponsor ◆

Chinese Society of Inertial Technology

◆ Chair ◆

Weimin Bao　Academician

◆ Honorary Chair ◆

Henggao Ding　Academician　　Yuanjiu Lu　Academician

◆ Co-Chair ◆

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Alain L.Kornhauser	Professor	Princeton University	USA
Peide Feng	Academician	Beihang University	China
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Lianggui Xie	Assistant General Manager	China Aerospace Science and Industry Corporation	China
Wei Wang	Academician	Beijing Institute of Aerospace Control Devices	China
Jiancheng Fang	Academician	Beihang University	China
Weiren Wu	Academician	CNSA Lunar and Space Exploration Program Center China Nation Space Administration	China

ð Conference Session Ô

1. Inertial Sensor Technology
2. Inertial Navigation System Technology
3. Inertial Navigation Technology and Application

ð Agenda Ô

Conference Agenda

Date:31st October, 2016 **Place: China Hall of Science and Technology**

Time	Content	
08:30-18:30	**Registration**	**Lobby Hall, Building B**
18:30-20:00	**Reception Dinner**	**Multi-function Hall B205, Building B**

Date:1st November, 2016 **Place: China Hall of Science and Technology**

Time	Content	Speaker	Host
09:30-10:30	**Opening Ceremony, Conference Room B309, 3rd Floor, Building B**		
09:30-09:40	Introduce the guests	Wei Wang	Wei Wang
09:40-09:50	Address	Weimin Bao	
09:50-10:00	Address	Alain L. Kornhauser	
10:00-10:20	**Group Photo + Break**		
10:20-12:00	**Plenary Session**		
10:20-12:00	1.Development of Inertial Technology (Wei Wang)		Fei Liu
	2.Vision of Driverless Mobility: Where We Are, How We Will Get Along The Way (Alain L. Kornhauser)		
	3.Atomic Gyroscope: Technology and Prospective (Jiancheng Fang)		
	4. Status and Development Trends of Metrology in Micro and Nano Electronics Manufacturing (Krivtcov Evgenii)		
12:00-14:00	**Lunch + Break, Banquet Hall, 1st Floor, Building B**		
14:00-17:30	**Programme Session**		
18:00-19:30	**Dinner, Banquet Hall, 1st Floor, Building B**		

1st November 14:00-17:00 Conference Room B303, 3rd Floor Building B		
Session ÑAE Inertial Sensor Technology **Host** E Oleg A.Stepanov		
14:00-14:15	Optical-electronic Systems for Monitoring and Control in The Technogenic Environment	Valery V. Korotaev (ITMO University)
14:15-14:30	Vibration Induced Bias Drift of Fiber Optic Gyro and Improvement Methods	Shuying Zhang (Tianjin Navigation Instrument Research Institute)
14:30-14:45	A Low Phase Noise Raman Laser System for Atom Interferometer	Xiangxiang Lu (Beihang University)
14:45-15:00	Self-Adaptive Path Length Control Technique for Zero-lock Laser Gyroscope	Meng Wang (Avic Xiôan Automatic Control Research Institute)
15:00-15:15	Error Compensation for Fiber Optic Gyroscope under High-frequency Angular Vibration Based on RBF Neural Network Analysis	Feng Zhang (Beijing Institute of Aerospace Control Devices)
15:15-15:30	Design and Error Analysis of a Ground-used Electrostatically Suspended Accelerometer	Jilong Kou (Tsinghua University)
15:30-16:00	**Tea break**	
Session ÑAE Inertial Sensor Technology **Host** E Ningfang Song		
16:00-16:15	Nonlinear Identification Algorithm for Error Model Structure of Navigation Systems and Sensors	Oleg A.Stepanov / Andrei Vladimirovich Motorin (ITMO University)
16:15-16:30	Key Points of High Precision Solid-core Photonic Crystal Fiber FOGs	Xiaobin Xu (Beihang University)
16:30-16:45	Study of Influence of Probe Laser Frequency on Nuclear Magnetic Resonance Gyro	Yan Wang (Beijing Institute of Aerospace Control Devices)
16:45-17:00	The Vibration Control of a Vibratory Gyro with Conical Shell Resonator	Zhen Lin (Beijing Institute of Technology)
1st November 14:00-17:00 Conference Room B304, 3rd Floor Building B		
Session ÑBE Inertial Sensor Technology **Host** E Igor Konyakhin		
14:00-14:15	Electrostatic Gyros with Solid Rotors for Gimballess Attitude Reference and Control Systems	Boris Efimovich Landau (State Research Center of the Russian Federation Concern CSRI Elektropribor, JSC)
14:15-14:30	Research on Navigation Level Full Silicon MEMS Accelerometer Wafer Level Hermetic Packaging	Qifang Hu (Beijing Institute of Aerospace Control Devices)
14:30-14:45	Development of Near Gaussian-shaped Spectrum Erbium-doped Fiber Source in Double-pass Back Configuration	Fei Hui (Tianjin Navigation Instrument Research Institute)
14:45-15:00	Atom Interferometer for High-Rate Inertial Measurements	Bonan Jiang (Beijing Institute of Aerospace Control Devices)
15:00-15:15	Miniaturized Three-axis Photonic Crystal Fiber Optical Gyroscope Technology Based on Small Diameter Fiber	Jingming Song (Beihang University)
15:15-15:30	Analysis of Shupe Error in The Interferometric Fiber Optic Gyroscope Based on A New Model of Fiber Coil	Xiaodan Wang (Tianjin Navigation Instrument Research Institute)
15:30-16:00	**Tea break**	
Session ÑBE Inertial Sensor Technology **Host** E Xuefeng Wang		
16:00-16:15	Research The Optic-electronic Systems for Control Deformation of Millimeter Wave Range Radiotelescope Mirrors	Igor Konyakhin (ITMO University)
16:15-16:30	A Digital Controlled Heating System for The Nuclear Magnetic Resonance Gyroscope	Yicheng Deng (Beijing Institute of Aerospace Control Devices)
16:30-16:45	Analysis on The Hysteresis Phenomenon of Fiber Gyro Scale Factor Model and Compensation Technology	Zhihuai Yang (Tianjin Navigation Instrument Research Institute)
16:45-17:00	Key Technics and Experimental Research of Resonance Photonic Crystal Fiber Optical Gyroscope	Huaiyong Yu (Beijing Institute of Automatic Control Equipment)

1st November 14:00-17:30 Conference Room B306, 3rd Floor Building B		
Session ñ E Inertial Navigation System Technology **Host** E Alexander Zbrutsky		
14:00-14:15	Contextual Processing for Pedestrian Tracking in Infrastructure-free and GPS-denied Environments	Enrico De Marinis (DUNE Srl)
14:15-14:30	MEMS Personal Navigation System Based on Highly Robust ZUPT	Yanyan Pi (Tianjin Navigation Instrument Research Institute)
14:30-14:45	The Effect of GNSS Spoofing on INS/GNSS Integrated Navigation System	Yang Liu (Northwestern Polytechnical University)
14:45-15:00	Error Characteristic Analysis of INS/CNS Integrated Navigation under Single Star Observation for HCVs	Rong Wang (Nanjing University of Aeronautics and Astronautics)
15:00-15:15	Innovative Divided Difference Filter for Mars Entry Navigation under Biases	Zirui Xing (Beijing Institute of Technology)
15:15-15:30	INS/VNS Integrated Navigation Method Based on Structured Light Sensor	Yunshu Wang (Nanjing University of Aeronautics and Astronautics)
15:30-16:00	**Tea break**	
Session ñ E Inertial Navigation System Technology **Host** E Lei Wu		
16:00-16:15	Inertial Sensors and Navigation Technologies	Alexander Zbrutsky (National Technical University Of Ukraine)
16:15-16:30	An Improved Regional Rapid Compensation Algorithm of Deflection of Vertical	Weng Jun (Northwestern Polytechnical University)
16:30-16:45	A Positioning and Orientation Method Based On Double Magnetic Beacons	Qinghua Li (Harbin Institute of Technology)
16:45-17:00	Based on The Recursive Measurement Update to Design Nonlinear Target Tracking Method	Yonggang Zhang (Harbin Engineering University)
17:00-17:15	Stereo Vision/MIMU Integrated Navigation System Based on Unscented Kalman Filter	Huan Yu (Beijing Institute of Technology)
17:15-17:30	Research on the Multi-sensor Information Fusion in Long-endurance UAVs Based on The Technology of ASPN	Jianxin Xu (Nanjing University of Aeronautics and Astronautics)

1st November 14:00-17:30 Conference Room B407, 4th Floor Building B		
Session Inertial Navigation Technology and Application		**Host** Golovan Andrey
14:00-14:15	The Research Status and Future Development Trend of Inertial Navigation System for Aircrafts in Hartron-Arkos Company	Anatoliy Kalnoguz (Hartron-Arkos Company)
14:15-14:30	Inertial Measurements Metrology-current Trends and Problem	Aleksandr Iankovskii (D.I. Mendeleyev Institute for Metrology(VNIIM))
14:30-14:45	Application of Model Reconstruction Method and Uncertainty Evaluation in Accelerometer Test on Precision Centrifuge	Yonghui Qiao (Beijing Institute of Aerospace Control Devices)
14:45-15:00	The Study of Multi-sensor Inertial Navigation System Application in Launch Vehicle System	Zhonghai Pei (Shanghai Institute of Spaceflight Control Technology)
15:00-15:15	A Self-alignment Algorithm with Unknown Latitude Based on Three Gravitational Vectors and Adaptive Denoising Method	Weiwei Lv (Southeast University)
15:15-15:30	Gravity Gradient Forward Calculation Method of Complex Shape Based on Finite Element Simulation	Wei Wang, (Tianjin Navigation Instrument Research Institute)
15:30-16:00	**Tea break**	
Session Inertial Navigation Technology and Application		**Host** Bo Wang
16:00-16:15	On Calibration of Strapdown Inertial Navigation System on A Low-grade or High-precision Turntables	Andrey Golovan (Moscow State University)
16:15-16:30	The Design of SINS Rapid Transfer Alignment Test System	Jinda Wang (China Airborne Missile Academy)
16:30-16:45	Optimal In-Flight Calibration Method for Inertial Navigation System Based on Constrained Kalman Filter	Lei Shi (Beijing Institute of Technology)
16:45-17:00	Multipurpose Control Laws for Marine Autopilots with Time Delay in Thrust System	Evgeny I.Veremey (Saint-Petersburg State University)
17:00-17:15	An Autonomous Calibration Method for Star Vectors Fusion of Multi-FOV Star Sensor	Zhilong Ye (Shanghai Institute of Spaceflight Control Technology)
17:15-17:30	A Precise Positioning System Based on Multiple Sensors Applied to Complex Environment	Fan Li (Northwestern Polytechnical University)

ð Contact Information Ô

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ð Speaker Introduction Ô

Report Development of Inertial Technology in China

Name Wei Wang

Title Academician of CAS
President of BIACD

Biography: Professor Wei Wang is academician of Chinese Academy of Sciences. He is one of the leading scientists in the fields of inertial technology and optical fiber sensing technology in China. With nearly 30 years experience in this field, he has published over 49 professional papers, has been awarded 26 Patents, and authored and co-authored 3 technical books. Professor Wei Wang has ever been the presiding designer of kinds of optical fiber sensors, including FOG and its inertial system for various crafts, he has proposed new optical fiber sensor technology system, described the error mechanism and its suppression methods systemically, and has been appointed the chief scientist of inertial system and optical fiber sensor system for space application in Chinese Aerospace Science Corporation (CASC). Professor Wei Wang is also president of Beijing Institute of Aerospace Control Devices of CASC, a precision optical mechatronics advanced information technology institution with more than 3000 employees, including 800 with Ph.D. degrees and M.D degrees.

Abstract: Inertial technology is the only effective measure to establish orientation, attitude and position references of moving carriers under all kinds of environments, which plays a significant key role in navigation, guidance and control applications. In this paper, the characteristics and the development process of inertial technology are briefly described and reviewed. The current development status and applications, such as manned aerospace, deep space and deep sea explorations, of inertial technology in China are introduced in terms of gyroscope, accelerometer and inertial system. Development trends of inertial technology are also discussed.

ð Speaker Introduction Ô

Report Vision of Driverless Mobility: Where We Are, How We Will Get Along The Way

Name Alain L. Kornhauser

Title Professor, Operations Research & Financial Engineering
Director, Transportation Program
Faculty Chair, Princeton Autonomous Vehicle Engineering

Biography: Teaching-Transportation Systems Planning & Analysis: Studied is the transportation sector of the economy from a systems technology and planning perspective; eCommerce: Electronic commerce, commonly called eCommerce, is broadly defined as the buying and selling of goods using electronic transaction processing technologies.
Recent Research-The development and application of activity-based trip synthesizers; large-scale network models; stochastic optimization techniques; computer graphics to transportation problems; the design of deep-learning neural networks aimed at the development of autonomous vehicles; the formulation, development and enhancement of planning, analysis and real-time management models for freight transportation systems, worldwide.

ð Speaker IntroductionÔ

Report Atomic Gyroscope: Technology and Prospective

Name Jiancheng Fang

Title Academician of CAS

Biography: Professor Jiancheng Fang is the academician of Chinese Academy of Sciences, vice-president of Beihang University (BUAA), ñCheung Kong Scholarò Chair P also the director of several laboratories, including Sino-UK Space Science &Technology Joint Laboratory, Ministry of Education, National key laboratory of Inertial Technology Laboratory, National key Laboratory of Fundamental Science ñNovel Inertial Instrume His research interest includes inertial instrument and navigation technology, with a focus on high precision inertial actuator for attitude control of new generation spacecraft and high performance inertial measurement instruments for airborne accurate earth observation. Professor Jiancheng Fang, as one of the outstanding young experts in China, has been devoting himself in the research of magnetic suspension inertial attitude control actuators of space exploration platform technology, inertial measurement and combined measurement technology, space exploration formation technology, as well as novel atomic inertia and magnetic field measurement techniques. His research work has made innovative achievements for China's development of space science and space exploration technology.

Abstract: Gyroscopes have become the core component of Inertial Navigation System (INS), and nowadays play a vital role in many systems which require accurate position, velocity and orientation information. The demand of higher-precision, lower-cost and more compact gyroscope is increasing in the future applications. With the development of quantum precision measurement technology, the emergence of atomic gyroscope based on the combination of quantum technology and traditional inertial technology provides a new technical approach for the improvement of INS.

According to the working principle, the atomic gyroscope can be divided into atomic interference gyroscope and atomic spin gyroscope. The theoretical accuracy of atomic interference gyroscope based on Sagnac effect is 10^{10} times of the optical gyroscope because the wavelength of atom matter waves is much smaller than the light. The atomic interference gyroscope has been achieved high measurement accuracy, but the integration and stability still need to be improved. Atomic spin gyroscope can be divided into Nuclear Magnetic Resonance (NMR) atomic gyroscope, Spin Exchange Relaxation Free (SERF) atomic gyroscope and atomic gyroscope based on NV centers in diamond. A NMR atomic gyroscope measures the rotation rate by detecting the nuclear spin precession frequency. The chip level NMR gyroscope manufactured by micromachining techniques has achieved the precision of the navigation level. The SERF atomic gyroscope works on the state of SERF by manipulating the electron spin of the alkali metal atoms, which results in the nuclear spin strong coupling between the electron spin of the alkali mental and the noble gas atoms. The atomic spin gyroscope based on SERF shows ultra-high sensitivity and compact size. The research progress of the atomic gyroscope based on NV centers in diamond is still in the early stage; however, its potential in miniaturization has attracted more and more researchers to this field.

This talk will mainly introduce the research foundation and several technical methods of the atomic interference gyroscope and three kinds of atomic spin gyroscope based on quantum effect. In the meanwhile, the future development direction of the atomic gyroscope will be discussed.

ð Speaker Introduction Ô

Report	Status and Development Trends of Metrology in Micro and Nano Electronics Manufacturing
Name	Krivtcov Evgenii
Title	Professor

Biography: In 1978, he was educated from the Geophysics Specialty in School of Physics of Leningrad State University. In 1986, he had thesis defense to candidate of technical sciences with the topic of *R&D on Reference Level Power Laser Direction Finding System and Its Metric Characteristic Research Methods*. Krivtcov Evgenii won the Prize of the Government of the Russian Federation with other members of the work team of other institutions in All-Russian Mendeleyev Metrology Institute in 1998.

In the aspect of seismic surveying, earthquake monitoring equipment and methods researched by Krivtcov Evgenii have been successfully applied in the research of positions for the arrangement of standard instruments of All-Russian Mendeleyev Metrology Institute and other institutions, including PTB (Physikalisch-Technische Bundesanstalt) and BIPM (International Bureau of Weights and Measures).

With regard to online acceleration measurement, he manufactured a unique high-accuracy measuring system calibration and check device according to the task of Russian State Corporation for Atomic Energy ïRosatom ò and Aviation Industry Corporation of Chinaïrosmos ò.

In 2003, he started the research on impact type absolute gravimeter. In 2008, he was appointed as the deputy director in charge of scientific research. He is responsible for organizing and completing the maintenance and development of standard base of All-Russian Mendeleyev Metrology Institute, participating in the international check of the most important work finished by research institutions for the benefits of Russian Standards Committee and industrial enterprises and representing All-Russian Mendeleyev Metrology Institute in international conferences, including entering APMP.

Now, as the deputy director in charge of scientific research, he supervises the scientific departments of the research institute directly (magnetic survey, ionizing radiation parameters measurement and motion parameters measurement, etc.), including the most meaningful and important work directions (specialized planning of federation and department, redefinition of basic units in International System of Units, etc.).

ð Speaker Introduction Ô

Report Optical-electronic Systems for Monitoring and Control in The Technogenic Environment

Name Valery V. Korotaev

Title Academician

Biography: Valery Korotaev is a member of Russian Academy of Engineering, the head of the teaching and research office of optics of the Russian Saint Petersburg Information Technology, Machinery and Optics University, and members of several Russian and international optical organizations. In addition to the position as the academic leader of the profession of photoelectric instrument and video information processing, he is also the director of the photoelectric instrument research and education centre, and the director of the optics and laser system research centre.

Abstract: Modern man-made environment is characterized by large number of constructed and designed ground and water facilities, both production and general urbanistic: stadiums, water parks, floating docks. Ensuring failsafe functioning of the facilities under natural and operational loads is an important social and technical task. Deformation (settlements, displacement and bend) of foundations and load bearing structures resulting from movements and general instability of construction is one of the main reasons for accidents risk for large facilities. This papers is devoted principle technical solution for design of the universal optical-electronic system for control and monitoring of the technical condition of the large structures and facilities. The system based on using the reference LED marks and CMOS photodetector array as analyzer. The system allows continuous monitoring of the objects deformation by analyzing the linear displacement of the reference marks rigidly connected with the elements of the construction, issuance and display data on the monitor, as well as the transmission of information in digital form via RS-485, Ethernet or USB.

ð Speaker Introduction Ô

Report	Vibration Induced Bias Drift of Fiber Optic Gyro and Improvement Methods
Name	Shuying Zhang
Degree	Master

Biography: She graduated from Tianjin University in January 2012, works in Tianjin Navigation Instrument Research Institute, dedicated to the research in the field of optical fiber gyro. She is the second article of this paper.

Abstract: The model of transfer function of FOG is developed, and the vibration induced bias drift is deduced theoretically and simulated. The study indicated that vibration induced bias drift arised from overstrike of closed-loop circuit of FOG, and the vibration error can be restrained by optimizing the circuit parameter of FOG. The test result of vibration showed that vibration induced bias drift is reduced from greater than 0.12°/h to 0.02°/h . The test result is consistent highly with theory simulation.

ð Speaker Introduction Ô

Report	A Low Phase Noise Raman Laser System For Atom Interferometer
Name	Xiangxiang Lu
Degree	Ph.D.

Biography: Xiangxiang Lu is now a PhD candidate of 5th year in institute of Opto-electronics engineering, Beihang University. Born in 1988.9, He got his bachelor degree in Zhengzhou University, after finishing a four year study from 2007.9 to 2011.6, with majoring in Opto-electronic science and engineering. In 2011.9, He was enrolled by Beihang University as a master candidate in optics engineering and in 2012.9 he became a PhD candidate to continue his research. His current major is optics engineering, and research areas focus on atom interferometry and related work, which mainly involve preparation of high flux atomic beam and generation of low phase noise Raman lasers. Very recently he spread the research area into guiding cold atoms and continuous atomic beam by using modulated far-off resonant lasers inside a hollow core fibre. These techniques can be useful tools in atom optics and promising applications include atomic interferometer gyroscope, atom gravimeter and gradiometer, and atom lithography.

Abstract: Atomic interferometer gyroscopes based on stimulated Raman transitions are highly sensitive to angular velocity and linear acceleration and regarded as the development trend for next generation inertial navigation system with unprecedented precision. The Raman laser system with ultra-low phase noise is the key element in constructing such an atomic interferometer gyroscope. A Raman laser system with a frequency difference of 6.834 GHz is reported in this paper and used to manipulate the wave functions of neutral atom to interfere. The phase jitter by integrating the phase noise power spectral density from 1 Hz to 1 MHz is 34.7mrad, and the transferred phase noise to the interferometer is 8.2mrad. This Raman laser system with high performance should be able to find a variety of applications in atom interferometry, atom cooling and quantum simulation.

ð Speaker Introduction Ô

Report Self-Adaptive Path Length Control Technique for Zero-lock Laser Gyroscope

Name Meng Wang

Degree Master

Biography: Meng Wang, male, born in February 1975, senior engineer, doctoral student of advanced manufacture systems and intelligent control major in mechanical and electrical engineering college of Northwestern Polytechnical University (NPU). He is mainly engaged in guidance, navigation and control (GNC) technology research, especially, the digital laser gyro electronic control technology research and the integration design of research and manufacture.

Abstract: The zero-lock laser gyro is considered as one of the basic schemes to realize the high precision laser gyro, because of all solid state, no dither coupling, small random walk coefficient and so on. Since the traditional small amplitude path length control cannot achieve the automatic tracking function of the ideal operating point of the zero-lock laser gyro, we present the self-adaptive path length control technique for the zero-lock laser gyro in this paper. This technique is based on the small amplitude path length control, demodulating the fundamental and second harmonics of the light intensity modulation signal and designed to increase the light intensity gain control loop and modulation control loop. By improving the hardware circuit and control algorithm, the gain control, the modulation control and the path length control, these 3 control loops are tightly coupled together. We achieve the self-adaptive path length control system of the zero-lock laser gyro which can accomplish the automatic tracking function of the desired operating point of the zero-lock laser gyro. Experimental results show that, because the self-adaptive length control can eliminate the effects by the changes of the external environment, the changes of light intensity and the changes of electronic components parameters, the zero-lock laser gyro can always work on the desired operating point which can improve the performance of the zero-lock laser gyro.

ð Speaker IntroductionÔ

Report Error Compensation for Fiber Optic Gyroscope under High-frequency Angular Vibration Based on RBF Neural Network Analysis

Name Feng Zhang

Degree Master

Biography: The author is occupied in navigation, guidance and control technology research and adept at the overall design of FOG-IMU (fibre optic gyroscope inertial measurement unit), signal analysis and processing, strapdown inertial navigation algorithm and other related aspects. Until now, ten papers and patents have been published.

Abstract: Fiber optic gyroscope (FOG) would produce angular measurement errors when affected by high-frequency dynamic environments, such as a spiral motion reentry process. Furthermore, these errors could affect the accuracy of aircraft attitude measurement. In this study, based on an established FOG closed-loop control system, the mechanism of angular acceleration measurement error is analyzed and a compensation model is derived. Besides, a new data process method is proposed to reduce the error. This method divides the angular acceleration signal into linear and nonlinear parts. The linear part employs savitzky-golay algorithm fitting and the nonlinear part employs RBF neural network fitting. Finally, the angular velocity measurement error of FOG in high-frequency dynamic environments is tested and compensated. The results verify that this method is valid and the compensation effect is conspicuous.

ð Speaker Introduction Ô

Report Design and Error Analysis of A Ground-used Electrostatically Suspended Accelerometer

Name Jilong Kou

Degree Master

Biography: Jilong Kou is a master candidate in the Department of Precision Instrument at Tsinghua University, where he earned a Bachelor of Engineering degree (2014). His main research area is high-accuracy electrostatically suspended accelerometers.

Abstract: Accuracy and bias stability of an accelerometer are highly demanded in high-accuracy vector gravimeters. Electrostatically levitated accelerometer could meet the urgent demand for the high sensitivity and good bias stability by virtue of the non-contact suspension and thermal insensitive structure. A conceptual design of a six-axis electrostatically levitated accelerometer for ground use is presented. Firstly, the total error model, error sources and error propagation of the accelerometer are analyzed. Secondly, according to the error propagation model, the proof mass is designed as a hollow cubic structure which is suspended in the electrodes housing with levitating voltage lower enough to meet the low circuit noise requirement. At last, aiming at 1×10^{-6}g accuracy and 1×10^{-6}g/3months bias stability, a preliminary error budget is assigned. According to the gap between actual and assigned error, the further optimization is planned.

ð Speaker IntroductionÔ

Report Nonlinear Identification Algorithm for Error Model Structure of Navigation Systems and Sensors

Name Andrei Vladimirovich Motorin

Biography: Andrei V. Motorin graduated from the University ITMO in 2012. He is a teacher assistant in the University ITMO. He is pursuing a PhD in the Concern CSRI Elektropribor, JSC.

Abstract: The problem of identifying error models of sensors and systems is formulated and solved in the context of nonlinear filtering. It is shown that this approach provides a model in a form suitable for navigation information processing. An algorithm is proposed and described. Specific examples are given to illustrate its advantages over the known methods.

ð Speaker IntroductionÔ

Report Key Points of High Precision Solid-core Photonic Crystal Fiber FOGs

Name Xiaobin Xu

Degree Ph.D.

Biography: Xiaobin Xu received the Ph.D. degree in Precision Instruments and Machinery from Beihang University, Beijing. He studied abroad in France for one year supported by a scholarship under the State Scholarship Fund of the China Scholarship Council (CSC) in 2007.

At present Xiaobin Xu is an associate professor in Beihang University, and his research interests include microstructure fiber design, fabrication, and sensing. He has taken charge of tens of fundamental research projects, including National Natural Science Foundation of China, National 973 Project, National 863 Projects, National Advanced Research Projects, Support Foundation of Aerospace. He was selected as ñBeijing Young Talents Planò and ñBlue Sky Plan Prize in Science and Technology. He has published more than 40 papers and obtained more than 30 patents.

Abstract: Solid-core photonic crystal fiber (PCF), made of one single material silica, is a kind of micro-structure fiber which guides light by total internal reflection. Comparing to traditional panda fiber, PCF has a lower sensitivity to radiation and electromagnetism, also it the same time, PCF has a lower transmission loss and is easier to fabricate than photonic bandgap fiber, which makes PCF a better solution to improve environmental stability of high precision fiber optical gyroscope (FOG) at present. In this paper, we analysis and design a small-diameter PCF with better thermal stability. We also fabricate the PCF with length over 10km and good consistency. A high precision fiber coil is made. By analysis environment influence of FOG structure, we design and fabricated a split high precision FOG prototype. The FOG bias stability is 0.0023 ¢ª/h, the random walk is 0.0003 ¢ª/ h, and the scale factor error is less than 1ppm. And the peak-to-peak zero bias is less than 0.03deg/h through temperature variation from -40 ¢ãC to 60 ¢ãC without temperature compensation, which is notably better than FOG with panda fiber. As a result, the PCF FOG is very promising in high precision FOG applications.

ð Speaker IntroductionÔ

Report Study of Influence of Probe Laser Frequency on Nuclear Magnetic Resonance Gyro

Name Yan Wang

Degree Master

Biography: Yan Wang, Assistant Engineer from R&D Center of Beijing Aerospace Control Instrument Research Institute. She graduated with her Bachelorôs degree f degree from Beijing University of Aeronautics and Astronautics. She is now engaging in the researching of Nuclear Magnetic Resonance Gyro and has mainly worked on optical design and structure design. She has published one SCI paper and two EI paper of conference, and has applied for three China Invention Patents.

Abstract: Nuclear magnetic resonance gyro is one of the most important developing directions of atomic inertial sensors. The NMRG obtains rotation signal by demodulating the rotation angle variation of the probe laser ê polarization plane. The frequency of the probe laser directly affects the signal amplitude of the NMRG, thereby affecting the SNR of the system. In this paper, in-depth theoretical analysis and derivation about the relationship between the probe laser frequency and the rotation angle of the laser polarization plane are conducted. At the same time, numerical simulation is carried out combined with the relevant parameters of alkali metal rubidium (87Rb). Finally, the theoretical analysis is verified by specific experiments. The results show that the rotation angle of the probe laser ê polarization plane changing with the laser frequency is dispersion relation, and there are four best frequencies, respectively, $\pm 9GH_Z$ shifting from the resonance frequency line D1and $\pm 8.9GH_Z$ shifting from the line D2. Simultaneously, the result also shows that the rotation angle of the detecting laser ê polarization plane is linearly related to the density and the polarizing rate of alkali metal atom.

ð Speaker IntroductionÔ

Report The Vibration Control of a Vibratory Gyro with Conical Shell Resonator

Name Zhen Lin

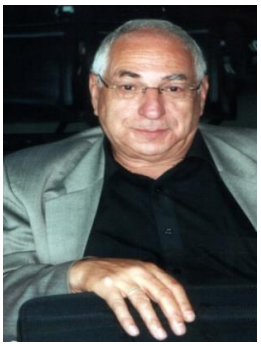
Degree Ph.D.

Biography: PhD candidate in Navigation, guidance and control at school of automation in Beijing Institute of Technology.

Abstract: Solid vibratory gyro is based on the principle of Coriolis effect of resonator. Gyro system should keep the resonator vibrating on its natural frequency and the amplitude of vibration should be stable. In this paper, a kind of conical shell resonator with variable thickness is used in the vibratory gyro. This conical shell resonator removes the isolation holes between piezoelectric electrodes. The quadrature signal ofresonatorôs detecting mode is larger than the affect zero position, scale factor and linearity separate the in-phase signal and quadrature signal of resonatorôs detec based on DSP and FPGA digital sample system. Frequency control loop and amplitude control loop are designed and simulated. PI controller is used in the control loops and some measures are conducted to avoid coupling relationship among the control loops because of eliminating the interference of quadrature signal. Finally all the loops are applied on gyro system and experimental results show all control loops work very well.

ð Speaker Introduction Ô

Report Electrostatic Gyros with Solid Rotors for Gimballess Attitude Reference and Control Systems



Name Boris Efimovich Landau

Title Dr.Sci. in Engineering

Biography: Boris E. Landau was born in 1940 in Leningrad (now St. Petersburg), Russia. In 1963 he graduated with honours from Leningrad Institute of Fine Mechanics and Optics in gyroscopic devices and systems, and joined Granit research institute, after that in 1966 moved to CSRI Elektropribor. In 1974 he received Cand.Sci. degree in Navigation Equipment, and in 1996, Dr.Sci. degree in Engineering. Dr. Landau is the author of more than 150 scientific publications and 100 inventions and patents.Currently he is a Chief Designer at Concern CSRI Elektropribor, JSC.

Abstract: The main lines in the development of the solid-rotor electrostatic gyroscope (ESG) for gimballess attitude reference and control systems for spaceborne and ground applications are considered. The latest accomplishments and the efficiency of innovations are discussed: the gyro drift from run to run has been reduced, making gyro calibrations at restarts unnecessary; the rotor angular position can be controlled in the body-fixed frame, which makes it possible to create correctable ESG-based systems and prevent convergence of the rotor axes in attitude reference systems; the accuracy of the rotor angle readout in the body-fixed frame has been enhanced; the accuracy of identification of gyro drift model parameters has been improved; the gyro drift autocompensation modes have been optimized.

ð Speaker Introduction Ô

Report Research on Navigation Level Full Silicon MEMS Accelerometer Wafer Level Hermetic Packaging

Name Qifang Hu

Degree Ph.D.

Biography: Hu Qifang got his Ph.D degree at Peking University in 2011, and now works in the Beijing Institute of Aerospace Control Devices as a senior engineer. His research focus on the design, fabrication, and calibration of the silicon based MEMS high performance accelerometers including sandwich capacitance accelerometer, and MEMS resonant accelerometer. His interests also covers the MEMS wafer level packaging, TSV-3D integration, and MEMS energy harvester. In the resent 5 years, his has three MEMS related projects in research, published 7 papers, and 5 patents.

Abstract: Full silicon MEMS inertial sensor has became the state of art for high performance guidance application for its advantages of high temperature stability, small size, low cost, and easy to integrated with ASIC. This work aims at the application of high precision accelerometer in the inertial navigation system. The comparison between full silicon sandwich accelerometer and silicon-glass based sandwich accelerometer though multi-physics analyze demonstrate the advantage of full silicon sandwich accelerometer. The 3D structures of silicon middle wafer are fabricated by KOH wet etching from both polished wafer surfaces, using SiO2 hard mask with thickness steps. The cap wafers are fabricated combing KOH anisotropic etching, and ICP silicon etching. Finally, the cap wafers are bonded with silicon middle wafer by Au-Si eutectic bonding from both sides. The cavity of the sandwich accelerometer is encapsulated with N2 gas, and the pressure is maintained between 200Pa. The measurement results demonstrated the presented accelerometer obtains closed-loop sensitivity of 0.575V/g, and zero bias of 0.43g. The -3dB bandwidth of the accelerometer is 278.14Hz. The output stablilty of 1 hour is measured to be 2.23 ¦ 10^{-4}g(1 õ).

Speaker Introduction

Report Development of Near Gaussian-shaped Spectrum Erbium-doped Fiber Source in Double-pass Back Configuration

Name Fei Hui

Degree Master

Biography: Fei Hui (1985-), female, the Han nationality, native place: Jilin, master degree, Tianjin Navigation Instrument Research Institute, engineer, research for FOG.

Abstract: With the improvement accuracy of fiber optic gyroscope, the source performance directly affected the gyroscope's performance of fiber optic gyroscope, so the higher various performance of the light source constantly was demand. Erbium-doped super-fluorescent fiber source has the advantages of output stability, wide and flat spectrum. Erbium-doped fiber source can be widely used in optical fiber gyroscope. For ultra-high precision fiber optic gyroscope, design and development of near Gaussian-shaped spectrum of erbium-doped super-fluorescent fiber source was the requirements for accuracy and stability of the light source. Because around 1530nm and 1560nm peak with wide spectrum of erbium-doped super-fluorescent fiber source similar highly cause each other constraint, it was difficult to control changes these peaks, therefore the stability of the mean wavelength was restricted. Based on the theoretical basis and practical application of erbium-doped super-fluorescent fiber source in double-pass back, through the calculation of simulation and experimental research, by the parameter adjusting and optimizing, obtained a near Gaussian-shaped spectrum of erbium-doped super-fluorescent fiber source in single peak. Near Gaussian-shaped spectrum of erbium-doped super-fluorescent fiber source in single peak asided the constraints of double peak, and single peak of fiber source more effective controlled the temperature sensitivity and stability that mean wavelength. Mean while pump power could be adjusted to optimize the intrinsic thermal coefficient of erbium-doped fiber. Finally, under the condition with erbium-doped fiber length of 4.25 m, LD power of 150mW, peak wavelength of 1530.9nm, and the whole optical path in the environmental temperature from -40 ℃ to 60 ℃, the near Gaussian-shaped spectrum of erbium-doped super-fluorescent fiber source with 0.17ppm/ ℃ mean wavelength stability was obtained. The stability of the set point temperature was better than 3ppm, and the repeatability of the set point temperature was better than 1ppm.

ð Speaker IntroductionÔ

Report Atom Interferometer for High-Rate Inertial Measurements

Name Bonan Jiang

Degree Ph.D.

Biography: Bonan Jiang spent 5 years at the Cold-Atom Centre in Shanghai Institute of Fine and Optical Mechanics, C.A.S., where he worked on the ultracold Alkali atoms under the supervision of C.A.S. fellow Yu-Zhu Wang. He received his PhD in optics from C.A.S. in 2015. In the same year, He joined Beijing Institute of Aerospace Control Devices and Quantum Engineering Research Centre, C.A.S.C., working on the light-pulsed atom interferometer and atom chip. His principle interests include light-pulsed atom interferometer, on-chip ultracold atoms, novel methods of inertial sensing, and low-dimensional strongly-correlated systems.

Abstract: We realize a high-rate light-pulse atom interferometer by recapturing the interferometer atoms in a single vacuum chamber. For each shot, Atoms are loaded by magneto-optical trap, further sub-Doppler cooled in optical molasses, and then released. The released cold atoms obtain the initial velocity from the free fall, and the atomic wave package is coherently separated, redirected and recombined to interfere by three temporal-separated Raman laser pulses. We observe Mach-Zehnder interference fringes after a gravitational displacement. To compliment or replace conventional technologies in dynamic environments, the atom interferometer presented here is explicitly tailored to curtail excursions of the cold atomic ensemble. We study the measurement dead time associated with replenishing the magneto-optical trap both from the interferometer atoms and vapor. And we find that as long as the gravitational displacement during the time of flight is smaller than the trap size, the magneto-optical trap can be replenished with much higher efficiency by recapturing the released atoms than from vapor. Thus, we trade the sensitivity for data rate and reduced system demands, and demonstrate a short interrogation light-pulse atom interferometer with the data rate improvement up to 83 Hz and a compact single-chamber sensor head, manifesting a promising application for the high-rate inertial measurements in dynamic environments.

ð Speaker Introduction Ô

Report	Miniaturized Three-axis Photonic Crystal Fiber Optical Gyroscope Technology Based on Small Diameter Fiber
Name	Jingming Song
Degree	Ph.D.

Biography: Jingming Song, received Ph.D degree from Huazhong University of Science and Technology, China, in 2005, then he works in Wuhan National Laboratory for Optoelectronics as staff of postdoctor from 2005-2007. Now he works in Beihang University as associate professor and master supervisor since 2007. He has been granted more than 10 China National Invention Patents and published more than 20 academic papers.

Major research domain

1 à Advanced fiber sensing: Photonic crystal fiber optical gyroscope à new-type fiber sensing technology'

2 à Miniature opto-electronic components technology'

3 à F-P sensing in high temperature and other harsh environments.

Abstract: The miniaturized three-axis photonic crystal fiber optic gyroscope (PCF-FOG) technology is introduced in this paper. The configuration of PCF-FOG is three optical channels with a sharing source and a digital processing circuit. Employing the developed small diameter PCF (ū 8 0 / 1), the volume of fiber coil is decreased by ~60% comparing with the conventional commercial PCF (NKT PM-1550 Ï ū 1 2 5 / 2) of the same length. Moreover, we developed miniature optical components to reduce the dimension of PCF-FOG. Low loss and high strength splicing technology is developed and the fusion loss is < 0.7dB and the strength is > 50kpsi. A miniaturized three-axis PCF-FOG prototype is made and the weight is < 200g, power consumption is < 3W at room temperature, the random walk coefficient (RWC) of this PCF-FOG is about 0.013 ¢ ã h. The testing result of radiation experiment of PCF, thermal performance and magnetic sensitivity of the PCF-FOG shows that taking small diameter PCF instead of conventional polarization maintaining fiber can upgrade the performance of FOG in harsh environment such as temperature variation, magnetic field and radiation etc.

ð Speaker Introduction Ô

Report	Analysis of Shupe Error in The Interferometric Fiber Optic Gyroscope Based on A New Model of Fiber Coil
Name	Xiaodan Wang
Degree	Ph.D.

Biography: Xiaodan Wang, female, PhD, graduated from Tianjin University in 2015, majoring in Solid Mechanics, now working in Tianjin Navigation Instrument Research Institute. The working direction is structure design and simulation analysis of Fiber Optic Gyroscope and analysis of Shupe error.

Abstract: The Shupe error is a thermal-induced non-reciprocal bias, which is one of the major factors impairing the I-FOG performance. For calculating the temperature transient and thermal stress transient induced Shupe error simultaneously and improving the accuracy of mathematical simulation model comparing to the test results, a new refined finite element model of fiber coil is presented, which is applied to obtain temperature and thermal stresses of fiber core. Furthermore, the distribution of temperature and stresses along the whole length of fiber are firstly obtained to propose a more accurate mathematical model of Shupe error in this paper. Compared with the test results, it is shown that, the results given by the new refined model of fiber coil are 50 percent closer to test results than those of the traditional normalized model.

Speaker Introduction

Report Research the Optic-electronic Systems for Control Deformation of Millimeter Wave Range Radiotelescope Mirrors

Name Igor Konyakhin

Title Professor

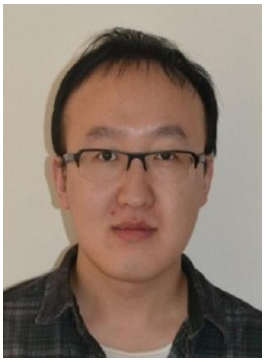
Biography: The professor of Department of Optical-electronic Devices and Systems, ITMO University, Saint-Petersburg. The Major member of the Russian Rozhdestvensky Optical Society. The member of SPIE. Since 2000-Professor. Department of Optical-electronic devices and systems, National Research University ITMO, Russia. Scientific research is in the field of optical-electronic measurement systems. Research is focused on the accuracy characteristics and the influence analysis of the most critical and important initial errors. The main attention is paid to measurement errors, prism reflector optimization and image of a point source processing. The main part is devoted to high precision systems for object line shifts and angle tilts (pitch, yaw and roll) control. So far, his publications contain 3 scientific monographs, 10 certificates publications of inventions, 48 reports at the scientific conferences and 115 published papers.

Abstract: The researches in the millimeter wave range are the important direction of progress at XXI century radio astronomy. Nowadays the new radio astronomy instruments are designed at many countries. The Russian Academy of Sciences realizes the project of radio observatory on a mountain Suffa in Uzbekistan. Full rotateable radiotelescope RT-70 for researches in millimeter wave range will be the main observatory tool. The RT 70 Suffa parameters are the following: the main mirror is realized as a 3-D parabola with a 21 meter focal length. the root mean square of the point deviation on a surface from theoretical parabola is not more than 0,05 mm and the non- stability of a mutual arrangement between main mirror and secondary mirror is not more than 0,08 mm.

The scheme includes 40 measuring video-system channels, it are constructed as 8 device units. The device units are located on the base ring circle. Each device unit contains 5 video-systems and measures the coordinates of 5 radiating targets at control points. The research experimental results of the optic-electronic measuring system are considered. Experiments have shown the success designing of the measurement systems.

ð Speaker Introduction Ô

Report A Digital Controlled Heating System for The Nuclear Magnetic Resonance Gyroscope



Name Yicheng Deng

Degree Ph.D.

Biography: Yi cheng Deng, male, from Changchun Jilin Province. Now he is engineer in Beijing Institute of Aerospace Control Device. He got his B.S.degree in 2008 from Jilin university and D.E.degree in 2013 from Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences. His main research interests include closed loop control system of Nuclear Magnetic Resonance Gyroscope.

Abstract: The nuclear magnetic resonance gyroscope (NMRG) is an atomic gyroscope, which detects the angular rate of the rotating system by utilizing the atomic spin steady processing in the inertial frame. The heating magnetic field and the cell temperature directly influence the polarization rate of atoms in the atomic cell, then influence the bias stability and the scale factor of the NMRG. Firstly, this paper introduces the basic principle of the NMRG Heating System. Secondly, this paper adopts Pulse-Width Modulation and H-bridge to generate a high frequency alternating current. This alternating current drives the heating boards and controls the heating power exactly. This method can reduce the residual heating magnetic field because the 129Xe is unsensible to the high frequency heating signal. Finally, this paper adopts the digital PID algorithm to keep the cell temperature stable by using a PT100 thermistor, which can make the cell temperature more stable. It is identified by the experiments. The heating time is about 7 min. when the cell temperature is f r o mC t2o0 ęC1. 7Th0 ęmaximum temperature fluctuation is about 0 . 1C1, w2hęre the temperature bias is about 0 . 0C1/h5 ę

ð Speaker IntroductionÔ

Report Analysis on The Hysteresis Phenomenon of Fiber Gyro Scale Factor Model and Compensation Technology

Name Zhihuai Yang

Degree Ph.D.

Biography: Zhihuai Yang, born in TianJin City, P.R. China, on Sept.13, 1982, received his Ph.D. degree from Zhejiang University in 2010. His research interests include optical fiber sensors and signal processing. He is the project director of high precision fiber optic gyro in Tianjin Navigation Instrument Research Institute.

Abstract: High precision inertial navigation system (INS) puts forward high demands on the scale factor stability of the fiber-optic gyro (FOG) which is affected strongly by the temperature change. The technology of temperature compensation is an effective method to improve the performance of the scale factor. The key point is how to establish an accurate scale factor model which is suitable for all kinds of temperature environment. The hysteresis phenomenon of the scale factor model in FOG is proposed firstly which is induced by the uneven temperature of FOGô s stru is proposed which is using multi-temperature points sampling to correct model. The method can improve the stability of scale factor under any temperature changing environment. The temperatures of light source and the fiber coil are sampled at the same time under all temperature (-40 ₠Љ+60 ₠). The relationship between the temperature and mean wavelength of light source is used to correct the hysteresis model. The stability of the scale factor can be improved from 36ppm to 12ppm through model correction.

ð Speaker Introduction Ô

Report	Key Technics and Experimental Research of Resonance Photonic Crystal Fiber Optical Gyroscope
Name	Huaiyong Yu
Degree	Ph.D.

Biography: Huaiyong Yu was born in China in 1982. He receiced his Ph.D degree in Optical Engineering from Beihang Univeristy, China, in 2012. He joined in Beijing Institute of Automatic Control Equipment in 2012 and presently an Associate professor and Academic Leader of Novel inertial optical device in the Department of FOG Technology. He has been a Senior member of Chinese Institute of Electronics(CIE) since 2015, and a Junior member of China Society of Micro-Nano Technology(CSMNT) since 2009. His main research interests are Resonance Photonic Crystal Fiber Optical Gyroscope(RPCFOG), Integrated optical gyroscope and Micro-Opto-Electro-Mechanical System(MOEMS). Up to now, He has published nearly 40 papers and 40 patents of invention (20 publication and grant as of the date of this paper published).

Abstract: Resonance Photonic Crystal Fiber Optical Gyroscope (RPCFOG) is a novel type and promising gyroscope, which has the advantages of miniaturization and high performance. In this paper, the scheme of RPCFOG is proposed, and the transfer function of photonic crystal fiber (PCF) resonator is calculated by optical multi-beam interference theory, as well as the mathematical expression in considering of spectrum width of input light. The impacts of finesse and the depth of resonance are simulated. The fundamental mechanism and scheme of narrow line-width laser source, pretreatment of PCF, fabrication process of PCF resonator, modulation and demodulation of high precision signal processing unit, are research respectively. And the measurement and evaluation method of narrow line-width laser source, PCF, PCF resonator and signal processing are constructed. Finally, the experimental setup of RPCFOG is constructed. The experimental results shows that the bias stability of RPCFOF is lower than 25 ¢ª/h over 10 min.

ð Speaker Introduction Ô

Report Contextual processing for Pedestrian Tracking in Infrastructure-free and GPS-denied Environments

Name Enrico De Marinis

Title Program Manager

Biography: From 1999 De Marinis works a freelance consultant in the realm of advanced technology and project management, after more than 12 years of work experiences as scientific researcher, both in military and civil structures. Before 1999, the previous employments have been: From 12/5/1986 up to 15/5/1995, Enrico de Marinis worked as a researcher in EL.SA.G. (Elettronica San Giorgio), actually W.A.S.S. (Whitehead Alenia Sistemi Subacquei), in the Underwater Research Group of the Naval Defence Systems Department. From15/5/1995 to 1/1/1998, Enrico de Marinis worked as a senior scientist and project manager in CO.F.A.S. (Consorzio Flegreo Applicazioni Subacquee) (tr: Flegrean Consortium for Underwater Applications). From 1/1/1998 up to 1/9/1998, Enrico de Marinis worked as a researcher and Program Manager in W.A.S.S. (Whitehead Alenia Sistemi Subacquei) in the Underwater Defence Department.

Abstract: This paper introduces the contextual processing (CTXP), a novel and powerful concept for 3D pedestrian tracking in GPS-denied environments. Its major advantages are: no need of external, ad-hoc infrastructures, no need of floorplans, low cost/weight/size, no need of calibrations or fingerprinting measurement campaigns, accuracy independent of the walked distance. In addition, CTXP processing is light enough to be hosted in a pocket-size commercial smartphone/tablet. CTXP has been extensively tested by Italian and International Agencies and industries in a widespread ensemble of scenarios (e.g. battleships, vessels, large industrial plants, malls) with experiments durations up to 3 hours and walked distance up to 6 km, always providing end-to-end results compliant with the target requirements.

ð Speaker IntroductionÔ

Report MEMS Personal Navigation System Based on Highly Robust ZUPT

Name Yanyan Pi

Degree Master

Biography: Senior engineer, mainly engaged in inertial navigation and integrated navigation, worked in Tianjin Navigation Instrument Research Institute, have participated in the national "12th Five-Year" and the General Equipment Department "12th Five-Year" project. Now, focusing on the projects about MEMS personal navigation system and the inertial navigation technology for oil Pipeline.

Abstract: Personal Navigation System based on low cost MEMS inertial sensors can be widely used in the field of anti-terrorism, fire emergency and other fields. The big drift of low cost MEMS-based inertial sensors is the main source of error in Personal Navigation System (PNS). An amendment navigation algorithm based on ZUPT(zero velocity update) is studied, and by analyzing the accel statistical characteristic on walkerôs foot, a Acceleration Slip Variance and Angular Rate Magnitude) detection algorithm is designed for detecting stance phase between steps. This method improves the robustness of zero velocity detection. Based on traditional SINS navigation algorithm, a ZUPT method is developed to improve navigation accuracy, through an improved Kalman Filter which is designed for ZUPT, the navigation errors including attitude error, velocity error and position error can be estimated. Therefore, the navigation precision can be improved by feeding these estimated errors back to original navigation system. In the end, the experiments show that the designed amendment navigation algorithm can reduce the drift error of the MEMS inertial sensors efficiently and make the PNSôs accuracy less t condition.

ð Speaker Introduction Ô

Report	The Effect of GNSS Spoofing on INS/GNSS Integrated Navigation System
Name	Yang Liu
Degree	Ph.D.

Biography: Yang Liu is pursuing a Ph.D. in the School of Automation at Northwestern Polytechnical University, where he also received his M.S. and B.S. degrees. He is currently a member of INS and Multi-sensor Integrated Navigation Research Group at NWPU. His research interests are in GNSS spoofing detection, position and orientation system, and multi-sensor integrated navigation. He is a student member of ION (the Institute of Navigation) and CSIT (Chinese Society of Inertial Technology).

Abstract: GNSS spoofing is a technique to trick the receiver into generating erroneous locations by deliberately broadcasting false satellite signals. Since spoofing is concealed and difficult to detect, it is even more harmful than jamming. As the software radio technology matures, the technical barriers and cost of spoofing attacks are getting lower and lower. Inertial and satellite integrated navigation system has some anti-interference ability, but in the face of emerging spoofing attacks, the navigation performance and anti-spoofing capability are worth further exploration. This paper focuses on the effect of different spoofing attack modes on navigation accuracy and state estimation in the Kalman filter, and further the effect on commonly used fault detection methods including snapshot and sequential chi-square test. Theoretical analysis and simulation show that spoofing can significantly reduce the accuracy of the navigation system, and contaminate filter state estimation. For gradually established spoofing attack, traditional fault detection method fails, or takes a long time to give an alarm. The paper proposes several suggestions for fault detection design in different spoofing scenarios and presents a brief introduction of several possible spoofing detection methods.

ð Speaker Introduction Ô

Report Error Characteristic Analysis of INS/CNS Integrated Navigation under Single Star Observation for HCVs

Name Rong Wang

Degree Ph.D.

Biography: Dr. Rong Wang received his Ph.D. degree from Nanjing University of Aeronautics and Astronautics in 2014. He worked as a postdoctoral fellow at University of Southern California in United States, between 2014 and 2015. He is currently a lecture at the Navigation Research Centre, College of Automation Engineering, Nanjing University of Aeronautics and Astronautics. His research interests include celestial navigation and integrated navigation technology.

Abstract: In the application of hypersonic cruise vehicle (HCV), the situation that only single star is available may occur due to the restrictions star tracker's vi environment. In this paper, the scheme of INS/CNS integrated navigation system for HCV is analyzed. The model of INS/CNS integrated navigation is built according to the principle of CNS positioning and then the performance of INS/CNS integrated navigation under single star observation in typical trajectory of HCV is verified. The conclusions of this paper provide reference for scheme design of INS/CNS integrated navigation system and its application in HCVs, which of significant engineering value.

ð Speaker Introduction Ô

Report Innovative Divided Difference Filter for Mars Entry Navigation under Biases

Name Zirui Xing

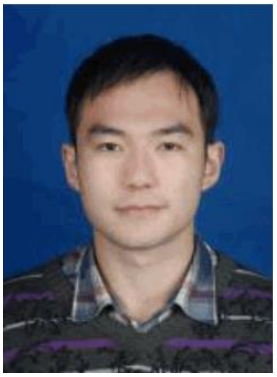
Degree Ph.D.

Biography: Zirui Xing received the B.S. and M.S. degrees from Hebei University of Science and Technology, Shijiazhuang, China, in 2010 and 2013, respectively. He is currently working toward the Ph.D. degree with the School of Automation, Beijing Institute of Technology, Beijing, China.
His current research interests are in the fields of multi-sensor information fusion, fault diagnosis, nonlinear filter, and signal processing.

Abstract: To overcome the problems of unknown disturbances and measurement outliers during Mars entry navigation, in this paper, a novel kinds of divided difference filter (DDF) is proposed, which is Huber DDF. By using the Huber function to modify the cost function of standard Kalman filter, a novel version of predictive state estimation error covariance (PSEEC) and measurement noise covariance (MNC) is deduced. The Huber DDF is derived by embedding the novel PSEEC and MNC into the frame of general DDF. By simulations, it is verified that the proposed Huber DDF has much better performance than general DDF under large disturbances for Mars entry dynamic models. When the measurement models have outliers, the Huber DDF still has much better performance than general DDF.

ð Speaker Introduction Ô

Report INS/VNS Integrated Navigation Method Based on Structured Light Sensor



Name Yunshu Wang

Degree Ph.D.

Biography: Yunshu Wang received his B.Sc. degrees from Nanjing University of Aeronautics and Astronautics, Nanjing, China, in 2008. He is currently a Ph.D. candidate at the Navigation Research Centre, College of Automatic Engineering, Nanjing University of Aeronautics and Astronautics. His research interests include image matching, visual navigation and integrated navigation.

Abstract: The INS/VNS integrated navigation is widely used and researched as an important navigation method in GNSS denied environment. The environment information is difficult to obtain by visual sensor because of the insufficient illumination and the sparse feature in GNSS denied environment. In the industrial measurement field, the visual sensor is usually combined with the structured light sensor for the noncontact measurement because of the advantages such as low cost, noncontact and high efficient. The partial deep information can be obtained through capturing the structured light by visual sensor. So the deep information can be obtained by monocular vision through once measurement. Through the combination of visual sensor and different structured light such as line, circle and net, the pose of visual sensor can be calculated by once measurement. The speed of calculation will be much faster than the traditional monocular visual measurement.

Aiming at the problem of traditional visual navigation invalid in the insufficient illumination and the spars feature environment, the INS/VNS integrated navigation method based on structured light sensor is proposed in this paper. The pose measurement model based on structured light sensor combined with visual sensor is built first. Then the INS error equations are used as the state model, and the relative motion errors are used as the measurement for the integrated navigation in the in the insufficient illumination and the spars feature environment. The simulation and the experiment based on real flight data shows that higher estimation accuracy of position and attitude can be obtained.

ð Speaker Introduction Ô

Report Inertial Sensors and Navigation Technologies

Name Alexander Zbrutsky

Title Academician

Biography: Alexander Zbrutsky, born on March 7, 1953, he graduated from the Kiev Polytechnic Institute in 1976. Academician of the International Academy of Navigation and Motion Control (1997), Chairman of the Ukrainian branch of the Academy (since 2008), Academician of the Academy of Technological Sciences of Ukraine (since 1993).
Winner of USSR State Prize (1986). And the State Prize of Ukraine (1998) in the field of science and technology for the creation of new classes of navigation sensors, instruments, systems and complexes.
Chief editor of the scientific journal "Information systems, mechanics and control» (ISSN 2219 -3804), «Mechanics of g yroscopic systems» (ISSN 0203 -3771). The organizer of the International Scientific-Technical Conference "Girotehnologii, navigation, traffic management and the construction of aviation - Space Technology" (1993), a member of the editorial boards of scientific journals and program committees of international conferences in the Ukraine, Russia, Poland, Algeria.
Participated in the development of strategies and areas of training in high school and develop and implement training plans for training specialists in the field "Control Systems lethal machines and complexes", "Avionics", "Spacecraft", "Planes and helicopters."
EU Project Coordinator of Tempus, Erasmus Mundus.

Abstract: New and modern directions of inertial sensors and navigation systems technologies are demonstrated.

ð Speaker Introduction Ô

Report An Improved Regional Rapid Compensation Algorithm Of Deflection of Vertical

Name Jun Weng

Degree Ph.D.

Biography: Jun Weng (1988-), graduated from the NorthWestern Polytechnical University (NWPU) where he received his MS and BS degrees in Automation school, and continuing reading Doctor degree in major precise instruments and machinery. The main research direction is inertial and integrated navigation technology, and more 9 related papers has been published (including 4 EI papers).

Abstract: In the specific force equation of strapdown inertial navigation system, gravity can not be measured by accelerometer, which should be calculated using gravity model stored in navigation computer. When standard gravity model is used, a non-negligible influence on velocity and position precision will be introduced by deflection of vertical in high precision pure inertial navigation. Considering the shortcomings for its bad real-time capability and large storage request of using high order spherical harmonics gravitational model, a improved regional rapid compensation algorithm is proposed, which based on planar interpolating, and influence on deflection of vertical caused by height of the vehicle is taken into account. The long distance flight simulation testified that the precision of the rapid compensation algorithm is better than $1^{\#}$. At last, three land vehicular tests show that horizontal positioning precision respectively improved from 0.3806 nm/h, 0.3420 nm/h, 0.1797 nm/h to 0.2931 nm/h, 0.1373 nm/h, 0.0655 nm/h.

ð Speaker Introduction Ô

Report A Positioning and Orientation Method Based On Double Magnetic Beacons

Name Qinghua Li

Degree Ph. D.

Biography: Received the bachelor ê, master ê and Ph.D. ê degrees from Harbin Institute of Technology in China, in 2001, 2003 and 2008 respectively. He is currently an associated professor in Space Control and Inertial Technology Research Centre of Harbin Institute of Technology. His research interests are pedestrian navigation, magnetic navigation and motion control.

Abstract: In the environment of underground or building, the Global Positioning System (GPS) would fail because of its weak signal penetration. Inertial measurement unit (IMU) cannot be used alone for a long time working for its error accumulated. In this paper, a positioning and orientation method based on double magnetic beacons is proposed. The invariance of direction vector of rotary magnetic field and the distance between the two magnetic beacons are used to calculate the position and orientation to improve the stability of the method. The attenuation of the signal in indoor navigation owing to block and wall is avoided by this method. Finally, the numerical simulation show the effectiveness and accuracy of the proposed method and the method based on double magnetic beacons is more stable and accuracy than the method based on one.

ð Speaker IntroductionÔ

Report	Based on The Recursive Measurement Update to Design Nonlinear Target Tracking Method
Name	Yonggang Zhang
Degree	Ph.D.

Biography: Yonggang Zhang was born in 1981. He received his Ph.D degree from Cardiff University, UK in 2007. Now he is a professor at Collage of Automation, Harbin Engineering University. His research interest covers fiber-optic gyroscope, inertial navigation, filtering algorithms and integrated navigation.

Abstract: Nonlinear Gaussian filter is usually used to achieve the state estimation task in the nonlinear target tracking application. However, the nonlinear Gaussian filter is a linear minimum variance estimator based on Gaussian approximation, and its filtering performance degrades in some cases with high measurement accuracy and strong nonlinearity. This problem has become the current and future focus of improvement of nonlinear Gaussian filter. In order to solve this problem, the nonlinear iterated Kalman filtering mehtod is proposed, which provides a maximum posteriori estimation for state. However, the Kalman filter gain is almost equal to zero after the first iteration so that most iterations are redundant, thus the total measurement update is linear.

In order to solve the problems of the existing nonlinear iterated Kalman filter, a new recursive update strategy is first proposed in this paper. As compared with existing iterative update method, measurement information is not drawn all at once, but extracted gradually based on the linear minimum variance rule, which makes the total measurement update is nonlinear. Thus, the proposed method can solve the problem of iterative redundant effectively. Secondly, a new sigma point kalman filter with recursive measurement update is developed by applying the statistical linear error propagation method to the proposed recursive update. The proposed filtering method recursively operates by combining the Gaussian weighted integrals and analytical calculations, and different sigma point Kalman filter with recursive measurement update can be developed by using different numerical integral methods to compute these Gaussian weighted integrals.

In this paper, the proposed method is applied to radar target tracking, and it is implemented by using the third-degree spherical-radial cubature rule. The proposed sigma point Kalman filtering method with recursive measurement update has higher estimation accuracy and faster convergence speed than existing nonlinear iterated filtering methods.

ð Speaker Introduction Ô

Report Stereo Vision/MIMU Integrated Navigation System Based on Unscented Kalman Filter

Name Huan Yu

Degree Master

Biography: Huan Yu received the bachelor degree from Hunan University in 2010, Master degree in Control engineering from Beijing Institute of Technology in 2014. Now he is a first year PhD student in Navigation, Guidance and Control.
His research interests include Inertial Navigation, Vision Navigation and Integrated Navigation. During master-degree study, he mainly studied high accurate positioning system by Binocular vision system, and researched the method of fusing vision and inertial data. Now he is mainly doing research on Rotating modulating strapdown Inertial Navigation System.

Abstract: Under the condition of not increasing the hardware cost of vehicle location system, an integrate navigation system based on on-board vision system and Micro Inertial Measurement Unit (MIMU) is researched in this paper, which can provide high accuracy position and attitude information for vehicle when GNSS is failed. Firstly, existing location algorithm for binocular CCD vision system is analyzed, and SURF feature detector is selected, then feature matching method based on FLANN and RANSAC with multiple constraints is proposed. Secondly, according to the characteristics of the vision and MIMU system, Vision/MIMU integrated navigation algorithm based on Unscented Kalman Filter is proposed, which selects the difference of position and of two systems as the measurement variables of the system. Finally, according to the theoretical approaches, dynamic car test is designed, which use ZED stereo camera and MTi-G-710 GNSS/INS as the sensor system. In a rectangular closed campus road, the results of the experiment show that the closed loop positioning error of the integrated system is 0.82 meters.

ð Speaker Introduction Ô

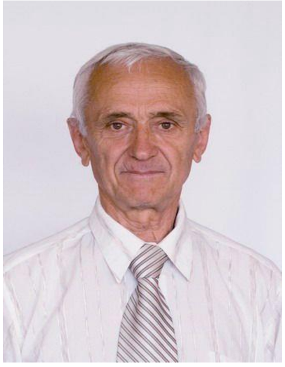
Report	Research on The Multi-sensor Information Fusion in Long-endurance UAVs Based on The Technology of ASPN
Name	Jianxin Xu
Degree	Ph.D.

Biography: Jianxin Xu received the B.Eng. degree in automation from Nanjing University of Aeronautics and Astronautics (NUAA) in 2012. Now he is a graduate student of the Master-Doctorate program and pursuing the Ph.D. degree in Guidance Navigation and Control (GNC) at NUAA, Navigation Research Centre. His major research fields are inertial technology and information fusion technology.

Abstract: The All Source Positioning and Navigation (ASPN) program was proposed by DARPA in recent years. This program seeks to enable low cost, robust, and seamless navigation solutions for military users on any operational platform and in any environment, with or without GPS. One of the ASPN program topics is the navigation algorithm. It focuses on the derivation and development of new navigation filtering (e.g., fusion) algorithms for positioning and navigation solutions. In recent years, a new method for information fusion is called factor graph based incremental smoothing. Taking the SINS/GNSS/CNS/SAR integrated navigation system of the long-endurance UAV as research object, this paper focuses on the method of multi-sensor information fusion with asynchronous measurement. Through this method, the measurements of celestial navigation and scene matching can be effectively used in the existing SINS/GNSS navigation system. The simulation results show that the proposed method can solve the problem of measurement error caused by asynchronous information of celestial navigation and scene matching navigation system, and improve the navigation accuracy.

ð Speaker Introduction Ô

Report The Research Status and Future Development Trend of Inertial Navigation System for Aircrafts in Hartron-Arkos Company



Name Anatoliy Kalnoguz

Title Chief Designer

Biography: 1968-graduated from Kharkov polytechnic institute, specialty-research engineer on flight dynamics and control. 1966-up to the present time-employee of Hartron-Arkos company. 1975-defended Ph.D. thesis on the subject –ñeSnttarbyi lsitzaagtaelizatioMn aojfo stabilization systems for aircrafts; initial preparation of inertial navigation systems (initial alignment, calibration, targeting, integrated development of control systems). Currently holds the position of Chief Designer for Hartron-Arkos company.

Abstract: Hartron-Arkos Company is built in 1959, which has 11 subsidiary corporations and more than 1200 technical staff. The main business fields are aircraft navigation, guidance technology and equipment, aircraft control system and its single unit equipment.

Hartron-Arkos Company is located in Ukraine, which mainly develops aircraft inertial navigation system (INS) in the Soviet Union. Today, this company is responsible for navigation and guidance mission of carrier rocket, aircraft, international space station, etc. The developed INS is successfully applied to many missions, such as the platform type INS of ïZenit ò carrier rocket, ïProton ò carrier rocket, ïEnergia ò carrier rocket. Also INS of spacecraft like ïUniverse ò, ïSalvo ò, ïSea ò series. Hartron-Arkos Company has high reputation in aircraft navigation system field.

ð Speaker IntroductionÔ

Report Inertial Measurements Metrology-current trends and Problem

Name Aleksandr Iankovskii

Title Professor

Biography: Aleksandr Iankovskii started working at D.I. Mendeleyev Institute for Metrology (VNIIM) in 1986 after graduating from the Leningrad State University as an engineer. The very first field of interest was metrology of seismic measurements for nuclear test control systems. In 1998 his colleagues and he have got a Government State Award for the development of state system of metrological assurance for national nuclear test control survey. Now He is a head of department of low frequency mechanical motion quantities, gravimetry an plane angle metrology. His department deals with metrology of constant and low frequency accelerations and velocities (linear and angular), seismic measurements, free-fall acceleration measurements and measurements of plane angle in dynamics. Vibration measurements is not the duty of his department, but they collaborate very narrow with corresponding lab in our institute. He is a representative of Russia as a vibration expert in CCAUV and COOMET.

ð Speaker Introduction Ô

Report Application of Model Reconstruction Method and Uncertainty Evaluation in Accelerometer Test on Precision Centrifuge

Name Yonghui Qiao

Degree Ph.D.

Biography: Yonghui Qiao received the M.S. and Ph.D. degrees in control theory and control engineering from Harbin Institute of Technology, Harbin, China, in 2002 and 2008, respectively. He is now a senior engineer at Beijing Aerospace Control Device Institute, Beijing, China. His current research interests include inertial instruments and systems testing techniques.

Abstract: The model reconstruction method and the evaluation method of measurement uncertainty for the error model test of accelerometer on precision centrifuge were illustrated in this paper. The principle of accelerometer test on centrifuge, the model of centripetal acceleration produced by the precision centrifuge and the error model equation of accelerometer were given. Based on the actual condition of accelerometer test on centrifuge, the relationship between the error sources of the precision centrifuge and the calibration accuracy of the accelerometer error model was analyzed. From the above, accelerometer odd-quadratic coefficient was introduced, and thus, the error model of accelerometer test on precision centrifuge was reconstructed. The test data processing method after model reconstruction and the data processing method before model reconstruction were illustrated, and the evaluation methods of measurement uncertainty for the two conditions were also given. For the example of practical test, according to the two conditions of use of the model reconstruction method and nonuse of this method, model coefficients were calibrated and the uncertainties of the model coefficients were evaluated respectively, and the results were given. The test results show that the model reconstruction method has a significant effect on improving the test precision of accelerometer.

ð Speaker Introduction Ô

Report The Study of Multi-sensor Inertial Navigation System Application in Launch Vehicle System

Name Zhonghai Pei

Degree Master

Biography: ZhongHai Pei, graduated from southeast university navigation guidance and control, in the Shanghai aerospace control technology research institute is engaged in the launch vehicle control system design and research work, and the successful completion of the new generation of some model rocket first flight work, participate in and complete a 705 project. Science and technology progress prize of China aerospace science and technology group for once. The main research direction of strapdown inertial navigation technology and strapdown imu redundancy technology. Three authorized patents, published an article.

Abstract: In order to improve the reliability of inertial measurement units for launch vehicle Ï the application requirement of the strapdown inertial system is proposed and the redundant sensor configurations of the strapdown inertial navigation system for launch vehicle are investigated. The principle of redundant sensor configuration is firstly introduced Ï the comparison of different structures and the corresponding reliability evaluations are conducted, furthermore, the error analysis of typical redundant sensor configurations is accomplished. The result shows that Ï following the overall requirement of the launch vehicle, the suitable redundant sensor configuration of the strapdown inertial system can achieve the optimal system design and improve the reliability.

ð Speaker IntroductionÔ

Report	A Self-alignment Algorithm with Unknown Latitude Based on Three Gravitational Vectors and Adaptive Denoising Method
Name	Weiwei Lv
Degree	Ph.D.

Biography: Weiwei Lv was born in August 1989. He received the B.S. and M.S. degrees from Nanjing University of Aeronautics and Astronautics, Nanjing, China, in 2012 and 2015, respectively. Now he is a PhD student in Key Laboratory of Micro-Inertial Instrument and Advanced Navigation Technology, Ministry of Education, School of Instrument Science and Engineering, Southeast University, Nanjing, China. And his doctoral supervisor is professor Xianghong Cheng. His research interests include SINS initial alignment technology, AUV (Autonomous Underwater Vehicle) integrated navigation systems, adaptive filtering technology and nonlinear filtering technology

Abstract: In the traditional method of initial alignment in strapdown inertial navigation system under static base, the accurate local geographic latitude is required. If error occurs in the latitude, the accuracy of initial alignment will be jeopardized. As an improvement to self-alignment method based on two vectors of gravitational apparent motion a self-alignment method is proposed using three vectors of gravitational apparent motion in case the latitude information is unknown. In this paper, the improved alignment method based on three vectors of gravitational apparent motion is introduced in detail and the calculation formula for the latitude using three vectors of gravitational apparent motion is also deduced. In order to obtain the accurate vector of gravitational apparent motion from the accelerometer measurements that contain random noise and to avoid the occurrence of collinear vectors as well, a parameter adaptive Kalman filter is designed, which can effectively remove the random noise from the accelerometers and improve the alignment accuracy in unknown environments. Simulation results show that the proposed method can complete the self-alignment of strapdown inertial navigation system under static and swinging base when the latitude information is unknown, and in addition the alignment accuracy can reach the extreme accuracy determined by the errors of inertial devices.

ð Speaker Introduction Ô

Report Gravity Gradient Forward Calculation Method of Complex Shape Based on Finite Element Simulation

Name Wei Wang

Degree Master

Biography: Wei Wang, male, the engineer of the 707th Research Institute of China Shipbuilding Industry. Born in December 1986, from Tianjin, graduated from Tianjin University in 2009, majoring in mechanical design, manufacturing and automation. The master's degree was obtained from the Chinese Naval Academy in 2012, majoring in navigation guidance and control. In the same year, the 707th Research Institute of China Shipbuilding industry. Started working in the 707th Research Institute of China Shipbuilding Industry in the same year. Mainly engaged in the structure design of inertial navigation products and gravity gradient forward and inverse modeling, participated in and completed a number of National Natural Science Foundation, the national "973" plan and research project, having a deep research in the finite element simulation and calculation. In structural design, the whole model simulation of the inertial navigation system is first put forward, which greatly improves the simulation precision, and lays the foundation for the miniaturization and lightweight design of inertial navigation system. In gravity gradient forward modeling, the accurate calculation of gravity gradient around arbitrary complex shape is realized by using the mature finite element analysis software for the first time. The finite element method is applied to the gravity gradient forward to obtain a substantial breakthrough. A number of articles have been published in the Journal of Chinese Inertial Technology and geophysical and geochemical exploration.

Abstract: It is necessary to explain the gravity anomaly in the airborne geophysical exploration and the gravity gradient instrument also needs to create a precise gravity gradient field for its calibration, which can not be separated from the forward calculation of the gravity gradient of the three dimensional object. The quality of simple shape has a theoretical solution, but the quality of complex shape can only use the finite element method, which divides the complex body into some simple forms, and calculate the data independently and then sum. This method can only rely on manual at present Ï and the fitting degree of the segmentation model and the actual shape is poor Ï so it has low precision and low efficiency, and its engineering application value is low.

In this paper, the finite element analysis software is used for the first time with its grid partition function to realize the automatic precise division of arbitrary complex shapes. For existing software without gravity gradient field calculation module, considering the calculation formulas of the gravitation and Coulomb force similar, using the method of calculating the electric field around the charged body to calculate the gravitational field around the object is proposed creatively. Then, the gravitational field data is regarded as the displacement force applied to the model to calculate the strain, and the derivative of the gravitational field is obtained, and then the gravitational gradient distribution of the complex shape is obtained. The model fitting degree of this method is high, and the simulation error is less than 2%. All the data of the observation field is solved in once calculation, and the gradient tensor contours of arbitrary observation surface can be displayed at the same time. The advantages of this method are obvious for the calculation of complex shapes.

ð Speaker Introduction Ô

Report On Calibration of Strapdown Inertial Navigation System on A Low-grade or High-precision Turntables

Name Andrey Golovan

Title Professor

Biography: Andrey Golovan is the Head of Laboratory of Control and Navigation (since 2004) at Lomonosov Moscow State University, Doctor of Science in Physics and Mathematics, the Honoured Scientist of Lomonosov Moscow State University, the Academician of International Navigation and Motion Control Academy.

His research and research done in laboratory is closely related with Inertial and GNSS technology and corresponding applications (underground, marine, urban, airborne, space) on the basis of cooperation with Russian instrument-making companies.

Particularly, he elaborated the inertial and GNSS parts of post-processing software for Russian GT-2A gravimeter and for another two Russian gravimeters of previous generation.

Abstract: Calibration of inertial sensors of strapdown inertial navigation system (INS) is the necessary stage of INS assembling that takes place before system operation. A mathematical model of instrument errors is given a priori.

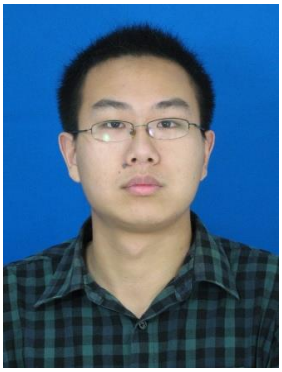
The special bench tests are conducted for the estimation of the parameters of this model.

In Laboratory of Control and Navigation at Lomonosov Moscow State University, the new calibration method was elaborated. The method itself is designed for a calibration of inertial measurement units of navigation, tactical and low grade on a turntable with horizontal axis of rotation. Neither angular nor rate measurement or precise positioning is required from the turntable in principle. This allows to get estimates for all desired parameters in a simple procedure with no need in precise equipment and without strict compliance with any predefined plan of operations. In case of high-precision turntable when turnt a b l e ô s angular data are available, its application can improve results of calibration procedure but not significantly.

Simulation results, covariance analysis and experiments with IMU of different levels of accuracy show efficiency of the proposed calibration method.

ð Speaker Introduction Ô

Report The Design of SINS Rapid transfer alignment Test system



Name Jinda Wang

Degree Master

Biography: Jinda Wang (1989-03), male, native place: Henan province Luoyang City. Master degree, research direction: inertial navigation and integrated navigation technology.

Abstract: A simulation scheme of navigation system that can simulate airborne movement environment in a laboratory movement is put forward. The scheme is applicable to test the transfer alignment of strap down inertial navigation system and performance evaluation of navigation system. Using this test method solve the problem that in ground test heading misalignment estimation ability of transfer alignment algorithm can ô verify and airborne test misalignment angle estimation without evaluation benchmark. The key technical problem solving algorithm is given. An optical fiber type inertial navigation system successful using the test equipment to carry out TA(transfer alignment) accuracy test, the results show that testing scheme is feasible and practical.

ð Speaker Introduction Ô

Report Optimal In-Flight Calibration Method for Inertial Navigation System Based on Constrained Kalman Filter

Name Lei Shi

Degree Ph.D.

Biography: Ph.D. candidate in Navigation, guidance and control at school of automation in Beijing Institute of Technology.

Abstract: An optimal in-flight calibration method for inertial navigation system (INS) based on constrained Kalman filter is proposed in this paper. It is known the INS errors accumulate with time due to initial errors and sensor errors among which the north gyro and upward gyro bias contribute a major part to the diverging position errors. Therefore in-flight calibration for the INS should be implemented when auxiliary navigation information, e.g. GPS, is available to reset the position outputs of INS and estimate the gyro biases. The INS is assumed to work under horizontal damping mode, which is the common case for long-term usage and the horizontal misalignment angles approximate to zero. The error model under horizontal damping mode is presented to illustrate the relationship between position errors and platform drift angles together with gyro biases. The constrained Kalman filter is applied to integrate the constraint to the dynamic model. Finally, simulation result demonstrate the effectiveness of the proposed method.

ð Speaker Introduction Ô

Report Multipurpose Control Laws for Marine Autopilots with Time Delay in Thrust System

Name Evgeny I.Veremey

Title Professor

Biography: Control Theory and its application in control of moving crafts and energy plants. Optimal control: new methods of optimization on the controller's sets, which are determined by various dynamical restrictions. New methods of mean-square optimization and optimization in the sense of H2 and Hinf norms. New methods of robust control. Control of moving crafts (new theory and applications): universal multipurposes structure of control laws with various applications for ships, moving robots and modern tokamaks.

Abstract: The problems of analytical design of control laws for marine autopilots are considered. Despite numerous known methods of a solution, nowadays the mentioned problems have further development, taking into account actual conditions of control system operation. One of the urgent questions to be investigated is a feedback synthesis for marine ships with time-delays in rudder's actuators. In this work, the new approach is proposed providing all desirable dynamical features of the autopilot taking into account the presence of a time-delay. This approach is based on the predictive compensation of time-delays by the special transformation of the initially given reference controller with a special multipurpose structure. Applicability and effectiveness of the proposed method is illustrated by the practical example of a controller design.

ð Speaker Introduction Ô

Report An Autonomous Calibration Method for Star Vectors Fusion of Multi-FOV Star Sensor

Name Zhilong Ye

Degree Master

Biography: Zhilong Ye received his MS from Nanjing University of Aeronautics and Astronautics in 2014. He is currently an engineer at Shanghai Institute of Spaceflight Control Technology. His main research interests are Photoelectric sensor and image processing.

Abstract: In order to further improve the measurement accuracy and reliability of attitude of star sensor, an autonomous calibration method for star vectors fusion of Multi-FOV (field of view) star sensor is proposed. Multi-FOV star sensor has several OHs (Optical Heads) which point to different FOV respectively. Base OH (Optical Head) is selected according to the requirement firstly. Attitude information of OH under tracking mode is used to compute the installation matrix between non-base OH and base OH, and weighted filter algorithm (WFA) is utilized to calibrate the matrix autonomously. At the same time the calibration is also live updated depend on the work condition of OHs. A star vectors fusion will be implemented by using calibrated install matrix. Finally, three-axis attitude with the same accuracy can be achieved by QUEST using all recognized star fusion vectors. The experimental simulation and principle prototype test results show that, compared with traditional single-FOV star sensor, the proposed method can improve the accuracy and robustness of attitude effectively. It has a significant enhancement in terms of accuracy around boresight axis and can achieve 6.7 times improvement of accuracy when angle between two OHs is 40 degree.

ð Speaker Introduction Ô

Report A Precise Positioning System Based on Multiple Sensors Applied to Complex Environment

Name Fan Li

Degree Bachelor

Biography: LI Fan, female, born in February 1993 and from Xi'an of Shaanxi province, a member of the Communist Party of China. She studied as an undergraduate at College of Automation, Northwestern Polytechnical University, specializing in Measurement and Control Technology and Instrument. She was proactive and studied hard. Meanwhile she was eager to participate in various community activities and competitions, and achieved excellent results, won several titles of "outstanding student". She obtained bachelor's degree in June 2015 and won the qualification of further study without entrance examination. Now she is a master's sophomore of Northwestern Polytechnical University, majoring in Precision Instruments and Machinery, whose tutor is Professor Zhong Zhao. The main research directions are inertial devices and inertial integrated navigation. Currently, she is mainly involved in researching projects including the study of multi-sensorial positioning system, GPS/INS integrated navigation and so on.

Abstract: With the constant improvement of the social informatization level, precise positioning of people, objects or vehicles in specific areas is increasingly required. In a complex environment, such as industrial park, mining area, airport, etc., positioning with a single sensor often cannot meet the demands of positioning coverage, accuracy and cost simultaneously. This paper presents a low-cost, high-precision and non-blind zone positioning system, which includes Global Positioning System (GPS), Ultra-wide Bandwidth (UWB), Wireless Fidelity (WIFI), Micro Electro Mechanical Systems (MEMS). Meanwhile, the tag designed for people in this system can be wearable. Positioning principle and algorithms of every aforementioned sensor are analyzed, and applicable sensor placement has been designed for specific areas. In order to get an optimal positioning result, several methods of multisensory data fusion have been studied in this paper: optimal estimation is adopted to get positioning result where more than one sensor can locate (signal of GPS, UWB, WIFI overlap); system can still provide comparatively accurate positioning results by data fusion even where aforementioned four sensors cannot complete effective positioning separately. Relevant precision argument and theoretical analysis show that the system can complete effective positioning without blind areas and with meter-scale precision.

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