CONFEENCE PROGRAM

2022 The 13th Asia Conference on Mechanical and Aerospace Engineering

13thACMAE 2022

Chengdu, China | December 22-24, 2022

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WELCOME ADDRESS

Dear Attendees,

Welcome to the 13th Asia Conference on Mechanical and Aerospace Engineering (ACMAE 2022), the sister conference of ICMAE, which is held during December 22-24, 2022, following the successful conferences in Nanjing last year, online in 2020, Bangkok, Thailand in 2019, Singapore in 2018 and Yokohama, Japan in 2017.

ACMAE 2022 is sponsored by Sichuan Institute of Electronics, Science and Engineering Institute, co-sponsored by Nanjing University of Science and Technology, Moscow Bauman State Technical University, technically supported by Capitol Technology University, Washington University in St. Louis.

After several rounds of rigorous review, the program committee not only indicated acceptance but also provided ratings on those papers accepted for publication in the ACMAE conference proceedings. We wish to express our sincere appreciation to all individuals who have contributed to ACMAE 2022 conference in various ways. Special thanks are extended to our colleagues in the program committee for their review of all the submissions, which is vital to the success of the conference, and also to the members in the organizing committee and other volunteers who had dedicated their time and efforts in planning, promoting and organizing the conference.

There are 9 oral sessions in this conference. The topics include material design and performance Simulation, power machinery design and control, aircraft structure design and control model, mechanical vibration analysis and fluid mechanics, control model and reliability analysis in mechanical and electronic systems, engine modeling and performance optimization, space propulsion system and reliability analysis, attitude control and trajectory tracking of UAV and helicopter, aerospace engineering and safety management etc.

One best presentation will be selected from each session, which will be evaluated based on originality, applicability, technical merit, quality of PPT and communication skill. The best one will be announced at the end of each Session.

We believe that these works will lay the foundation for further research and the interactions during the conference will lead to much improved version of the extended papers. Hope that all of you remain healthy and weather the pandemic well. We wish to see every one of you face to face in the same conference in the next year!

Have a nice communication on the conference!

ACMAE 2022 Organizing Committees

December, 2022

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GUIDELINE FOR ATTENDANCE

Time

December 22, 2022 is the test day for testing of some basic functions that we would use during conference. The whole program is arranged by **Beijing Time (GMT+8)**, please double-check your Test Time and Presentation Time, and update with your Local Time on your own schedule, to make sure be online on time.

Tool

ZOOM (zoom.com.cn or zoom.us) will be used for the whole online event. On the buttom of the web page, you can choose download the app for free and then choose 'JOIN A MEETING ', then input room's ID. As usual you could not create an account now, so you can join in our conference as a visitor, ZOOM may ask you to input your phone number and the passwords they sent to your number to verify.

How to Use Zoom

https://support.zoom.us/hc/en-us/articles/206618765-Zoom-Video-Tutorials

1. Download the ZOOM on https://www.zoom.us/download
2. Turn on your Audio and start your Video. Use headsets/Earphones to enhance the audio effect and avoid the speaker echo or howling. Stay in a quite place without noise.
3. Join TEST DAY on December 22th, we will help the delegates know better how to use ZOOM functions as following:
   - ✧ RENAME: authors please rename like Session Number+ Paper ID+ Name as you join the room. E.g.: S1+ME001+Lily. For KN or SC, please rename like KN/SC+ Name
   - ✧ SHARE SCREEN: Choose the files you need to share
   - ✧ RAISE HAND FUNCTIONS: If you have any questions, you can use this function
   - ✧ CHAT: type the word on the chat broad, you can chat to everyone in the room or someone privately

Presentation Tips

1. Please prepare a digital device with **Microphone** (mandatory) and Webcam (optional), a **computer or laptop** is recommended; And make sure you are connected to a stable and **high-quality Wi-Fi network**, or 4G/5G or Internet if available.
2. Presentation Time: **Total 15 Mins** for online oral presenter including 5 Q&A time.
3. Read the detailed program, check the time and Zoom information of the session that you will do your presentation.
4. One best Presentation will be chosen from each presentation session and announced at the end of the session. The conference secretary will email you the certificates after the conference.
5. An **English PPT** must be prepared and use English during the presentation
6. Each Presentation will be recorded, if you don't want it, please inform our staff ahead of time.
7. Please enter in your session's room 10 Mins earlier of the start of sessions.
8. For video presenters, you need to play the presentation video **yourselves**.
9. When giving your presentation, please **turn on the video**.

Room Information

Room A Zoom ID: 813 2355 6830 Zoom Link: https://us02web.zoom.us/j/81323556830

Room B Zoom ID: 816 2852 8297 Zoom Link: https://us02web.zoom.us/j/81628528297

KEYNOTE SPEAKERS

Keynote Speaker I

Date: December 23 Speech Time: 9:10-9:55

Zoom ID: 813 2355 6830

Speech Title: ***Towards Safety and Security in Socio-Cyber-Physical Systems***

Prof. Naira Hovakimyan

University of llinois, USA (IEEE Fellow)

Abstract: Control theory and feedback techniques have seen many success stories with various safety-critical systems in recent years. However, as more and more cyber-physical systems appear in our daily life, safety and security of these systems – from the perspective of human's perceptual and cognitive recognition – are becoming equally important. In the first part of the talk, we present an overview of L1 adaptive control and its combination with the recent tools from machine learning literature, and how it enables safety in autonomous systems, and discuss some of its success stories in the aerospace industry. In the second part of the talk, we present some of our recent results that explore human's perceptual safety and how a machine can learn human expert's actions for socially aware path planning. We will discuss ongoing research that addresses security in social networks using control-theoretic methods. We will wrap up with an open-ended question regarding how cognitive science can be integrated with control theory to build new system architectures.

Biography: Prof. Naira Hovakimyan received her MS degree in Theoretical Mechanics and Applied Mathematics in 1988 from Yerevan State University in Armenia. She got her Ph.D. in Physics and Mathematics in 1992 from the Institute of Applied Mathematics of Russian Academy of Sciences in Moscow, majoring in optimal control and differential games. Before joining the faculty of UIUC in 2008, she spent time as a research scientist at Stuttgart University in Germany, French Institute for Research in Computer Science and Automation (INRIA) in France, Georgia Institute of Technology, and she was on faculty of Aerospace and Ocean Engineering of Virginia Tech during 2003-2008. She is currently a W. Grafton and Lillian B. Wilkins Professor of Mechanical Science and Engineering at UIUC. In 2015 she was named inaugural director for Intelligent Robotics Lab of Coordinated Science Laboratory at UIUC. She has co-authored two books, eleven patents and more than 450 refereed publications. She was the recipient of the SICE International scholarship for the best paper of a young investigator in the VII ISDG Symposium (Japan, 1996), the 2011 recipient of AIAA Mechanics and Control of Flight Award, the 2015 recipient of SWE Achievement Award, the 2017 recipient of IEEE CSS Award for Technical Excellence in Aerospace Controls, and the 2019recipient of AIAA Pendray Aerospace Literature Award. In 2014 she was awarded the Humboldt prize for her lifetime achievements. In 2015 she was awarded the UIUC Engineering Council Award for Excellence in Advising. She is Fellow and life member of AIAA, a Fellow of IEEE, and a member of SIAM, AMS, SWE, ASME and ISDG. She is cofounder and chief scientist of IntelinAir. Her work in robotics for elderly care was featured in the New York Times, on Fox TV and CNBC. Her research interests are in control and optimization, autonomous systems, neural networks, game theory and their applications in aerospace, robotics, mechanical, agricultural, electrical, petroleum, biomedical engineering and elderly care.

Keynote Speaker II

Date: December 23 Speech Time: 9:55-10:40

Zoom ID: 813 2355 6830

Speech Title: *Diversified Functions of Ultrasonic Micro/nano* Manipulations

Prof. Junhui Hu

Nanjing University of Aeronautics and Astronautics, China
(Chang-Jiang Distinguished, IAAM Fellow)

Abstract: Ultrasonic micro/nano manipulation is an actuation technology, which employs the nonlinear and linear effects of ultrasonic vibration in fluid, solid and gas to implement the functions including (but not limited to) capture, concentration (or enrichment), decorating, driving, filtration and sorting of micro/nano scale materials. The nonlinear and linear effects of ultrasound utilized in the ultrasonic micro/nano/molecular manipulation include the acoustic radiation pressure, acoustic streaming, acoustic cavitation, ultrasonic vibration velocity and sound pressure. It is one of the promising technologies in biomedical sample treatment, micro/nano fabrication process and chemical reaction catalyses. In this lecture, ultrasonic vibration/field based micro/nano concentration (enrichment) methods, micro/nano tweezers, nano fabrication process and gas molecule manipulation method, which have been proposed and developed by the speaker's group in recently years, are presented through illustrating the structures, working principles and characteristics of the ultrasonic devices. Furthermore, applications of some of those manipulation methods in the nano sensor fabrication and high-performance gas sensor/electronic nose systems are experimentally demonstrated. The experimental and theoretical work on the manipulations, implemented by the speaker's group, has illustrated that ultrasonic methods can implement diversified micro/nano manipulation functions, and has indicated that the ultrasonic micro/nano manipulation methods may provide a promising way to facilitate the fabrication of high-performance nano-devices and nano composite materials, and to construct high-performance sensing systems. The contents of this lecture include the following five parts: introduction of ultrasonic micro/nano manipulations, ultrasonic micro/nano concentration, ultrasonic micro/nano tweezers, ultrasonic nano fabrication, and ultrasonically catalyzed gas sensors/electronic noses.

Biography: Prof. Junhui Hu received his Ph.D. Degree from Tokyo Institute of Technology, Tokyo, Japan, in 1997, and B. E. and M. E. degrees in electrical engineering from Zhejiang University, Hangzhou, China, in 1986 and 1989, respectively. Currently he works for Nanjing University of Aeronautics & Astronautics, China, as a full professor. His research interest is in ultrasonic sensors and actuators, ultrasonic nano fabrication, ultrasonic micro/nano/molecular manipulations, etc. He is a Chang-Jiang Distinguished Professor, China, and an IAAM Fellow.

He was an assistant and associate professor at Nanyang Technological University, Singapore, from 2001 to 2010, and an R&D engineer at Tokin, Japan, from 1997 to 1999. He authored and co-authored more than 300 publications, including more than 100 full research papers published in SCI journals, two books, 1 editorial review in an international journal and more than 60 disclosed/empowered China and Japan patents. He is the sole author of monograph book "Ultrasonic Micro/Nano Manipulations: Principles and Examples" (2014, World Scientific). He has given more than 30 keynote/invited lectures at international conferences, and his research work has been highlighted by 7 international scientific media. He served lots of international conferences as a Technical Program/Organizing/Scientific Committee member, and was the

chairman of International Conference on Mechanical Control and Automation 2016 (China), International Conference on Electric Engineering and Automation Control 2017 (China), and honorary chairman of International Workshop on Piezoelectric Materials and Applications in Actuators 2011 (USA). He was awarded the title of valued reviewer by Sensors and Actuators A: Physical and by Ultrasonics, and won the Paper Prize from the Institute of Electronics, Information and Communication Engineers (Japan) as the first author in 1998. He was once supported by the Shuang-Chuang Project of Jiangsu Province, China, as a “Shuang-Chuang” expert. Presently, he is an editorial board member of four international journals, board member of Chinese Acoustical Society and member of its academic work committee, and deputy director of expert committees on electronic information materials and devices, and on Aerospace materials, Chinese national think tank for materials and devices.

INVITE SPEAKERS

Invite Speaker I

Date: December 23 Speech Time: 11:00-11:30

Zoom ID: 813 2355 6830

Speech Title: ***A numerical study on surface flashover discharge***

Prof. Anbang Sun

Xi'an Jiaotong University, China

Abstract: The drift-diffusion-reaction fluid model is widely used to simulate streamer discharges. We compared simulations and experiments of single positive streamer discharges in air at 100 mbar, aiming toward model validation [1]. (Experimentally, streamers were generated in a plate–plate geometry with a protruding needle. Simulations were performed under conditions closely matching those of the experiments.) Good quantitative agreement was observed between the experimental and simulated optical emission profiles, and for the streamer velocity and radius during the entire evolution. We extended this model to surface discharge simulations. We simulated streamer discharges that propagate towards a dielectric surface, attach to it, and then propagate over the surface [2, 3]. We focused on the attraction of streamers to dielectrics and the differences between surface and gas-phase streamers. The effects of the applied voltage (polarization and amplitude), the permittivity of the dielectric material and the secondary electron emission on the streamer's inception time, propagation velocity and morphology were investigated.

Biography: Prof. An-bang Sun was born in Anhui, China, in 1984. He received the B.Sc degree and PhD degree from Northwestern Polytechnical Univerisity, in 2016 and 2010, respectively. From 2007 to 2008, he has been with the 'Institut de Mathematiques de Toulouse', Toulouse, France, as a visitor student. From 2010 to 2011, he was a postdoc at 'Departement Aerodynamique, Energetique et Propulsion', ISAE, Toulouse, France. He was a postdoc researcher with Centrum Wiskunde & Informatica (CWI), Amsterdam, The Netherlands, from 2011 to 2014. He worked at Leibniz Institute for Plasma Science and Technology (INP Greifswald), Germany, as a scientist, from 2014 to 2016. He was a Visiting Scholar with CWI in 2016. He is currently a Professor with the school of electrical engineering, Xi'an Jiaotong University. He has authored or co-authored over 100 scientific papers in international journals. His main research interests include gas discharges at low/atmospheric pressure, plasma propulsion technology, advance numerical skills for plasma sources and micro aerial vehicle.

Invite Speaker II

Date: December 23 Speech Time: 11:30-12:00

Zoom ID: 813 2355 6830

Speech Title: ***Wearable exoskeleton motion control technology***

Prof. Qing Guo

University of Electronic Science and Technology of China, China

Abstract: Wearable exoskeleton is a typical human-machine coupling cooperative sports equipment, which has broad application prospects in military, medical and industrial fields. This report integrates exoskeleton dynamics, human biomechanics and human-machine coupling nonlinear mechanics constitutives, realizes the precise prediction of human motion intention by exoskeleton, and proposes the cooperative motion control technology of human-machine coupling for exoskeleton, which realizes the exoskeleton. The skeleton follows the movement intention of the human body and drives the human body to complete the active and passive control tasks of the predetermined action. A strength-enhanced exoskeleton master-slave follow-up control method is proposed, and it is the first in China to realize the man-machine with a load of 60 kg to walk softly, squat to stand, and go up and down stairs.

Biography: Prof. Qing Guo is currently a Full Professor with the School of Aeronautics and Astronautics, University of Electronic Science and Technology of China, Chengdu, China. From 2013 to 2014, he was an Academic Visitor with the Center for Power Transmission and Motion Control, Department of Mechanical Engineering, University of Bath, U.K. His research interests include robust and adaptive controls, electrohydraulic, exoskeleton, and rehabilitation robots.

CONFERENCE AGENDA

Thursday December 22, 2022

Test Day		
Time	**Room A** **Zoom ID: 813 2355 6830**	**Room B** **Zoom ID: 816 2852 8297**
10:30-11:30	Keynote, Invite Speakers & Session Chairs	Session 1 & Session 2
11:30-13:30	Break	
13:30-14:30	Session 3 & Session 4	Session 5 & Session 6
14:30-15:30	Break	
15:30-16:30	Session 7 & Session 8 & Session 9	

Friday December 23, 2022

Time	Room A ➤ ZOOM ID: 813 2355 6830
9:00-9:10	**Opening Remarks** **Prof. Ian McAndrew,** Capitol Technology University, USA
	Program Address **Prof. Qing Guo,** University of Electronic Science and Technology of China, China
	Chair: Yao Yan, University of Electronic Science and Technology of China, China
9:10-9:55	**Keynote Speaker I** **Prof. Naira Hovakimyan,** University of llinois, USA (IEEE Fellow) **Speech Title:** Towards Safety and Security in Socio-Cyber-Physical Systems
9:55-10:40	**Keynote Speaker II** **Prof. Junhui Hu,** Nanjing University of Aeronautics and Astronautics, China (Chang-Jiang Distinguished, IAAM Fellow) **Speech Title:** Diversified Functions of Ultrasonic Micro/nano Manipulations
10:40-11:00	Morning Break and Group Photo
	Chair: Yuan Yue, Southwest Jiaotong University, China
11:00-11:30	**Invite Speaker I** **Prof. Anbang Sun,** Xi'an Jiaotong University, China **Speech Title:** A numerical study on surface flashover discharge
11:30-12:00	**Invite Speaker II** **Prof. Qing Guo,** University of Electronic Science and Technology of China, China **Speech Title:** Wearable exoskeleton motion control technology
12:00-13:30:	Lunch Break

Time	Room A ZOOM ID: 813 2355 6830	Room B ZOOM ID: 816 2852 8297
13:30-15:30	**Session 1: Material Design and Performance Simulation**	**Session 2: Aircraft Structure Design and Control Model**
	AM037, AM004, AM021, AM027, AM029, AM101, AM009, AM066	AM076, AM002, AM005, AM011, AM012, AM039, AM060, AM105
15:30-15:50	Break	
15:50-17:35	**Session 3: Power Machinery Design and Control**	**Session 4: Control Model and Reliability Analysis in Mechanical and Electronic Systems**
	AM104, AM006, AM020, AM052, AM065, AM073, AM008	AM090, AM001, AM015, AM017, AM022, AM041, AM097

Saturday December 24, 2022

Time	Room A ZOOM ID: 813 2355 6830	Room B ZOOM ID: 816 2852 8297
10:00-11:45	**Session 5: Engine Modeling and Performance Optimization**	**Session 6: Attitude Control and Trajectory Tracking of UAV and Helicopter**
	AM031, AM049, AM088, AM093, AM096, AM018, AM083	AM030, AM034, AM056, AM095, AM023, AM028, AM050
11:45-13:30	Lunch Break	
13:30-15:30	**Session 7: Mechanical Vibration Analysis and Fluid Mechanics**	**Session 8: Space Propulsion System and Reliability Analysis**
	AM003, AM032, AM048, AM053, AM072, AM103, AM057, AM091	AM061, AM035, AM036, AM081, AM084, AM080, AM010 AM098
15:30-15:50	Break	
15:50-17:50	**Session 9: Aerospace Engineering and Safety Management**	
	AM067, AM094, AM007, AM033, AM059, AM063, AM064, AM087	

TECHNICAL SESSIONS

13:30-15:30 December 23		**Session 1: Material Design and Performance Simulation** Room A ZOOM ID: 813 2355 6830 Zoom Link: https://us02web.zoom.us/j/81323556830
Session Chair:		
13:30-13:45	**AM037**	A Review on Mechanical Properties and Simulation Methods of Stitched Composites **Lei Shi,** Yongjie Zhang Northwestern Polytechnical University, China Abstract: Stitching technology is an effective and advanced textile method to improve the interlayer performance of composites and has broad application prospects in aerospace, military, civil and other fields. In recent years, various aspects of sutured composites have been continuously updated. In this paper, the mechanical properties, failure mechanism and numerical simulation methods of stitched composites are introduced.
13:45-14: 00	**AM004**	Thermal Buckling Behavior of Metal/Composite Wall Panels Wenliang Deng, **Kai Lei**, Jingtao Wu Aircraft Strength Research Institute of China, China Abstract: This paper has carried out the research on the thermal buckling behavior of the metal/composite composite structure wall panel. The thermal buckling behavior of the hybrid structure has been studied from analytical methods, finite element methods and experimental tests. Aiming at the thermal buckling behavior of the hybrid structure from room temperature 20℃ to -55℃, non-contact optical testing technology is used to obtain the thermal buckling deformation parameters of the entire temperature history, and the critical heat of the hybrid structure is obtained through theoretical solution, simulation and data judgment methods. The buckling temperature reveals the thermal buckling deformation law of the mixed structure wall panel under the aircraft temperature envelope. Conclusion: The change of structural off-plane displacement is the manifestation of structural buckling instability. Although buckling instability occurs in the wall structure during the cooling process, the structure can still be restored to a normal state without post-buckling. The slope of structural deformation changes dramatically after -15℃, basically showing a linear relationship; the theoretical solution, simulation method and data judgment method determine the critical temperature of structural thermal buckling with a maximum difference of 4.8℃. The test data judgment method can be used for thermal buckling Determination of critical load.
14:00-14:15	**AM029**	Study on KIC of TC4-DT Titanium Alloy Electron Beam Welding **Xianglin Ye**, Yuchun Feng, Jiawen Feng, Linyu Shang AVIC Chengdu Aircraft Industrial(group) Co.Ltd, China

		Abstract: With the development and application of TC4-DT titanium alloy and electron beam welding, the research on fatigue crack growth of its joints is very important in engineering. In this paper, the relevant fracture mechanics and crack growth theory are proposed for the fatigue crack growth of TC4-DT titanium alloy electron beam welded joints, and the experimental and finite element method simulation crack growth research is carried out. The results show that: during the fatigue crack test, with the continuous increase of the cycle period, the crack growth rate in different regions increases significantly, among which the growth rate of the weld zone is higher, and the crack propagation path in the weld zone is almost completely along the weld zone. The direction of the axis of symmetry of the center of the crack propagates linearly, and the crack propagation in the base metal area basically expands along the straight line but slightly deviates to the upper base metal area. By calculating the stress intensity factor of different preset crack lengths through simulation, it is found that within the allowable error range, with the increase of the prefabricated crack length, the stress intensity factor k1 of the specimen increases gradually.
14:15-14:30	**AM021**	Research Progress of Evaluation Methods of Failure Criteria for Fiber Reinforced Composites **Samya Ettoumi, Yongjie Zhang** Northwestern Polytechnical University, China Abstract: Integration of composite materials in aviation applications undeniably offer multiple important benefits, and more modelling techniques and failure analysis tools are increasingly being developed in evaluated to reduce the high costs associated with investigating the mechanical behavior and failure prediction of fiber reinforced composites. This article evaluates and compares between some of the most common failure criteria, Hashin, Puck and maximum stress criteria. The conclusion of this article shows that the interactive failure criteria are more adequate to use in the prediction of failure although they are inherently more complex to describe.
14:30-14:45	**AM101**	Analytical and Experimental Study on Honeycomb Sandwich Plates Reinforced by Ring Beam of Satellites Dalei Zhu, **Xiaoxin Wang**, Shuang Yao, Jianfeng Zhang, Mengmeng Jiao Beijing Space Craft Manufacturing Co. Ltd, China Abstract: The equivalent parameters of hexagon aluminum honeycombs are work out with the theories of sandwich plates in this paper. The honeycomb sandwich plate reinforced by ring beam applied with static load is simulated by the finite element model of honeycomb sandwich plates, which is validated by static test. The research results show that the numerical calculation error of the honeycomb sandwich plate is less than 10% compared with test results, which is acceptable for an engineering project, and the mechanical behavior of the honeycomb sandwich plate can be described in detail. Thus, the method of equivalent honeycomb parameter is proved to be effective for the design and analysis of honeycomb sandwich plates. The influence of equivalent elasticity modulus and equivalent shear modulus to honeycomb sandwich plates can be reflected exactly from the results which are figured out with the equivalent theories of sandwich plates. The assembly clearance and assembly accuracy have a significant influence to the test results of honeycomb sandwich plates, which is obvious especially at a lower load level.

14:45-15:00	**AM027**	A Review of The Design of Medium and Large Open Reinforced Structures in Composite Fuselages Yongjie Zhang, **Ming Zhang** Northwestern Polytechnical University, China Abstract: Composite materials are widely used in the design and manufacture of modern civil aircraft fuselage structures. Some large airliners already have full-size composite fuselages, which reduced the weight of the fuselage structure, but the problem of reinforcing the opening of the composite fuselage is also very important. In this paper, the design of medium and large scale open reinforcement structures in composite fuselages is focused. The force characteristics of passenger doors, cargo doors, landing gear hatch openings, and the reinforcement structure form are elaborated, and based on the current research status at home and abroad, the future development of composite fuselage opening reinforcement design is prospected.
15:00-15:15	**AM009**	Pressure Resistance Analysis of Multi-Layer Fluid-Solid-Coupling Shell Structure **Runkun li,** Tieshu Li, Pengrui Dai, Jingyu Yang Kunming Shipborne Equipment Research and Test Center, China Abstract: This paper focuses on the pressure resistance of underwater equipment. A shell structure that divided into multi-layer is proposed, the spaces between layers are filled with fluid medium, which is applied gradually decreasing pressure in outside-inside order that helps offsetting external pressure. Using the Finite Element Method, the Multi-layer Fluid-Solid-Coupling Shell Structure has been proved to be effective in improving the pressure resistance of underwater equipment without increasing the total thickness of material, in the scope of the study, the maximum equivalent stress of the whole structure decreased with increase of the number of layers without instability phenomenon.
15:15-15:30	**AM066**	A Novel Thrust Vector Nozzle with Conical Surface Based on Coanda Effect **Haibo Zheng**, Jiangtao Huang, Chengjun He, Bin Wu, Chao Gao Northwestern Polytechnical University, China Abstract: In this paper, a novel thrust vector control method based on Coanda effect is proposed for conical surface. The effect of thrust vector control is studied by computation fluid dynamic (CFD) numerical simulation. When there is no side plate on both sides of Coanda surface, there are large vortex structures on both sides of nozzle wake, and the vector control cannot be realized. After adding the side plate, the comprehensive control of the pitch and yaw thrust vectors was realized. When the nozzle pressure ratio (NPR) is 2~2.4, the pitch and yaw vector angles decreased with the increase of NPR, and the maximum pitch vector angle is 8°. And the yaw vector angle is 8°.

13:30-15:30 December 23		**Session 2: Aircraft Structure Design and Control Model** Room B ZOOM ID: 816 2852 8297 Zoom Link: https://us02web.zoom.us/j/81628528297
Session Chair:		
13:30-13:45	**AM076**	Effect Of Leading-Edge Parameters of Multi-Element Airfoil on Aerodynamic Characteristic **Jinyang Cai**, Jiaming Luo Shanghai Aircraft Design and Research Institute, Commercial Aircraft Corporation of China, China Abstract: Studying the effect of leading-edge parameters of 30P30N on aerodynamic characteristic was carried out. Effect of changing the gap and overlap of the slat of the airfoil were mainly investigated. Numerical simulation was applied to obtain aerodynamic characteristics, results show that: the lift coefficient in the linear segment basically does not change with the gap, the drag coefficient decreases with change of the gap. The overlap and gap of slat have obvious effect on the lift-to-drag ratio. The smaller the gap between slat and fixed wing, the greater the lift-to-drag ratio is achieved. With the increase of overlap between slat and fixed wing, lift to drag ratio increases.
13:45-14: 00	**AM002**	Design of Flap/Spoiler Follower Mechanism for Civil Aircraft Yunwen Feng, **Jiaqiang Tang**, Zhiyu He, Xiaofeng Xue, Yue Liu Northwestern Polytechnical University, China Abstract: With the gradual development of the lift device to a simple and efficient direction, the drooped spoiler has become an emerging lift device. The drooped spoiler can improve the aerodynamic performance of the wing by reducing the air flow separation and increase the lift coefficient, which requires the spoiler to deflect a certain angle following the downward deflection of the flap. Aiming at this requirement, this paper proposes a design method of spoiler follower mechanism based on the relative pole method. The applicability and correctness of the method are verified by kinematics simulation. Moreover, the kinematic characteristics of the simple four-bar linkage and the complex four-bar linkage are compared, and the results show that the complex four-bar linkage is more stable in the motion process.
14:00-14:15	**AM005**	Optimization of Auxiliary Fuel Tank Layout to Decrease the Aircraft Empty Weight **Rui Wang**, Fangyu Shi Shanghai Aircraft Design and Research Institute, China Abstract: The modern civil aircraft has the trend to utilize the auxiliary fuel tank to increase the range. This paper presents an optimization concept for fuel tank design to optimize auxiliary fuel tank placement in aircraft to decrease the aircraft empty weight. A model formulation has been created to satisfy the minimum fuel weight requirement and the aircraft center of gravity limit. To solve the fuel tank layout issue, the integer linear programming algorithm has been applied. In order to validate the concept a simulation

		model and different calculation cases have been built. The calculation results show that the method can effectively reduce the aircraft empty weight and can gain high benefits.
14:15-14:30	**AM011**	An Advanced Warning Model of Airplane Hard Landing Based on Adaboost Rui Zhang, Liuyiting Cai, Duojia Huang, **Chunyu Gao** China Electronic Product Reliability and Environmental Testing Research Institute, China Abstract: This paper breaks through the limitation of establishing early warning logic in the time dimension of the previous hard landing early warning model. In this research, flight altitude has been set as the scale of the corresponding early warning logic. According to the specific characteristics of the original flight parameter data set, the data preprocessing methods have been studied. The application of oversampling and frequency compression methods effectively solved the problems of different sample size and multi-frequency flight parameters in the original data set. On this basis, the method of ensemble learning is used to establish the early warning model of aircraft hard landing based on Adaboost. Further, the model is optimized to ensure the accuracy and generalization ability of the early warning model. Verified by the case study of the actual flight parameter data of Airbus A320 aircraft, the early warning model can realize high-precision prediction of hard landing events, which is of great significance for the improvement of the landing safety level of the aircraft in constructing both.
14:30-14:45	**AM012**	Reconfiguration Control Allocation of Actuator Faults for Tailless Aircraft with Low Aspect Ratio **Gen Li**, Liguo Sun, Bo Yang, Shuang Yu, Zhangmengke Yang Kunming Institute of Physics, China Abstract: The triaxial attitude control of the tailless aircraft depends heavily on the effectiveness of the actuators. Still, the actuators have redundancy characteristics, cross-coupling of rudder effect, and so on. Therefore, the reconfigurable control allocation of the tailless aircraft under typical actuator faults is deeply studied in this paper. The effectiveness and rationality of the incremental control allocation method based on quadratic programming are thoroughly verified for application to maximize the residual control ability of the aircraft, ensure that the aircraft can still complete the flight mission typically, and guarantee flight safety. According to the research principle of surface failures from slight to severe, three typical rudder surface faults are designed successively: Efficiency loss of single actuator, single actuator stuckness, and double actuators combined stuckness. On this basis, the mechanism of reconfiguration allocation after actuator failures is studied, and the residual control ability of the actuator after loss is fully explored. What's more, the range of allowable reduction of efficiency of each actuator and the acceptable stuck angle range of each actuator are explored, and the most severe failure in the combination of double actuators stuck is obtained. The attitude controller is designed with incremental backstepping (IBKS). The reconstruction allocation adopts a quadratic programming allocation method based on an effective set solver, which can be seamlessly connected with the IBKS method to improve the control accuracy and disturbance immunity effectively.
14:45-15:00	**AM039**	Fatigue Life Prediction of Aircraft Gun Cabin Structure Under Impact

		Zhenhao Ding, Ke Wang Nanjing University of Aeronautics and Astronautics, China Abstract: The aircraft gun firing will cause serious impact on airframe structure. According to the gun firing principle, the muzzle blast wave is simulated by chemical explosion. ALE method is used to deal with the fluid-structure interaction between high-pressure flowing air and the surface of the cabin. Then the expression model of the impact load is established. The numerical calculation is completed to analyse the dynamic response of the cabin structure under the impact load. The parameters of load and cabin model are modified by using the experimental results. Comparing the calculated dynamic response with the experimental results, the error is within acceptable range. Multiaxial stress equivalence and rain-flow counting method are used to process the simulation impact response data to estimate the impact fatigue life. In conclusion, the paper provides a feasible method for analysing dynamic response and fatigue life of gun cabin structure.
15:00-15:15	**AM060**	Design of Tandem Wing Layout of Pneumatic Cooperative Lift Train **Shaocheng Ding**, Chao Gao, Rihua Yan, Bin Wu, Ya Liu, Zhangsong Ni, Ming Xue Northwestern Polytechnical University, China Abstract: Pneumatic lift train together is the concept of under the background of further accelerate the speed of high-speed train running speed, in order to under higher speed train the whole life cycle cost, the researchers put forward the concept of aerodynamic lift high-speed train together, break through the traditional high-speed train aerodynamic shape design concept, combined with high speed trains and aircraft their respective advantages, hope that through increasing train aerodynamic lift, It is hoped that by increasing the aerodynamic lift of the train, the overall energy saving and consumption reduction of the high-speed train can be achieved. In this paper, a high lift airfoil is optimized to improve the lift coefficient as much as possible while the drag coefficient is basically unchanged. The thickness and drag coefficient of the optimized airfoil are almost unchanged at the designed Angle of attack, and the lift coefficient is increased by 13%. A flat wing is designed based on the optimized airfoil, and the influence of wall effect and tandem wing layout on the lift drag coefficient of the wing is studied. A better aerodynamic lift cooperative train tandem wing layout is obtained, which can reduce the weight of a single train by 17%.
15:15-15:30	**AM105**	An Effective Flight Attitude and Trajectory Control Scheme for Sounding Rocket **Wentong Zhang**, Chunyu Wen, Tianxing Zhou Beijing Institute of Technology, China Abstract: Existing sounding rocket flight is probably disturbed by external factors, of which attitude is lack of automatic control function and flight trajectory is not stable, thus the project designed a canard adjustable posture scheme based on PID control algorithm, which can effectively solve the sounding rocket flight stability and flight path anti-interference problem with high efficiency.

15:50-17:35 December 23		**Session 3: Power Machinery Design and Control** Room A ZOOM ID: 813 2355 6830 Zoom Link: https://us02web.zoom.us/j/81323556830
Session Chair:		
15:50-16:05	**AM104**	Aerodynamic Design of Wind Turbine Blade with Second Derivative of Thickness Distribution as Constraint **Jianhua Xu**, Shiqiang Zhang, Wenping Song, Zhonghua Han, Shaojun Zhou, Xinlong Li Northwestern Polytechnical University, China Abstract: In order to make more use of wind energy, large-scale wind turbine blade size is the trend of development. With the increasing of blade length, the design and manufacture of the structure with the requirements of safety and economy are faced with great challenges. It is most sensitive to the blade manufacturer to reduce the composite lamination and production cost as long as the stress and strain level of the structure is satisfied. Therefore, the ideal thickness distribution requires not only the thickness monotonically decrease along the radial direction, but also the concavity and convexity of the thickness distribution function are required to be constant. Based on the in-house design code SurroOpt and the momentum-blade theory method, an optimization design platform for wind turbine blades was established. A 400kW wind turbine blade design was carried out with the aim of maximizing the output power and the constraint of the second derivative of the thickness distribution. The results show that the concave-convex characteristic of thickness distribution function has not changed, which is beneficial to the structural design. The designed blades have been manufactured and installed for operation. For the whole device, the maximum coefficient of wind energy utilization (including the loss of motor and machinery) reaches 0.42, which is 2.4% higher than 0.41 of the same kind of products.
16:05-16:20	**AM006**	Surge Margin Monitoring of One Turboshaft Engine with Inlet Distortion **Siqi Yan**, Yun Zhang, Benwei Li, Chenguang Liu Aeronautical Foundation Institute, Naval Aeronautical University, China Abstract: In order to explore the engine surge when inlet distortion index and engine surge margin, the relationship between the parameter characteristics of research engine surge, strengthen safety monitoring assessment engine, this paper designed a kind of a certain type of engine bench test surge monitoring system, and unstable flow field of a certain type of vortex axis engine working parameters for monitoring and analysis. In this paper, a plug-plate distortion generator is used to induce a surge engine, and the circumferential static pressure changes of the inlet and outlet of the engine, the axial compressor and the centrifugal compressor under different working conditions are obtained. The changes of circumferential unevenness and mean turbulence, the pressure ratio at working point and the converted air flow rate at working point are analyzed with the increase of the height of the plug-plate under different working conditions. The results show that the distortion index of the working point increases and the surge margin decreases with the increase of the height of the plug-plate at the same rotating speed. When the height of the plug-plate is

		similar, the higher the speed is, the greater the distortion index of the working point is, and the smaller the surge margin is.
16:20-16:35	**AM020**	Research on Transition State Control Strategy of Propfan Engine Based on SAC Algorithm **Jiangtao Zhou**, Yafan Wang, Zhaoxing Yang, Dongzhu Zhao Northwestern Polytechnical University, China Abstract: The engine performance search control plays a key role in the engine operation. How to find a suitable algorithm to make the control process fast and stable without exceeding various engine constraints is very important. With the continuous development of deep reinforcement learning in recent years, not only many deep reinforcement learning algorithms have emerged, but also deep reinforcement learning has made rapid development in the field of control. Considering the strong perception and decision-making ability of the deep reinforcement learning algorithm, and in order to adapt to the strong nonlinearity of the engine model and avoid falling into the local optimal value, this paper uses the SAC (Soft Actor Critical, SAC) algorithm to optimize the transition state performance. By introducing the strategy information entropy into the objective function, the search stability of the algorithm and the final optimization effect are significantly improved. Finally, the SAC algorithm is compared with the DDPG algorithm to optimize the transition state performance, and the results show that the SAC algorithm has a better optimization effect on the transition state performance.
16:35-16:50	**AM052**	Experiment Research on Instantaneous Characteristics of Variable-Thrust Hybrid Rocket Motor by Reconstruction Techniques **Tianfang Wei**, Guobiao Cai, Hui Tian, Guang Tan Beihang University, China Abstract: The firing test of variable-thrust Hybrid Rocket Motor (HRM), operated with Hydrogen Peroxide (HP) and Polyethylene (PE), based on closed-loop thrust control, has been carried out in this paper. The experiment research on instantaneous characteristics of HRM is conducted based on reconstruction techniques. A post-processing software has been developed to reconstruct the instantaneous performance parameters during the burning stage of HRM. Meanwhile, the formula of regression rate is fitted by reconstruction results through a single firing test, which is a significant advantage compared with traditional method. The averages of instantaneous parameters calculated by reconstruction techniques accord well with experimental data summarized by traditional consumption weight loss method, and the accuracy of reconstruction calculation is better than 1%. This paper is designed to achieve the reconstruction for instantaneous parameters and research the instantaneous characteristics during the variable-thrust firing test of HRM. The reconstruction techniques have the better accuracy, and also provide a critical method for the research on instantaneous characteristics of hybrid rocket motor.
16:50-17:05	**AM065**	Multivariable Steady-state Control of Variable Cycle Engine Based on LQGLTR

		Yunhui Dong, Yingqing Guo, Jiale He, Pengfei Guo, Wanli Zhao Northwestern Polytechnical University,China Abstract: In order to improve the steady-state control performance of variable cycle engine, a steady-state multivariable control method based on LQG/LTR is proposed in this paper. The working characteristics and control laws of variable cycle engine are analyzed, and the linearized model of engine design point is obtained by system identification. Based on the LQG/LTR control method and the linear model, a multivariable steady-state controller for the variable cycle engine is designed. Through simulation verification and comparison with the control performance of the three-loop univariate PI controller, it is concluded that the multivariable LQG/LTR controller has excellent disturbance suppression and command tracking ability, and has a wider application range and better control effect than PI controller.
17:05-17:20	**AM073**	Improvement Methodology of Predicting Engine Jet Noise in Engineering Application Yaoxiang Zeng, **Haoxuan Wang**, Yi Rong, Wei He Beijing Institute of Astronautical Systems Engineering, China Abstract: The typical methods for predicting rocket engine noise were comprehensively illustrated. Simultaneously including some modification, implement noise environmental prediction of any engine number, any position via programming. For instance, in a liquid rocket engine, noise field of the double engine was predicted, the results of which was compared with experimental data. We then evaluated the advantages and disadvantages of different methods and analyzed the source of the error. Finally, a methodology of predicting the jet noise was proposed, which can be applied to multiple engines. Given the high prediction accuracy on the overall acoustic pressure and the acoustic pressure spectrum, this method is of great importance in engineering application.
17:20-17:35	**AM008**	Design of Flow Controller for Aviation Electric Fuel Pump **Wenlong Zhang**, Xiao Ding, Jianghong Li AECC xi'an engine control Co.,Ltd, China Abstract: In order to meet the demand of high-precision flow control and modular design of aviation electric fuel pump control system, the flow controller is analyzed and designed from the demand of aviation engines for electric fuel pump. Tests show that the steady-state control deviation of the controller is no more than 1% for mass flow rate, and the dynamic control deviation of mass flow rate is no more than 3% in the range of 50kg/h~2000kg/h. A flow controller with high integration degree, high control accuracy and excellent dynamic characteristics for new pump-control system was designed for aero engine.

15:50-17:35 December 23		**Session 4: Control Model and Reliability Analysis in Mechanical and Electronic Systems** Room B ZOOM ID: 816 2852 8297 Zoom Link: https://us02web.zoom.us/j/81628528297
Session Chair:		
15:50-16:05	**AM090**	Influence of Cavitation State and Launch Angle on Water-Exit Process of Vehicle Based on Moving Domain Method **Jiamin Li**, Jian Zheng, Shibo Jing Nanjing University of Science and Technology, China Abstract: This paper, aiming at the water-exit process of the vehicle with cavitation, based on the moving domain method coupled with the SDOF (six degrees of freedom) solver, using VOF (volume of fluid) multiphase model and the Schnerr-Sauer cavitation model, carrying out numerical simulation research on multi-conditions. Comparing vertical launch vehicles with different water-exit Ca (cavitation number) cases, the sudden decrease in cavitation number is closely related to the cavitation state, and there is a maximum influent cavitation state of the cavitation collapse on the process of the water-exit. Comparing different initial launch angle cases, it is found that there is a most unstable launch angle, which makes the angular deflection of the vehicle the most severe during the water-exit process.
16:05-16:20	**AM001**	A Universal and Simple Method to Solve the Velocity / Acceleration of Parallel Mechanism Rui Wang, **Xiangyu Guo**, Shisheng Zhong, Yuhao Ge, Faqian Zhang Harbin Institute of Technology, China Abstract: The equivalent parameters of hexagon aluminum honeycombs are work out with the theories of sandwich plates in this paper. The honeycomb sandwich plate reinforced by ring beam applied with static load is simulated by the finite element model of honeycomb sandwich plates, which is validated by static test. The research results show that the numerical calculation error of the honeycomb sandwich plate is less than 10% compared with test results, which is acceptable for an engineering project, and the mechanical behavior of the honeycomb sandwich plate can be described in detail. Thus, the method of equivalent honeycomb parameter is proved to be effective for the design and analysis of honeycomb sandwich plates. The influence of equivalent elasticity modulus and equivalent shear modulus to honeycomb sandwich plates can be reflected exactly from the results which are figured out with the equivalent theories of sandwich plates. The assembly clearance and assembly accuracy have a significant influence to the test results of honeycomb sandwich plates, which is obvious especially at a lower load level.
16:20-16:35	**AM015**	Double Three -Phase Permanent Magnetic Motor Based on The Smallest Copper Consumption and Maximum Torque Single Phase Lack of Phase Compromise and Tolerance Error Control

		Bing Song, Yebin Cui, Xinbin Zhang, Cheng Fang, Kai Wang Shanghai Institute of Spaceflight Control Technology, China Abstract: Multi-phase machines with single-phase open still have additional degrees of freedom and flexibility, which can improve system performance while achieving disturbance-free operation. The traditional fault-tolerant control strategy either minimizes stator copper loss or maximizes torque output capacity, and cannot take into account efficiency and torque density simultaneously. To solve this problem, the fault-tolerant performance of different control modes under fault-tolerant operation is analyzed and a compromise fault-tolerant control strategy based on the minimum copper loss and the maximum torque is proposed. In order to reduce the change of the control framework pre- and post-fault, the fault-tolerant control is realized based on the normal decoupling vector control. Through analyzing the influence of the weight coefficient on the fault-tolerant performance, it can be concluded that compared with the minimum copper loss control method, the proposed fault-tolerant control strategy has stronger load capacity; compared with the maximum torque system, the proposed fault-tolerant control strategy has higher operating efficiency. That is, the proposed fault-tolerant control strategy achieves the best efficiency while improving the load capacity. Finally, the experiment on dual three-phase permanent magnet synchronous machines verifies the accuracy and effectiveness of the proposed fault-tolerant control strategy.
16:35-16:50	**AM017**	A Tracking Method for GEO Space Targets Based on Adaptive Memory Attenuation UKF **Senhao Jia**, Shaoyong Sun, Hui Fang Shanghai Aerospace Control Technology Institute, China Abstract: Aiming at the problem that the nonlinearity of the tracking state equation and the problem of strong noise in the measurement process in the process of tracking the target, a non-cooperative target tracking method in geostationary earth orbit based on adaptive memory attenuation UKF is proposed. Firstly, the relative motion model of the non-cooperative target is constructed, and the state equation and measurement equation are established. Use the memory attenuation adjustment factor to enhance the correction effect of the new measurement on the state estimation, improve the adaptability of the filtering method to nonlinearity and noise, and finally the relative motion trajectory of the space non-cooperative target is obtained. Finally, the standard EKF algorithm, standard UKF algorithm and improved UKF algorithm are applied to target tracking and compared by simulation. The deviation of the three coordinate axis components of the actual motion trajectory and the predicted trajectory of the space target is used as the evaluation index. The simulation results show that the filtering accuracy of the improved UKF algorithm is significantly improved, while taking into account the real-time performance of on-orbit tracking.
16:50-17:05	**AM022**	Research On the Association Algorithm of Space-Target Track Segments **Senhao Jia**, Shaoyong Sun, Weizhi Qu, He Jin Shanghai Aerospace Control Technology Institute, China Abstract: In order to improve the tracking continuity and stability of space targets, the track segments association algorithms are studied. The extrapolation prediction based on the CW

		motion model in the main spacecraft orbital coordinates is carried out. The model of space target is used to forecast and extrapolate the trajectory of the interrupted target. Based on the extrapolation of the terminated track, the track segments are associated by using the extrapolation results and the state update values at the first few moments of each track segment after the interruption. In this way, the association and fusion of space target interrupted tracks are completed. The results can improve the tracking accuracy of space targets and the trajectory association.
17:05-17:20	**AM041**	Sensitivity Analysis of Antenna Gain Loss to the Disturbance of Control Moment Gyroscope **Shiyu Tan**, Jingbo Gao, Cong Wang, Yingyong Shen Harbin Institute of Technology, China Abstract: The multi-body dynamic model of the SAR satellite and the Ruze formula are used to investigate the antenna gain loss's sensitivity to the control moment gyroscope. First, by using finite element method, the satellite's dynamic model is created and the modal characteristic is then determined. Then the distribution of input disturbance and CMG diagram is established. And the effect of each CMG disturbance on the antenna gain is studied. The sensitivity parameters of gain loss to disturbance are computed by using the One-at-a-Time (OAT) method. The results show that for CMGs, although they are placed asymmetrically and have the same loading characteristics, their effects on the antenna gain are different and need to be considered separately. The method and ideas proposed in this paper can be used to quantify the influence of various disturbances' sensitivity and control system design.
17:20-17:35	**AM097**	The Effect of Reflux Schemes in Hydrogen Peroxide Electric Pump on Anti-cavitation of Inducer **Xiaoming Gu**, Hui Tian, Jiangning Wang, Yudong Lu, Xianzhu Jiang, Hao Zhu School of Astronautics, Beihang University, China Abstract: Hydrogen peroxide electric pump supply system can improve the performance of hybrid rocket motor. Due to the physical and chemical properties of hydrogen peroxide, a canned pump scheme is more suitable to be used in hybrid rocket motor. The high-temperature liquid between the stator and rotor of the electric motor, returning to the inlet of the inducer, has a significant effect on the cavitation performance of the inducer. The numerical simulation results show that the optimal reflux scheme is different when the inlet pressure range of the inducer is different. When the inlet pressure of the inducer is 0.4 MPa, the performance of the inducer is less affected by the reflux schemes, and the optimal scheme is the axial scheme in the simulation. When the inlet pressure is 0.12 MPa and there is a large cavitation area in the inducer, the radial reflux scheme is better than the axial and mixed reflux. When the inlet pressure is 0.1 MPa and the cavitation areas almost extend to the whole blade passage, the radial reflux scheme is much better than the axial and mixed reflux.

10:00-11:45 December 24		**Session 5: Engine Modeling and Performance Optimization** Room A ZOOM ID: 813 2355 6830 Zoom Link: https://us02web.zoom.us/j/81323556830
Session Chair:		
10:00-10:15	**AM031**	Parameter Modelling of Fleet Gas Turbine Engines Using Gated Recurrent Neural Networks **Shuai Ma**, Yafeng Wu, Hua Zheng, Linfeng Gou Northwestern Polytechnical University, China Abstract: Oriented by the gas-path fault diagnosis of aircraft engines, this work presents a novel parameter modelling scheme for fleet gas turbine engines based on gated recurrent neural networks. Four dynamic models are constructed based on the long short-term memory (LSTM) network and gated recurrent unit (GRU) network to predict the total temperature at the high-pressure turbine outlet of gas turbine engines. We apply the dynamic networks to model the engine parameters by solving a sequence-to-feature regression problem. The proposed scheme is assessed through a comprehensive comparison study on training performance, validation performance, generalization, robustness against noise, and extrapolation performance. The results showed that the proposed network models performed a promising performance on parameter modelling. For the proposed four network models, the NARX-based models have better one-step-ahead prediction performance, while the state-space-based models have better long-term prediction performance. The discussion of the results also showed that the GRU network was an effective data-driven model for parameter modelling of gas turbine engines.
10:15-10:30	**AM088**	Three-Dimensional Numerical Study on the Interaction Between RDC and NGV **Sainan Xue**, Bo Yang, Denghang Liu, Zhenjuan Xia, Hu Ma Nanjing University of Science and Technology, China Abstract: Long-term maintenance missions present a challenge for low-orbit heterogeneous area-to-mass ratio (AMR) microsatellite constellations due to inconsistent fuel consumption and carrying capacity. Based on the idea of cooperative control, the fuel consumption of fuel-rich satellites is properly increased in this paper to assist fuel-starved satellites in saving fuel, so as to optimize the fuel consumption balance of each satellite and extend the controllable lifetime of the constellation. The evolution of the relative phase under J2 and atmospheric drag perturbation is analyzed. The target configuration and the strategy of maintenance are modeled and optimized based on the principle of fuel consumption balance. The traditional absolute phase maintenance method for heterogeneous AMR constellation is devised. On this basis, the orbit altitude is optimized with the simulated annealing algorithm to improve the fuel consumption balance. Based on the relative phase maintenance method, the maintenance strategy is optimized with the genetic algorithm to further reduce fuel and enhance the fuel consumption balance. Finally, the three methods are contrasted.

10:30-10:45	**AM018**	Transition State Performance Optimization of Propfan Engine Based on DDPG Algorithm **Hua Zheng**, Zhaoxing Yang,Yafan Wang, Dongzhu Zhao Northwestern Polytechnical University, China Abstract: As the "heart" of an aircraft, aero-engines work in harsh environments of high temperature and high pressure for a long time. In order to ensure that the engine can operate safely and reliably within the entire flight envelope, a large safety margin needs to be reserved in the design of the control system. This design idea limits the full play of the engine performance, so it is necessary to carry out the research on the performance search control (PSC) of aero-engine. This paper studies the performance optimization control of propfan engine based on deep reinforcement learning algorithm. The Deep Deterministic Policy Gradient (DDPG) algorithm, which is more suitable for continuous action space, is used to optimize the acceleration process of the propfan engine. The simulation results show that, compared with the unoptimized adjustment process, the transition state adjustment time of the engine is reduced by 32.5% under the action of the optimal adjustment law obtained by the DDPG algorithm. Therefore, the DDPG algorithm can be applied to the performance optimization of the engine acceleration process, and has a good transition state performance optimization effect.
10:45-11:00	**AM093**	Numerical Analysis of Fuel Regression Rate and Flow Field in Solid Fuel Ramjet with the Gas Generator **Xuancheng Lu**, Changsheng Zhou, Luhao Wang, Min Zhu Nanjing University of Science and Technology, China Abstract: In this paper, to improve the combustion characteristics and working performance of the solid fuel ramjet, a solid fuel ramjet with a gas generator is proposed. Based on SST and Eddy-Dissipation equations, the turbulent combustion model is established, and the internal flow field of the ramjet, as well as the regression rate, and species, were numerically analyzed. The results show that the temperature of the ramjet and the regression rate with a gas generator is increased. When the airflow is 0.4kg/s, the increase of the gas generator flow will lead to a more obvious regression rate increase, and the maximum value will increase by 33%. When the airflow is 0.6kg/s, the regression rate with the gas generator is evenly distributed along the axis. The flame with a gas generator makes the head burn more completely, the combustion chamber temperature increases, and the average regression rate of solid fuel increases by 14%.
11:00-11:15	**AM049**	Numerical Study of Nozzle Erosion in a Hybrid Rocket Motor with Wagon Wheel Fuel Grain **Xianzhu Jiang**, Hui Tian, Chengyong Diao, Ruipeng Yu, Sheng Zhao, Hao Zhu Beihang University, China Abstract: Nozzle erosion directly affects the design quality of hybrid rocket motors, and it is a key problem that restricts the engineering application of hybrid rocket motors. In this paper, coupled numerical simulations of combustion flow field and thermochemical erosion of a graphite nozzle in hybrid rocket motor with multi-port wagon wheel fuel grain are carried out. The results indicate that distributions of temperature, species and erosion rate in the flow field of hybrid rocket motor with wagon wheel grain show symmetrical

		characteristics related to the grain shape. The erosion rate decreases at first and then increases at the convergent section of throat insert, and it reaches the maximum value at the transition arc between convergent section and straight section of the throat. The maximum erosion rates at the central hole (position A) and outer edge of wheel holes (position B) are 0.0625 mm/s and 0.0902 mm/s, respectively. The erosion rate increases slowly in the straight section of the throat and it decreases gradually in the divergent section. Circumferentially inhomogeneous ablation occurs in the throat, and the erosion rate at the front end of throat straight section varies from 0.0484 mm/s to 0.0809 mm/s. The main oxidizing species causing thermochemical erosion are H2O and OH. At position A in the front end of throat straight section, erosion rates caused by H2O and OH are 66.50% and 30.48%, respectively. With the increase of oxidizer mass flow rate, the combustion chamber pressure increases linearly, and the erosion rate at position A in the front end of throat straight section gradually increases, but the growth rate decreases.
11:15-11:30	**AM083**	Mixing and Combustion Characteristics Analysis for Solid Rocket Ramjet **Xiaoyu Lei**, Lin Sun, Jiming Cheng, Desheng He, Futing Bao, Xiping Feng Northwestern Polytechnical University, China Abstract: It is of great significance to study the mixing combustion characteristics of solid rocket ramjet for better organizing the secondary combustion of the air flowing into the inlet and the combustion-rich gas, enhancing the mixing degree of the supplementary combustion chamber, and improving the combustion efficiency. In this paper, the L-W model is used as the boron particles ignition combustion model. Combined with the UDF function of fluent ,the boron particle ignition combustion program is self-programmed, the finite rate/eddy dissipation model is used as the gas combustion model, and the Realizable k-e turbulence model is used as the turbulence model. The numerical simulation was carried out under the cold flow state and the hot flow state, and the flow field distribution and parameters were obtained, and the mixing characteristics were analyzed.The error of simulation results and test results shows that that the numerical simulation results are in good agreement with the experimental results.By comparing the combustion efficiency and mixing degree, it is found that generally, When the mixing effect is not good, the combustion efficiency must be bad; When the mixing effect is good and the mixing degree is high, the combustion efficiency may be high.
11:30-11:45	**AM096**	Study on Conjugate Heat Transfer Characteristics of Flexible Structure of Solid Motor Nozzle Based on Multiple Working Conditions **Shengxiong Wang**, Yingkun Li, Jinsheng Xu Nanjing University of Science and Technology, China Abstract: In order to study the influence of the deformations of the nozzle's flexible sections on its inner wall's heat transfer, this research uses the two-dimensional axisymmetric model and the SST turbulence model to numerically analyze the tail flow field of the flexible-extendible nozzle under multiple working conditions. The flow field and the inner wall's heat transfer of the flexible sections with and without deformations are simulated and analyzed. The simulation results show that when the flexible sections are deformed, new shock waves will be generated in the tail flow field of the nozzle; the temperature and the heat flux of the first half of each flexible section decrease, while those at the end of each flexible section increase, and the deformations' effect on temperature and heat flux

		diminishes over time. The research shows that the deformations of the flexible sections will make the inner wall's heat transfer of the flexible sections uneven, and the inner wall's ablation at the end of each flexible section may be aggravated, while that of the front half may be alleviated.

10:00-11:45 December 24		**Session 6: Attitude Control and Trajectory Tracking of UAV and Helicopter** Room B ZOOM ID: 816 2852 8297 Zoom Link: https://us02web.zoom.us/j/81628528297
Session Chair:		
10:00-10:15	**AM030**	Optimal Trajectory Planning Technology for The Cooperative Flight of Unmanned Aerial Vehicles **Kai Feng**, Ying Nan Nanjing University of Aeronautics and Astronautics, China Abstract: In the face of a complex battlefield environment, a multi-dimensional dynamic planning algorithm is proposed to solve the trajectory planning problem of the cooperative flight mission process of unmanned aerial vehicles. Under the constraints of aircraft kinematics, the collision between aircraft and space-time cooperation, and under the influence of random wind field, threat area, and other interference factors, the algorithm can make the UAV group pass through the mission points as much as possible, and at the same time, smooth the track points to make the trajectory reach the optimal solution. Finally, the simulation results of the program written in C++ and MATLAB show that the algorithm can meet the global optimization, and can calculate in real-time and online. It has strong engineering application value.
10:15-10:30	**AM056**	Efficiency Analysis of Intercepting UAV Swarm by Various Air Defense Methods **Shiguang Hu**, Le Ru, Bo Lu, Wenfei Wang Air Force Engineering University, China Abstract: In order to accurately intercept incoming swarm targets and improve interception efficiency, the interception efficiency of various air defense equipment was studied. The paper introduces the current ways to deal with the UAV swarm, and establishes the mathematical model of different types of interception equipment ; Under the premise of given interception probability, the time and cost of different interception methods are calculated respectively, and the weight distribution is used to analyze the interception efficiency of different weapons. According to the analysis process and results, the interception effectiveness of different weapons is sorted. The analysis results show that the analysis has certain practicability, which can support the development and application of air defense interception weapons and equipment to a certain extent, and has practical reference value and significance.
10:30-10:45	**AM034**	Adaptive Attitude Control of UAV Based on Neural Network Compensation **Yihang Li**, Zhongkui Lei, Yueru Guo, Kuiyu Chen, Jie Jin, Yixin Yang Nanjing University of Aeronautics and Astronautics, China Abstract: Aiming at the problem of unmanned aerial vehicle (UAV) attitude control with insufficient robustness and anti-disturbance, this paper proposes a UAV attitude control

		method combining incremental nonlinear dynamic inverse (INDI) and neural network (NN) adaptive compensation. Firstly, the attitude model of UAV with time scale separation is proposed. On this basis, the INDI control law is derived, and the angular acceleration information required by INDI method is feedback by the filter. Then, the adaptive NN compensation structure is introduced to eliminate the uncertainty caused by model mismatch, sensor delay and external disturbance. Finally, the UAV simulation is carried out. The result shows that this method improves robustness and anti-disturbance of original INDI method without changing structure and parameters of controller, and has a certain adaptive compensation ability for system uncertainty.
10:45-11:00	**AM023**	A SysML-centric Integration Framework for Helicopter Fuel System Development **Hui Zhao**, Wenke Wu, Xueming Hu, Yuqiang Guo, C Zhang, Guangxin Hao China Helicopter Research and Development Institute, China Abstract: Data and model exchange between SysML (Systems Modeling Language) Modeling tools and other system development tools is a critical aspect of Model-Based Systems Engineering (MBSE). This paper introduces an application of the SysML-centric integration framework, which allows integrating multi-disciplinary engineering models into a SysML Modeling environment. A design practice of helicopter fuel system is then presented to illustrate how to combine the external simulation models within the SysML Models to explore the performance and verify corresponding requirements. In this case, FMI (Functional Mock-up Interface) based co-simulation creates a bridge between SysML Modeling tools and simulation tools in the SysML-centric integration framework. According to the practice, we believe it will significantly improve model consistency and traceability to provide early evaluation of concepts during conceptual design phase.
11:00-11:15	**AM050**	Research On Modelling Analysis and Design Method of Helicopter Operation Requirements Based on MBSE **Lei Sun**, Fu Gao, Lingqin Li, Benchao Lou Institute of Army Aviation, China Abstract: Helicopters are characterized by complex missions, high risk, high cost, high reliability and long lead times. In order to adapt to the more complex operational requirements in the future, the thesis addresses the problems of long iterative cycles, low efficiency and model duality in the traditional helicopter operation requirements analysis process, the theory of model-based systems engineering (MBSE) is introduced into operation requirements analysis for helicopter. A modelling analysis and design method for helicopter operation requirements analysis is proposed based on MBSE. The overall framework for helicopter operation requirements analysis based on the model is designed. On this basis, a modelling design method and key implementation process of requirements analysis is established, which provides theoretical and technical support for the positive design of helicopter operation requirements demonstration.
11:15-11:30	**AM028**	Trajectory Tracking Control for Unmanned Helicopter Based on RBFNN **Yueru Guo**, Zhongkui Lei, Yihang Li, Kuiyu Chen Nanjing University of Aeronautics and Astronautics, China

		Abstract: This paper proposes a nonlinear adaptive radial basis function neural network (RBFNN) control method for Unmanned Helicopter. The control objective is to reduce the trajectory tracking error of the unmanned helicopter in the presence of system uncertainty and external disturbances. Based on the backstepping control technique, the controller of the unmanned helicopter are designed in order of position kinematics, position dynamics, attitude kinematics and attitude dynamics, and the block processing is used in the last three steps above. Then, RBFNN is added to compensate the error caused by external interference. Meanwhile, the derivatives of virtual controls are obtained by second-order command filter, and the stability of the system is analyzed by Lyapunov stability theorems. Finally, the simulation results verify the stability and robustness of the control method.
11:30-11:45	**AM095**	Attitude Control of a Moving Mass-Actuated Fixed-Wing UAV Based on LADRC **Jingzhong Zheng**, Maria Sergeevna Selezneva, Jianfeng Yi, Liangliang Zhu Bauman Moscow State Technical University, Russia Abstract: This paper concerns attitude control of a moving mass-actuated fixed-wing unmanned aerial vehicle (MFUAV). Unlike conventional roll motion of UAV, which is controlled by ailerons, this MFUAV uses the movement of mass block inside the wing to generate roll moment. It is difficult to design a suitable attitude controller for it due to the strong non-linearity and coupling of the MFUAV dynamics. Linear active disturbance rejection control (LADRC) proved to be a simple and effective alternative to conventional PID control. LADRC is able to eliminate disturbances with the help of extended state observer (ESO) and does not depend on the accurate mathematical models of particular systems. Finally, simulation results are given to illustrate that the attitude tracking control of MFUAV is well achieved and the disturbances are estimated and compensated with robustness. This shows that the designed method is easy to adapt and implement during the actual flight of the MFUAV.

13:30-15:30 December 24		**Session 7: Mechanical Vibration Analysis and Fluid Mechanics** Room A ZOOM ID: 813 2355 6830 Zoom Link: https://us02web.zoom.us/j/81323556830
Session Chair:		
13:30-13:45	**AM003**	Parameter Sensitivity Analysis under Failure Condition of Lifting Device Mechanism Yunwen Feng, **Zhiyu He**, Shuai Li, Xiaofeng Xue, Mingyue Cao Northwestern Polytechnical University School of Aeronautics, China Abstract: The sensitivity of each influencing parameter in the selected range of the complex multi-hinge space flap mechanism under typical fault conditions is studied, and the influence degree of each parameter and its dispersion on the driving torque of the mechanism is determined. Firstly, the rigid-flexible coupling dynamic model of the mechanism is established considering the flap deformation, and then the influence of four parameters that may cause mechanism failures, such as hinge friction, aerodynamic load, driving speed and assembly error, on the driving torque of the mechanism is explored. Then, the drive torque of the mechanism under each parameter value is given, finally, the sensitivity of each selected parameter is obtained by the direct de rivation method. The results show that the parameters are positively correlated with the driving torque, the aerodynamic load coefficient and hinge friction parameters are the most sensitive to the driving performance of the mechanism, while the driving speed is the smallest. After the aerodynamic load increased by 30%, the maximum driving torque of the inner mechanism increased by 28.8%; when the hinge friction parameter was in the range of 0~0.05, the maximum torque of the inner and outer mechanisms increased by 8.6% and 8.4% respectively. In engineering applications, the lubrication of each spherical hinge should be increased, the driving speed should be reduced, and the manufacturing and assembly accuracy should be improved.To a certain extent, it can prevent failures and improve the reliability of the flap mechanism.
13:45-14:00	**AM032**	Review on Vibration Test and Fault Analysis of RV Reducer Liang Xuan, **Wenxiong Hong**, Zefu Wan, Zhuang Lin Jianghan University, China Abstract: As the core component of industrial robots RV reducer, its health determines the life and accuracy of the robot. And it has become the main reason for restricting the long-term stable operation of industrial robots. In this paper, the advantages and disadvantages of various technologies are analyzed and compared from three aspects: state detection, signal processing, and fault diagnosis. Then it points out the problems that need to be further studied to develop real- time online assessment and prediction technology. Deep data mining and exploring new methods for condition monitoring of RV Reducer will be the research difficulties in this field. It provides a reference for further research in the field of RV Reducer.
14:00-14:15	**AM103**	Fault Detection and Isolation of Electromechanical Actuator based on SAE-BiLSTM

		Xinxin Tao, Yingqing Guo, Wanli Zhao, Qifan Zhou, Kejie Xu Northwestern Polytechnical University, China Abstract: The control technology of electromechanical actuator(EMA) and its fault diagnosis is one of the key problems of multi-electric aircraft study. The method based on deep learning is used to diagnose and isolate the classic faults of EMA. The simulation model of EMA is modeling according to the working principle and control law. Four typical faults of EMA are studied,including return channel jam, spall, motor fault, and position sensor fault. Sparse Auto Encoder (SAE) algorithm can perform adaptive extraction of sensor data, which preserves dimensionality reduction and compression while preserving important features. Bidirectional Long Short Term Memory (BiLSTM) neural network is used to effectively process the time series data, which considering both past and future data during the fault diagnosis process. The established EMA model is simulated to obtain normal and faulty data sets, which are used to train the network by SAE-BiLSTM algorithm, and then the trained network is used for online fault diagnosis. After the experiment, SAE-BiLSTM algorithm can well complete the EMA fault detection and isolation.
14:15-14:30	**AM048**	Study of Dynamic Load Identification Under Unknown Initial Conditions **Shuang Chen**, Jinhui Jiang Nanjing University of Aeronautics and Astronautics, China Abstract: Dynamic load identification belongs to the second inverse problem of structural dynamics, i.e. the inversion of the load history in the real state by collecting the measured data of structural vibration. Some traditional dynamic load identification methods do not consider the initial conditions, i.e. the initial conditions of the structure are assumed to be zero, however, the structure is not always at rest during the process of collecting the vibration response, which leads to a large error between the identified force and the actual force using traditional methods. Since the measurement of initial conditions is very difficult, in order to solve the influence brought by the initial conditions to the dynamic load identification process, this paper proposes a method based on sparse regularization to identify the load history under unknown initial conditions. Firstly, the unknown force is represented using basis functions, and the vibration response of the structure is divided into two parts: forced vibration caused by the force and free vibration under the initial conditions, and finally sparse regularization is used to solve the ill-conditioned equation. The experimental and simulation results also further verify the applicability and robustness of the method proposed in this paper in dealing with the load identification problem under unknown initial conditions.
14:30-14:45	**AM053**	Regulating Generation of Multiple Emulsion Through Double Parallel-Crank Mechanism **Meng Wang**, Li Zhu, Chuanwen Zhang Nanjing University of Science and Technology, China Abstract: A method was proposed for preparing multiple emulsions based on a double parallel-crank mechanism. The dispersed phase flows into the glass capillary, and the glass capillary was driven to make a circular motion via connecting the crank structure. Then, the external phase shears the dispersed phase through the double parallel-crank mechanism to prepare water in oil (W/O) droplets, and the process of generation of droplets was

		simulated by CFD. The effects of rotating speed, capillary diameter, external flow rate, and external viscosity on droplet formation were investigated. The size and generation frequency of the droplets was controlled by the rotational speed. More importantly, Single or multicore droplets were generated by the rotation droplet generator, and the effects of rotational speed on the number of cores and droplet size were investigated. Finally, the multi-component microgels were produced by the pre-crosslinking method. This study provides a rotation droplet generation system that has the ability to generate various droplets, expanding the practicability and versatility of the rotation droplet generator, and providing a new platform for multiple emulsion preparations.
14:45-15:00	**AM072**	Dynamic Simulation of Nozzle Structure Based on Thermal-Fluid-solid Coupling Analysis **Jiahui Yuan**, Ke Wang, Xiucong Gu Nanjing University of Aeronautics and Astronautics, China Abstract: Many engineering structures are subjected to the combined action of thermal field, flow field and vibration load during use. The mechanical analysis of this kind of structure has important theoretical significance and engineering practical value. However, due to the complexity of multi-field coupling, it is difficult to analyze dynamic response and dynamic strength. A method to simplify the thermal-fluid-solid coupling model for specific engineering issues was proposed aiming at modeling the actual situation in which the high temperature field of the engine nozzle structure is relatively stable. Heated grid reconstruction, thermal modal analysis technology, and fluid-structure coupling response calculation method based on modal superposition were taken to obtain the load distribution and dynamic response level of the engine nozzle structure under the condition of thermal-fluid-solid coupling, which created conditions for structural dynamic strength evaluation including the prediction of vibration fatigue life. The test structure of an engine nozzle was taken as an example to perform dynamic response calculation and fatigue life prediction under thermal fluid-solid coupling conditions. Then the location of weak parts of the structure was identified, and effective suggestions for design improvement was put forward. Compared with the actual test results, the feasibility and accuracy of the method are preliminarily verified.
15:00-15:15	**AM057**	Effect of Flow Distribution on Shock Vector Nozzle Vector Performance **Bowen Shu**, Jiangtao Huang, Zhenghong Gao, Chengjun He Northwestern Polytechnical University, China Abstract: For the dual-slot jet controlled two-dimensional shock vector nozzle, the effect of flow distribution on the vector performance of the nozzle is studied by RANS method, in which the total flow rate is unchanged. The results show that the flow distribution has no effect on the thrust coefficient. Increasing the downstream jet flow and reducing the upstream jet flow helps to improve the vector angle and vector efficiency, and the effect is obvious when there is separation and re-attachment between the two jets. Increasing the upstream jet flow and reducing the downstream jet flow will reduce the vector angle. The effect is not noticeable when the separation zone between the two jets is stable and no re-attachment. Maintaining a stable separation zone between dual-slot jet without re-attachment helps improve the vector performance of SVC nozzles. The dual-slot jet flow distribution should aim to eliminate reattachment of separation between jets.

15:15-15:30	**AM091**	Influence of Panel Oscillation on Shock Flow Field in Isolation Section Under Complex Background Wave System **Tiexiang Wang**, Yingkun Li, Min Zhu, Changsheng Zhou Nanjing University of Science and Technology, China Abstract: In this paper, a self-developed solver is used to numerically simulate the isolator section under complex inlet conditions, and the influence of forced panel vibration on the shock flow field in the isolator under complex inlet conditions is investigated. The results show that the forced vibration of the panel has a certain influence on the shock flow field in the isolator under complex inlet conditions.

13:30-15:30 December 24		**Session 8: Space Propulsion System and Reliability Analysis** Room B ZOOM ID: 816 2852 8297 Zoom Link: https://us02web.zoom.us/j/81628528297
Session Chair:		
13:30-13:45	**AM061**	Numerical Analysis of Separation Dynamics for Space Debris Removal Payload Based on Solid Thruster **Xiaoyu Tao**, Haibo Yang, Hanyu Deng, Hao Zhou Nanjing University of Science and Technology, China Abstract: Aiming at the current mainstream flying anchor payload for space debris removal, a solid thruster was proposed as the separation driving force, and a complete dynamic model of the spacecraft platform and payload were established. The effects of the gap between the directional button and the directional tube, thrust eccentricity and the initial attitude of the platform on the target accuracy under the flying anchor payload were studied. The analysis results showed that the initial attitude of the platform was the main factor affecting the target accuracy of the flying anchor payload. The control gap between 0.1mm ~ 0.25mm can effectively reduce the displacement of payload separation and the influence of disturbance on the platform.
13:45-14:00	**AM035**	Numerical Simulation of The Effect of Different Impeller Structural Parameters on the Lift and Thrust of a New Impeller Thruster **Hang Chen**, Xiaoyi Wang, Sheng Wang,Zixiong Wang, Zhizheng Qiu Anhui University of Technology, China Abstract: The Half-Rotating impeller thruster(HRIT) based on the Half-Rotating Mechanism is a new type of impeller thruster . Its impeller motion principle is different from the fixed impeller of the ordinary impeller thruster. In order to obtain better aerodynamic force in working, it is necessary to explore the HRIT in different structural parameters.The influence of the radius of the rotating arm ,the width of the blade is calculated and analyzed in detail by numerical calculation method.The calculation results show that the radius of the rotating arm is the main factor affecting the lift and thrust of the HRIT.The aerodynamic characteristics of the thruster under different blade widths are also different.The aerodynamic characteristics of the thruster under different blade widths are also different, the lift reaches its peak value when blade widths d=30mm, and the thrust reaches its peak value when d=35mm;The blade lengths also has a great influence on the aerodynamic force of the thruster, and the lift and thrust both increase with the increase of blade lengths.At the same time, compared with the fixed impeller thruster, the HRIT has relatively balanced aerodynamic performance.
14:00-14:15	**AM084**	Transient Study on Filling Characteristics of LOX Dome Jiabao Xu, Yan Wu, **Qingcheng Zhu**, Ping Jin, Jue Wang, Guobiao Cai Beijing University of Aeronautics and Astronautics, China

		Abstract: The 3D flow filling process of LOX (Liquid Oxygen) dome is studied in a liquid oxygen/methane rocket engine. The volume, flow field pressure and velocity distributions of liquid oxygen at different time are determined. The flow property of propellant and the injection characteristic time of liquid oxygen are obtained. The results show that when the LOX dome has not been filled, the LOX flow state is disorder, and flows around the annular wall in the middle dome. The static pressure near the equalizing orifice near the liquid oxygen inlet is high and the velocity is slow. When the LOX filling is completed, the pressure at the outlet of each equalizing orifice is the same. The liquid oxygen flow is in a stable state, and the flow rate decreases. The overall velocity distribution is more uniform. In addition, in the filling process of LOX dome, the time of arrival in each area is different. There are different injection delays in each area on the injection panel, and the time of arrival of liquid oxygen in the opposite area of the inlet section of LOX dome is the latest. This result leads to the inhomogeneity of injection characteristic time and flow rate in thrust chamber.
14:15-14:30	**AM036**	Dynamics Research and Analysis of Landing on The Surface of Asteroid **Danhe Chen**, Chuangyi Li, Wenhe Liao Nanjing University of Science and Technology, China Abstract: Asteroid detection has been the main research field of deep space exploration, and even in the future years. Countries have carried out missions to flyby and landing on the surface of asteroids, the sampling can help humans explore the origins of small bodies, as well as the origin of the solar system. While the particular environmental factors such as small size and low gravity of asteroids make the landing more difficult, this paper designs a four-legged inverted triangle soft lander, supplemented by thrust reversers and rope anchors for stable landing. The mathematical model of the lander landing on the surface of the asteroid is established, the motion and dynamic response of the lander in different landing modes is studied, and the safe landing range of the lander is defined. Results of the analysis have demonstrated the effectiveness of dynamic model for the proposed lander.
14:30-14:45	**AM080**	Finite Element Dynamic Modeling and Attitude Control for a Slender Flexible Spacecraft **Wenke Huang**, Linfeng Li, Wenye Dong, Liwen He, Taoming Feng, Jun Xiao Sichuan Institute of Aerospace Electronic Equipment, China Abstract: This paper aims to study the dynamic modeling and attitude control of a kind of slender flexible spacecraft. The basic structure of this kind of spacecraft is different from the traditional structure of a center rigid body with flexible appendages, but rigid bodies at both ends, which are connected by a flexible truss structure. Firstly, the finite element modeling method is adopted to establish the dynamic model of this kind of spacecraft, and the vibration frequency and damping of the flexible structure are obtained. The unconstrained modes of the flexible spacecraft are obtained through mathematical analysis, finite element analysis and frequency domain analysis. In addition, a nonlinear sliding surface with angular velocity constraint is designed. On this basis, an adaptive sliding mode (ASM) controller is proposed, stability of the close-loop system under the controller is proved, and the dynamic model is verified through mathematical simulation.
14:45-15:00	**AM010**	Comprehensive Evaluation of the Climatic Environment Adaptability on the Civil Typical System in the Alpine Environment

		Binwen Wang, **Hui Zhang**, Jingtao Wu, Peiqiang Tian, Yanggang Tang Aircraft Strength Research Institute of China, China Abstract: The function and performance of the aviation equipment are greatly affected by the alpine climate conditions. Combine with the test data obtained from the extreme climatic environment test, the fuzzy comprehensive evaluation method can effectively evaluate the adaptability of the civil avionics system on the plateau alpine environment. By analyzing the influencing factors of the alpine environment on the civil avionics system, the evaluation index system was established; and the fuzzy comprehensive evaluation method was used to obtain the adaptability evaluation value of the civil avionics system on the alpine environment. The evaluation results of the climatic environment adaptability can provide technical support for the improvement design of the civil aircraft system.
15:00-15:15	**AM098**	Prediction Model of GEO Spacecraft Position After Maneuver Based on Bayesian Network **Xi Long**, Leping Yang, Siya Chen, Song Xu National University of Defense Technology, China Abstract: Predicting the position of Geosynchronous (GEO) spacecraft under maneuver is a crucial work for space domain awareness (SDA) as it can help to improve the flexibility and operational efficiency of space surveillance network (SSN). The longitude is a unique freely assigned parameter for GEO spacecraft, in this paper, a predictive model of GEO spacecraft longitude based on causal Bayesian network is proposed. Firstly, the causal parameters of longitude is found by Gaussian perturbation equation. Secondly, the Markov order of the causal parameters is obtained by transfer entropy. Finally, the linear expressions for Gaussian functions is proved and a causal Bayesian network (CBN) prediction model for longitude is constructed. After experimental analysis, the mean absolute error (MAE) and mean square error (MSE) of the proposed method are decreased by 71.88% and 72.18%, respectively compared with the traditional Long short-term memory (LSTM) method.
15:15-15:30	**AM081**	A Multi-Segment Multi-Pulse Maneuver Control Method for Micro Satellite **Gen Xu**, Nengwei Zeng, Danhe Chen Nanjing University of Science and Technology, China Abstract: Aiming at the constraint due to micro satellite orbital maneuverability and relative navigation, a multi-segment multi-pulse maneuver control method is proposed for approaching a target satellite. Convert the along-track approaching trajectory into an impulsive control problem with fixed time and fixed distance. With time and distance from origin to destination as the optimization objectives, the time-distance optimal solution set is generated under the delta-v constraint and trajectory constraint. The planning function is obtained by fitting a segmented polynomial to the optimal solution set. In the approach mission, the maneuver time to reach the expected terminal is determined based on the planning function, and the approaching to the terminal is accomplished using fixed-time multi-pulse control. Based on the simulation scenario, a multi-segment maneuvering strategy is obtained according to the optimization result, and the mission simulation is completed using the three-pulse control. The results show that the proposed multi-segment

		multi-pulse maneuver control method can reliably complete the approach mission under the constraints.

15:50-17:50 December 24		**Session 9: Aerospace Engineering and Safety Management** Room A ZOOM ID: 813 2355 6830 Zoom Link: https://us02web.zoom.us/j/81323556830
Session Chair: **Vsevolod V. Koryanov,** Bauman Moscow State Technical University, Russia		
15:50-16:05	**AM067**	Experimental Research on Effect of Zonal Heating Airfoil About Boundary Layer Flow and Heat Transfer **Meijuan Dong**, Weimin Sang, Guangjun Yang, Feng Jiang Northwestern Ploytechinical University, China Abstract: The anti-icing of aircraft and large wind turbines, where the wall temperature is higher than the fluid temperature, can significantly alter the flow evolution characteristics of the boundary layer. Local heating strategies for the manifold state need to be designed based on the changing characteristics of the flow velocity and temperature field in order to precisely control the heat supply and reduce inefficient energy consumption. In order to obtain accurate heat transfer characteristics of the airfoil's boundary layer flow, it is necessary to refine the measurement of the boundary layer characteristics during flow and heat transfer. In this paper, wind tunnel experiments are carried out on the NACA2412 model with full surface's zonal electric heating. The wall surface is equipped with a built-in heater and the temperature of the wall surface is obtained through the corresponding temperature sensor. By studying layer characteristics of the four heated regions, namely the laminar flow region near leading edge, the laminar flow destabilisation region, the transition region and the fully turbulent flow region, and comparing them with the boundary layer characteristics of the unheated airfoil, the effects of the presence of heat sources in different regions on the stability of the flow field and the spatial heat transfer pattern are revealed. The results show that heating in the laminar and turbulent zones maintains the stability of the flow field to a greater extent and achieves better heat transfer strength, while heating in the unstable zone brings forward the turbulence and heating in the fully turbulent zone intensifies the flow separation at the trailing edge of the airfoil. This study can be used as a reference for the design of efficient anti-icing systems on full wing surfaces.
16:05-16:20	**AM094**	Integrated Flutter Test of Horizontal Tail Model in the Large-Scale Continuous Transonic Wind Tunnel Jiangxu Han, Nan Liu, **Yanxin Huang**, Ximing Yang, Song Wang AVIC Aerodynamic Research Institute, China Abstract: This study presents integrated test techniques for the transonic flutter analysis of horizontal tails in the continuous wind tunnel. The long operational time, wide dynamic pressure bandwidth, continuously varying capability, and stable flow field characteristics make the continuous wind tunnel capture the "transonic dip" behavior to a much better extent. These techniques include non-contact optical measurements, rapid real-time flutter boundary predictions, and a safety protection system. This study also introduces a flutter test of a horizontal tail model in the large-scale wind tunnel (FL-62) to demonstrate the feasibility and accuracy of these techniques. For Mach numbers ranging between 0.65 and

		0.9, the dynamic pressure is varied step by step, and the dip is accurately captured around 0.88 Mach number.
16:20-16:35	**AM063**	Thermal Design and Analysis of JZJ-5 CubeSat **Yudong Zhou**, Xiang Zhang, Chang Xu, Xudong Yang Nanjing University of Science and Technology, China Abstract: JZJ-5 is a 3U commercial CubeSat contracted by Nanjing University of Science and Technology. This paper first introduces the thermal control design of the CubeSat, then calculates the temperature field in the high and low temperature conditions by using the finite element method, and finally compares the measured temperature data in orbit with the thermal simulation data. The data results show that the temperature state of the CubeSat in orbit meets the requirements of thermal design, and the thermal control design scheme and simulation model are reasonable.
16:35-16:50	**AM007**	Research on the Properties of Missile Dynamic Attack Zone **Xin Wang**, Ying Nan Nanjing University of Aeronautics and Astronautics, China Abstract: For different types of penetration targets, based on penetration interception model of missile and target, Influence of wind field on trajectory and hit results is demonstrated. On this basis, considering influence of target maneuver and random wind field, a translation numerical algorithm with high accuracy and real-time calculation is proposed. The dynamic attack zone of missile is numerically simulated and its properties are studied, The simulation results show that, in general, after a period of time, the range of the missile's dynamic attack zone will be affected by the random wind field and change of the enemy and our situation. For traditional attack zone which can only reflect enemy and our situation before firing, and has poor real-time and accuracy, the dynamic attack zone algorithm proposed in this paper have better adaptability to the air combat environment with rapid change of battlefield situation in future.
16:50-17:05	**AM033**	Research Hotspots, Frontiers, and Topics of Aviation Safety Based on Citespace **Lu Chen**, Jihui Xu, Wenjie Tian Air Force Engineering University, China Abstract: There have been more and more studies on aviation safety in the past decade, but studies from a systematical angle are few. 6353 related literature were selected from the WOS from 2012 to 2021 in this study, and visual analysis software CiteSpace was used. Quantitative analysis methods, such as co-occurrence, clustering, and time evolution, were adapted to conduct multi-dimensional analysis on keywords, burst words, and co-cited literature, to characterize research hotspots, frontier trends, and themes of aviation safety. Research shows that global research on aviation safety is steadily increasing. Currently, the main research frontiers are computer vision, machine learning, atmospheric modeling, task analysis, and mathematical model, and the important research topics are UAV, deep learning, and accident analysis. UAV and deep learning are the primary research object and research method respectively. This systematic review is expected to provide a reference for relevant researchers to understand the development trend of aviation safety.

17:05-17:20	**AM059**	Design and Analysis of Direct Abort Trajectory for a Crewed Lunar Mission Based on the Quasi-Lambert Problem Tianshan Dong, **Hailiao Wang**, Qinqin Luo, Chao Han Beihang University, China Abstract: A direct design method for direct abort trajectory based on the quasi-lambert problem is proposed. The re-entry constraint is analytically addressed via a quasi-lambert problem instead of variables iteration and optimization method in the past. Then a new parameter is introduced to determine the plane. The exact solution is determined by differential correction based on the initial solution. Numerical simulation is carried out to test the validity and efficiency of the method. The comparison with STK verifies its reliability. Additionally, the characteristics of direct abort trajectory and their application in the option strategy for different abort ways are studied. The flight time and abort point affect the abort trajectories' velocity increment and the latitude of the landing area.
17:20-17:35	**AM064**	Thermal Control System Design and Analysis for a Micro-Nano Satellite Stays on Target Satellite **Zhezheng Chen**, Haibo Yang, Yongjun Yu, Songlin Yang Nanjing University of Science and Technology, China Abstract: Aiming at the future satellites on-orbit service requirements, this paper researched the thermal control system for a micro-nano satellite. The micro-nano satellite can be attached on target satellite. The extreme temperature conditions of the micro-nano satellite has been determined by analyzing the complex space heat environment and power consumption, the thermal control system of micro-nano satellite has been designed, the finite element model (FEM) of the satellite is established, and the temperature fields about the extreme temperature conditions are calculated. The simulation results proves the feasibility of the thermal control system.
17:35-17:50	**AM087**	Optimized Relative Phase Maintenance for Heterogeneous Area-to-mass Ratio Microsatellite Constellations **Siyang Liu**, Tao Meng, Zhonghe Jin Micro-satellite Research Center of Zhejiang University, China Abstract: Long-term maintenance missions present a challenge for low-orbit heterogeneous area-to-mass ratio (AMR) microsatellite constellations due to inconsistent fuel consumption and carrying capacity. Based on the idea of cooperative control, the fuel consumption of fuel-rich satellites is properly increased in this paper to assist fuel-starved satellites in saving fuel, so as to optimize the fuel consumption balance of each satellite and extend the controllable lifetime of the constellation. The evolution of the relative phase under J2 and atmospheric drag perturbation is analyzed. The target configuration and the strategy of maintenance are modeled and optimized based on the principle of fuel consumption balance. The traditional absolute phase maintenance method for heterogeneous AMR constellation is devised. On this basis, the orbit altitude is optimized with the simulated annealing algorithm to improve the fuel consumption balance. Based on the relative phase maintenance method, the maintenance strategy is optimized with the

		genetic algorithm to further reduce fuel and enhance the fuel consumption balance. Finally, the three methods are contrasted.